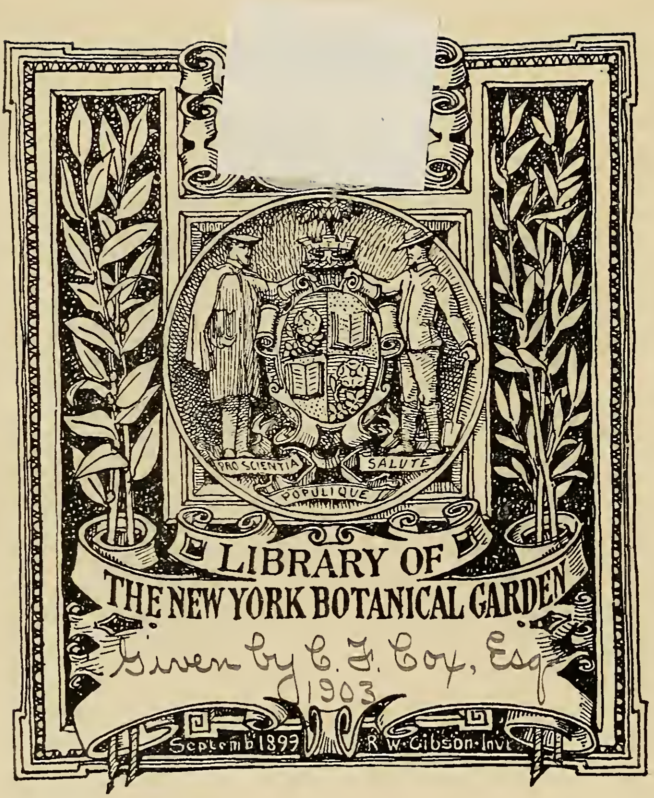
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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

FRANK CRISP, LL.B., B.A.,

One of the Secretaries of the Society
and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S.,
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AND

J. ARTHUR THOMSON, M.A.,
Lecturer on Zoology in the School of Medicine, Edinburgh,

FELLOWS OF THE SOCIETY.

FOR THE YEAR

1889.

Part 1.

PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

THE

Royal Microscopical Society.

(Established in 1839. Incorporated by Royal Charter in 1866.)

The Society was established for the promotion of Microscopical and Biological Science by the communication, discussion and publication of observations and discoveries relating to (1) improvements in the construction and mode of application of the Microscope, or (2) Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows, without distinction of sex.

Ordinary Fellows are elected on a Certificate of Recommendation, signed by three Ordinary Fellows, setting forth the names, residence, and description of the Candidate, of whom the first proposer must have personal knowledge. The Certificate is read at two General Meetings, and the Candidate balloted for at the second Meeting.

The Admission Fee is £2 2s., and the Annual Subscription £2 2s., payable on election, and subsequently in advance on 1st January annually, but future payments may be compounded for at any time for £31 10s. Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows permanently residing abroad, are exempt from one-fourth of the annual subscription.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of five Ordinary Fellows and the approval of the Council.

Ex-officio Fellows (limited to 100) consisting of the Presidents for the time being of any Societies having objects in whole or in part similar to those of the Society, are elected on the recommendation of ten Ordinary Fellows, and the approval of the Council.

The Council, in whom the management of the property and affairs of the Society is vested, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Ordinary Fellows.

The Meetings are held on the second Wednesday in each month from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

In each Session two additional evenings are devoted to the exhibition of Instruments, Apparatus, and Objects of novelty or interest relating to the Microscope or the subjects of Microscopical Research.

The Journal, containing the Transactions and Proceedings of the Society, and a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, &c., is published bi-monthly, and is forwarded post-free to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows daily (except Saturdays) from 10 A.M. to 5 P.M., and on Wednesdays from 6 to 9 P.M. also. It is closed for four weeks during August and September.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.

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*Thomas Bell, F.R.S.	1844–5
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* Members of the Publication Committee.

It is with the greatest regret that I find myself obliged to relinquish the Editorship of this Journal, after having been associated with it for more than eleven years.

My interest in the Journal and the subjects which it was founded to promote, remains as great as it was in 1878, but other duties have now absorbed the hours of the night which were formerly reserved for the Journal, and have left me no time for even a limited amount of supervision.

Whilst I shall no longer have any official connection with the Journal, I shall still, I hope, be able to watch over its interests, and I have every confidence that under the care of my former colleagues in the Editorship it will maintain the reputation it has obtained, and will continue to be recognized as an indispensable guide to the ever-increasing mass of periodical literature relating to Biology and Microscopy.

FRANK CRISP.

December 1889.

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γ. Brachiopoda.

Arthropoda.

a. Insecta.

β. Myriopoda.

γ. Prototracheata.

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(2) Nutrition and Growth (including Movements of Fluids).

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Characeæ.

Algæ.

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Mycetozoa.

Protophyta.

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β. Schizomycetes.

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(3) Illuminating and other Apparatus.

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(6) Miscellaneous.

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(2) Preparing Objects.

(3) Cutting, including Imbedding and Microtomes.

(4) Staining and Injecting.

(5) Mounting, including Slides, Preservative Fluids, &c.

(6) Miscellaneous.

Royal Microscopical Society.

LIST OF FELLOWS.

ORDINARY FELLOWS.

* *Fellows who have compounded for their Annual Subscriptions.*

Elected.

1888 Abel, William Jenkinson, B.A.
Burford Road, Nottingham.

1866 *Abercrombie, John, M.D. (Cantab.), F.R.C.P.
23, *Upper Wimpole-street, W.*

1885 Aberdein, Robert, M.D.
Syracuse, N.Y., U.S.A.

1872 Abraham, Phineas, M.A., B.Sc., F.R.C.S.I.
University Club, Dublin.

1871 Ackland, William, L.S.A.
416, *Strand, W.C.*

1886 Alabone, Edwin William.
11, *Highbury-quadrant, N.*

1884 Alling, Charles Edgar.
5, *Rundel Park, Rochester, N.Y., U.S.A.*

1869 *Ames, George Acland.
Union Club, Trafalgar-square, W.C.

1870 Anthony, John, M.D. (Cantab.), F.R.C.P.L.
6, *Greenfield-crescent, Edgbaston, Birmingham.*

1871 Armstrong, Thomas.
Brookfield, Urmston, Manchester.

1883 Atwood, H. F.
German Insurance Company, Rochester, N.Y., U.S.A.

1883 Aylward, Henry Prior.
15, *Cotham-street, Strangeways, Manchester.*

1874 Badcock, John.
270, *Victoria Park-road, E.*

1888 Bage, Edward.
Cranford, Fulton-street, St. Kilda, Melbourne.

1887 Bailey, Rev. George.
The Manse, Finchingfield, Essex.

1863 Baker, Charles.
244, *High Holborn, W.C.*

1885 Baker, Frederick Henry.
100, *Bridge-road, Richmond, Victoria.*

1882 Bale, William Mountier.
H.M. Customs, Melbourne, Victoria.

1882 Balem, Abraham D.
Plainfield, New Jersey, U.S.A.

Elected.	
1882	Ball, Joseph. *South Hill, Guildford, Surrey.*
1887	Ball, William. 61, *Bourke-street East, Melbourne, Victoria.*
1888	Ballard, Rev. Frank, M.A., F.C.S. *Crosby, Liverpool.*
1885	Ballard, John Farrow. *Somerby Villa, Norfolk Park, Maidenhead.*
1867	Bannister, Richard. *Laboratory, Inland Revenue, Somerset House, W.C.*
1867	*Barker, Samuel, M.D., L.R.C.P. Edin. M.R.C.S., F.R. Met. S., &c. 24, *Eaton-place, Brighton.*
1881	Barrow, John. *Beechfield, Folly-lane, Swinton, near Manchester.*
1883	Bastin, E. S. 3330, *South-park Avenue, Chicago, Ill., U.S.A.*
1874	Bate, George Paddock, M.D., F.R.C.S.E. 2, *Northumberland Houses, King Edward's-rd., Hackney, E.*
1889	Bateman, Rev. B. Jones. *Sheldon Rectory, near Birmingham, and Pentre Mawr, Abergele, Denbighshire.*
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1883	Beaumont, Walter Ibbetson. 10, *Burlington-street, Bath.*
1885	*Beck, Conrad. 68, *Cornhill, E.C.*
1859	*Beck, Joseph, F.R.A.S. 68, *Cornhill, E.C.*
1875	Beeby, William Hadden, A.L.S. 14, *Ridinghouse-street, W.*
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1879	*Bell, F. Jeffrey, M.A., F.Z.S., *Professor of Comparative Anatomy and Zoology in King's College, London,* SECRETARY. 5, *Radnor-place, Gloucester-square, W.*
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1866	*Berney, John. 61, *North-end, Croydon.*

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1884 *Bettany, George Thomas, M.A., B.Sc., F.L.S.
33, *Oakhurst-grove, East Dulwich-road, S.E.*
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Avondale, Coleraine-road, Westcombe Park, Blackheath, S.E.
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339, *Essex-road, Islington, N.*
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1876 Brindley, William.
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66, *Kimbolton-road, Bedford.*

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1864 *Browne, Rev. Robert Henry Nisbet, M.A. (Oxon), F.R.B.S.
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13, *Charing Cross, S.W.*

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85, *Upper Richmond-road, Putney, S.W.*

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1881 Collins, William P.
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134, *York-road, Lambeth, S.W.*

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1867 *Coppock, Charles, F.R.A.S., F.R.Met.S.
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1881 Cox, Jacob D., M.A., LL.D.
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1870 *Crisp, Frank, LL.B., B.A., V.P. & Treas. L.S., *Hon. Member of the American Society of Microscopists, of the Manchester Microscopical Society, of the New York Microscopical Society, of the Troy Scientific Association, Corresponding Member of the Chicago Academy of Sciences, &c.*, SECRETARY.
5, *Lansdowne-road, Notting-hill, W.*

1874 Crisp, John Shalders.
Ashville, Lewin-road, Streatham, S.W.

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Farnham Hall, Ware, Herts.

1860 *Crofton, Edward, M.A. (Oxon.).
45, *West Cromwell-road, Earl's Court-road, S.W.*

1885 Crookshank, Edgar March, M.B. (Lond.), M.R.C.S., *Professor of Bacteriology, King's College, London.*
24, *Manchester-square, W.*

1871 Croydon, Charles.
Pato Point, Wilcove, Torpoint, Cornwall.

1878 Cunliffe, Peter Gibson.
Dunedin, Handforth, Manchester.

1886 Curnock, Rev. Nehemiah.
Dalkeith, Glengall-road, Woodford Green, Essex.

1866 Curties, Thomas.
244, *High Holborn, W.C.*

1883 Curtis, Lester, M.D.
35, *University-place, Chicago, Ill., U.S.A.*

Elected.	
1887	Dadswell, Edward. *21, Montrell-road, Streatham-hill, S.W.*
1887	Dale, Henry Frank. *2, Savile-row, W.*
1871	Dallinger, Rev. W. H., LL.D., F.R.S., F.L.S., *Hon. Member of the American Society of Microscopists, of the Manchester Microscopical Society, of the Liverpool Lit. Phil. Soc., &c. Ingleside, Newstead-road, Lee, S.E.*
1889	Dalzell, Anthony. *St. Thomas's Hospital, S.W.*
1884	Damon, William E. *Care of Tiffany & Co., Union-square, New York, U.S.A.*
1884	Davies, Arthur Ellson, Ph.D., F.L.S., F.C.S. 10, *Brunstone-road, Portobello, N.B.*
1866	Davis, Charles. 29, *Gloucester-place, Portman-square, W.*
1862	*Davis, George. 45, *Stanley-gardens, Belsize-park, N.W.*
1880	Davis, George Edward, F.I.C., F.C.S. *South Cliff House, Higher Broughton, Manchester.*
1878	Davis, John. 41, *Stirling-road, Birmingham.*
1865	Davison, Thomas. 248, *Bath-street, Glasgow.*
1887	Dawson, George Mercer, D.Sc., F.G.S. *Assistant Director, Geological Survey of Canada. Ottawa, Ontario, Canada.*
1881	Dawson, William. 24, *Abbeygate-street, Bury St. Edmunds.*
1887	Day, George. 137, *Whitechapel-road, E.*
1854	*Dayman, Charles Orchard, M.A. (Cantab.), F.R.A.S. *Merrie Meade, Millbrook, Southampton.*
1878	Deby, Julian, C.E. 31, *Belsize-avenue, Hampstead, N.W.*
1886	Dennis, Samuel William, M.D. 809, *Market-street, San Francisco, California, U.S.A.*
1883	Detmers, Henry Johnson, M.D. 1350, *Dennison-avenue, Columbus, Ohio, U.S.A.*
1880	Devron, Gustavus, M.D. *P.O., Box* 1230, *and* 631, *Royal-street, New Orleans, La., U.S.A.*
1885	De Witt, William G. 88, *Nassau-street, New York, U.S.A.*
1888	Dimsdale, John, F.Z.S. 50, *Cornhill, E.C.; and* 4, *Palace Gardens Terrace, Kensington, W.*
1886	Disney, Alfred Norman, M.A., B.Sc. *Islington High Schools, Barnsbury-street, N.*
1879	Douglas, John Andrew. 23, *Bentley-street, Bradford.*

Elected.	
1881	Dowdeswell, George Francis, M.A., F.L.S., F.C.S. *Windham Club*, 13, *St. James's-square, S.W.*
1879	Dreyfus, Ludwig. 44, *Frankfurter-strasse, Wiesbaden.*
1874	Drysdale, John James, M.D. 36*a*, *Rodney-street, Liverpool.*
1879	Duncan, Peter Martin, M.B. (Lond.), F.R.S., F.G.S., *Professor of Geology in King's College, London, Acad. Nat. Sci. Philad. Corr. Mem.* 6, *Grosvenor-road, Gunnersbury, W.*
1883	Dunkerley, John Whiteley, L.D.S. 262, *Oxford-road, Manchester.*
1868	Durham, Arthur Edward, F.R.C.S., F.L.S., &c. 82, *Brook-street, Grosvenor-square, W.*
1884	Durkee, Richard P. Hart. 10, *Ashland Block, Chicago, Ill., U.S.A.*
1886	Durrand, Alexander. *Care of Messrs. Whitelow & Co., Flinders-street East, Melbourne, Victoria.*
1853	Dyster, Frederick Daniel, M.D., F.L.S. *Tenby.*
1886	Eastman, Lewis M., A.M., M.D. 349, *Lexington-street, Baltimore, Md., U.S.A.*
1868	Eddy, James Ray, F.G.S. *The Grange, Carleton, near Skipton.*
1878	Edmunds, James, M.D. 8, *Grafton-street, Piccadilly, W.*
1853	Elliott, William Timbrell. 113, *Adelaide-road, N.W.*
1862	Ellis, Septimus. *Homewood, Ulundi-road, Westcombe Park, S.E.*
1860	*Elphinstone, Howard Warburton, M.A. (Cantab.), F.L.S. 2, *Stone-buildings, Lincoln's Inn, W.C.*
1888	Epps, Hahnemann. 95, *Upper Tulse-hill, Brixton, S.W.*
1887	Evans, Griffith, M.D. 208, *Burrage-road, Plumstead, Kent.*
1859	Eve, Richard Wafford, M.B., F.R.A.S. 101, *Lewisham High-road, S.E.*
1886	Ewell, Marshall D., LL.D., M.D. *South Evanston, Cook Co., Ill., U.S.A*
1885	Farquharson, Marian S. (Mrs.). *Haughton, Alford, N.B.*
1883	*Fawcett, John Edward. *Low Royd, Apperley-bridge, near Leeds.*
1882	Fell, George E., M.D. 72, *Niagara-street, Buffalo, New York, U.S.A.*

Elected.

1883 Fellows, Charles Sumner.
330, *Temple-court, Minneapolis, Minnesota, U.S.A.*

1862 *Finzel, Conrad William.
The Downs, near Bideford, Devon.

1860 *Firmin, Philip Smith.
Ladbroke, Mortlake-road, Kew.

1879 Fischer, Carl F., M.D., F.L.S., F.G.S., *Soc. Zool.-Bot. Vindob. Socius. Sydney, N.S. Wales. Care of Gerich & Co.*, 7, *Mincing-lane, E.C.*

1866 Fitch, Frederick, F.R.G.S.
Hadleigh-house, Highbury New-park, N.

1866 Fitch, Frederick George.
"*Pines*," *Windmill-hill, Enfield.*

1886 Fletcher, Charles.
11, *Canfield-gardens, West Hampstead, N.W.*

1880 Forrest, Herbert Edward.
Abbeyville, Cherry Orchards, Shrewsbury.

1884 Fournet, Aristide.
18, *Bentinck-street, Manchester-square, W.*

1872 Fowke, Francis.
8, *College-terrace, South Hampstead, N.W.*

1879 *Frampton, Lieut.-Col. Cyril, R.M.
Porchester, Hants.

1886 Fraser, Francis John, M.A.
Inverness Lodge, Roehampton.

1885 Freeman-Underwood, Charles Henry, M.D.
5, *Meadow-street, Bombay.*

1883 Fuller, Charles Gordon, M.D.
38, *Central Music Hall, Chicago, Ill., U.S.A.*

1884 Fuller, Henry Weld.
P.O., Box 2955, *New York, U.S.A.*

1889 Gadd, William, C.E.
50, *Richmond-grove West, Manchester.*

1887 Gadd, William Lawrence, F.C.S.
Wath-on-Dearne, viâ Rotherham.

1863 Garnham, John.
Hazelwood, Crescent-road, St. John's, S.E.

1889 Gasking, Rev. Samuel, B.A., F.G.S.
8, *Hawthorne-terrace, Liscard, Cheshire.*

1866 *Gay, Frederick William.
113, *High Holborn, W.C.*

1862 *George, Edward.
70, *Old Broad-street, City, E.C., and Vernon House, Westwood Park, Forest-hill, S.E.*

1879 Gibbes, Heneage, M.D., *Professor of Pathology, University of Michigan.*
Ann Arbor, Michigan, U.S.A.

1858 *Gibbons, William Sydney.
Messrs. G. Lewis & Son, Melbourne, Australia, care of Messrs. Hearon, Squire & Co., 5, *Coleman-street, E.C.*

Elected.
1885 Gibbs, John George, M.R.C.S.
5, *Riggindale-road, Streatham, S.W.*
1872 Gibson, Joseph F.
22, *Norfolk-road, St. John's Wood, N.W.*
1885 Giles, George M., M.B. (Lond.), F.R.C.S.
Marine Survey of India, Poona.
1889 Gill, Charles Haughton, F.C.S.
Berkeley-lodge, Staines.
1856 *Glaisher, James, F.R.S., F.R.A.S., *Pres. Phot. Soc., Ord. Bras. Rosae Eq.*
1, *Dartmouth-place, Blackheath, S.E.*
1885 Godden, Wilfred, F.L.S.
Ridgfield, Wimbledon.
1877 *Godman, Frederick Du Cane, F.L.S.
10, *Chandos-street, Cavendish-square, W.*
1889 Goodfellow, John.
9, *Laxton-terrace, Sedgwick-road, Leyton, E.*
1874 Goodinge, James Wallinger.
119, *High Holborn, W.C.*
1880 Goodwin, Thomas.
12, *Southwark-street, Borough, S.E.*
1885 Gordon, Rev. John More, M.A.
St. John's, Redhill, Surrey.
1884 Gorman, Rev. Thomas Murray, M.A.
Invermore, Woodstock-road, Oxford.
1867 Gowland, Peter Yeames, F.R.C.S., *Surgeon to St. Mark's Hospital.*
34, *Finsbury-square, E.C.*
1883 Gravill, Edward Day.
Marquis-villa, Marquis-road, Stroud-green, N.
1866 *Gray, William John, M.D.
32, *Devonshire-street, Portland-place, W.*
1861 Green, Edward Baker, F.R.H.S.
Burdett Works, Limehouse, E.
1880 Greenfield, William S., M.D., F.R.C.P.
7, *Heriot-row, Edinburgh.*
1870 Greenish, Thomas.
20, *New-street, Dorset-square, W.*
1887 Grenfell, John Granville, B.A., F.G.S.
55, *West Cromwell-road, W.*
1883 Griffith, Ezra H.
Post-office, Fairport, N.Y., U.S.A.
1855 Grove, Edmund.
Norlington, Preston, Brighton.
1879 Groves, J. William, F.L.S., *Profess r of Botany, and Curator of Anatomical Museum at King's College.*
90, *Holland-road, Kensington, W.*
1886 Guardia, Julio.
Helston-house, Rozel-road, Clapham, S.W.
1872 Guimaraens, A. de Souza.
52, *Lowden-road, Herne-hill, S.E.*
1887 Gunn, W. D.
Fern Cottage, Maple-road, Anerley, S.E.

Elected.

1877 Habirshaw, Frederick.
260, West Fifty-seventh-street, New York, U.S.A.

1877 Habirshaw, John, M.D.
260, West Fifty-seventh-street, New York, U.S.A.

1888 Halkyard, Edward.
The Firs, Knutsford, Cheshire.

1888 Hall, Rev. Henry Armstrong.
Spring-grove Vicarage, near Isleworth.

1885 Hallam, Samuel Robinson.
22, High-street, Burton-on-Trent.

1875 Hamilton, John James.
7, Barkston-gardens, Earl's Court, S.W.

1882 *Hanaman, Charles Edward.
103, First-street, Troy, N.Y., U.S.A.

1845 Handford, George Charlton.
24, West End-lane, Kilburn, N.W.

1874 †Hanks, Henry.
619, Montgomery-street, San Francisco, California, U.S.A.

1882 Hardy, James Daniel.
73, Clarence-road, Clapton, E.

1865 Harkness, William.
Laboratory, Inland Revenue, Somerset House, W.C.

1868 Harrop, Edward Davy.
Launceston, Tasmania.

1867 *Hartree, William, Associate Inst. C.E., F.Z.S.
Havering House, Dartmouth Point, Lewisham, S.E.

1884 Harwood, Robert.
Vale Bank, Bolton.

1883 Haselwood, James Edmund.
3, Lennox-place, Brighton.

1880 Havers, John Cory, F.L.S.
Joyce-grove, Nettlebed, Henley-on-Thames.

1881 Healey, George H.
Brantfield, Bowness, Windermere.

1885 *Hebb, Richard Grainger, M.A., M.D., M.R.C.S.,
9, Suffolk-street, Pall Mall, S.W.

1867 Helm, Henry James.
Laboratory, Inland Revenue, Somerset House, W.C.

1874 Hembry, Frederick William.
Sussex Lodge, Station-road, Sidcup, Kent.

1879 Hepburn, John Frankland.
Rannock View, Seven Sisters'-road, Stamford-hill, N.

1853 *Hepburn, John Gotch, LL.B. (Lond.), F.C.S.
Dartford, Kent.

1880 Hicks, J. Sibley, L.R.C.P., F.L.S.
2, Erskin-street, Liverpool.

1889 Higley, Walter Keir, Ph.D.
40, Dearborn-street, Chicago, Ill., U.S.A.

1881 *Hill, Joseph Alfred.
Greystone Lodge, Leamington.

† Corresponding Fellow.

Elected.	
1852	Hilton, James. 60, *Montague-square, W.*
1889	Hoagland, Cornelius Nevins, M.D. 410, *Clinton-avenue, Brooklyn, N.Y., U.S.A.*
1878	Hobson, Amos Herbert. 5, *Westminster Chambers, Victoria-street, S.W.*
1885	Hodges, Edward F., M.D. 2, *West New York-street, Indianapolis, Ind., U.S.A.*
1851	Hogg, Jabez, M.R.C.S. 1, *Bedford-square, W.C.*
1887	Holland, Charles Barclay. *St. Stephen's Club, S.W.*
1881	Hood, John. 50, *Dallfield-walk, Dundee.*
1856	Hopgood, James. *Clapham-common, S.W.*
1867	*Hopkinson, John, F.L.S., F.G.S. 95, *New Bond-street, W.*, and *The Grange, St. Albans, Herts.*
1889	Horn, Rev. James. 16, *Louis-street, Chapeltown-road, Leeds.*
1874	Horne, Robert. *Union-terrace, Cheetham-hill, Manchester.*
1880	Horsley, Charles, C.E. 174, *Highbury New-park, N.*
1882	Houston, David, F.L.S. 3, *Clarence-villas, Clarence-road, Wood Green, N.*
1876	*Hovenden, Charles William. 93, *City-road, E.C.*
1873	*Hovenden, Frederick, F.L.S. *Glenlea, Thurlow Park-road, Dulwich, S.E.*
1887	Howe, Lucien, M.A., M.D. 183, *Delaware-avenue, Buffalo, N.Y., U.S.A.*
1889	Huber, Gotthelf Carl, M.D. *University of Michigan, Ann Arbor, Mich., U.S.A.*
1872	Hudson, Charles Thomas, M.A., LL.D. (Cantab.), F.R.S., PRESIDENT. 6, *Royal York-crescent, Clifton, Bristol.*
1864	Hudson, William. 15, *Stockwell-street, Greenwich, S.E.*
1853	Huggins, William, D.C.L. (Oxon.), LL.D. (Cantab. and Edin.), F.R.S., F.R.A.S., *Math. D. Ludg. Bat. Ord. Imp. Bras. Rosae. Com. Inst. Fr. (Acad. Sci.) Acad. Lync. Romae Soc. Reg. Sci. Gött. Mem. Corr. et Socc. Reg. Sci. Hafn., Physiogr. Lund., Reg. Boie. Marob., Reg. Dubl. et Lit. Phil. Manc. Soc. Honor.* *Upper Tulse-Hill, S.W.*
1867	Humphrys, John James Hamilton. 5, *New-Square, Lincoln's-Inn, W.C.*
1887	Hunt, Daniel De Vere, L.R.C.P. Ed., L.R.C.S.I. *Westbourne Crescent, Canton, near Cardiff.*
1883	Hunt, George, F.R.A.S. *Hopefield, Alleyn-park, West Dulwich, S.E.*

Elected.

1885 Hutton, Rev. Edward Ardron.
Mottram, Manchester.

1881 Huzzey, Reginald Lee.
136, *Spa-road, Bermondsey, S.E.*

1867 Ibbetson, George Augustus, F.R.C.S., F.G.S.
21, *Thicket-road, Norwood, S.E.*

1867 *Ince, Joseph, F.L.S., G.S., C.S., &c.
11, *St. Stephen's-avenue, Shepherd's Bush, W.*

1867 Ingpen, John Edmund.
7, *The Hill, Putney, S.W.*

1888 Inskipp, Frank.
6, *Lawn-terrace, Blackheath, S.E.*

1875 Jackson, Charles Loxton, F.L.S.
Hill Fold, Sharples, Bolton.

1888 James, Professor George Wharton, F.R.A.S.
Oleander, Fresno County, California, U.S.A.

1868 Jayaker, Atmaram Sadashwa, L.R.C.P. (Lond.).
Muscat, Arabia, care of Messrs. Grindlay & Co.
55, *Parliament-street, S.W.*

1887 Jeaffreson, Christopher Samuel, F.R.C.S.Ed., M.R.C.S.Eng.
8, *Savile Row, Newcastle-on-Tyne.*

1887 Jelly, Eliza Catherine (Miss).
Hatchlands, Redhill, Surrey.

1886 Jerman, James.
33, *Paul-street, Exeter.*

1859 *Jeula, Henry, F.R.G.S., F.A.S.L., &c.
16, *Manor Park, Lee, S.E.*

1881 *Jobling, Thomas Edgar.
Croft Villa, Waterloo, Blyth.

1881 Jocelyn, Hon. William Nassau.
The British Legation, Darmstadt.

1872 *Johnson, David.
52, *Fitzjohn's-avenue, South Hampstead, N.W.*

1884 Johnson, Hosmar A., M.D.
4, *Sixteenth-street, Chicago, Ill., U.S.A.*

1881 Johnson, Michael, L.D.S.
9, *York-villas, Lorne-street, N., Chester.*

1888 Johnson, Thomas W., M.D.
Danville, Indiana, U.S.A.

1886 Johnson, William.
188, *Tottenham Court Road, W.*

1888 Jolliffe, Charles Henry.
The Brewery, St. Helens, Lancashire.

1877 Jones, George Horatio.
57, *Great Russell-street, Bloomsbury, W.C.*

1875 Jones, Henry William, F.C.S.
17, *White-street, Coventry.*

1875 Jones, Joseph Birdsall.
St. George's Chambers, 10, *St. George's-crescent, Liverpool.*

Elected.	
1863	Jordan, John. *6, Notting Hill-square, W.*
1889	Julien, Alexis Anastay, Ph.D. *School of Mines, Columbia College, N.Y., U.S.A.*
1885	Karop, George C., M.R.C.S. *198, Holland Road, Kensington, W.*
1885	Kay, James Alexander, M.D. *Pretoria, South African Republic.*
1883	Kellicott, David Simons, B.Sc. *State University, Columbus, Ohio, U.S.A.*
1860	Kelly, George. *9, Sutherland-gardens, Kilburn-road, N.W.*
1873	Kemp, Robert. *60, Windsor-road, Upper Holloway, N.*
1867	Kerr, Walter. *31, Fulham Park-gardens, S.W.*
1851	Kershaw, William Wayland, M.D. *10, Claremont-crescent, Surbiton, Surrey.*
1867	King, Edwin Holborow Green, M.R.C.S., L.D.S. *Netley Court, Southampton.*
1887	King, Rev. Thomas S. *9, Grange-road, Sheffield.*
1879	Kirby, Arthur Raymond. *11a, New-square, Lincoln's-Inn, W.C.*
1888	Kirk, Thomas William. *Museum, Wellington, New Zealand.*
1885	Kirkby, William, F.L.S. *51, Ackers-street, Chorlton-on-Medlock, Manchester.*
1878	Kyngdon, Francis Boughton. *Sydney, N.S. Wales.* *Care of A. B. Cobb, Esq., Margate-bank, Margate.*
1851	Ladds, John. *4, Craven-terrace, Uxbridge-road, Ealing, W.*
1885	Lambert, Thomas J. *Inglewood, Oakhill, Sevenoaks.*
1874	Lancaster, William James, F.R.A.S., &c. *The Hollies, Handsworth Wood, near Birmingham.*
1861	Lang, Major Frederick Henry. *St. Katherine's, Parkstone, Dorset.*
1865	Lankester, Edwin Ray, M.A. (Oxon.), F.R.S.; *Prof. of Zoology, and Comparative Anatomy, in University College, London.* *42, Half Moon-street, W.*
1887	Latham, Vida Annette (Miss). *Dental Department, Michigan University, Ann Arbor, Michigan, U.S.A.*
1887	Law, Frederick Thomas. *254, Kentish Town-road, N.W.*
1864	Lawson, Marmaduke Alexander, M.A., F.L.S.; *Director of Government Cinchona Plantations, Ootâcamund, Bombay.*

Elected.
1855 *Leaf, Charles John, F.L.S., F.S.A., F.R.G.S.
6, *Sussex-place, Regent's-park, N.W.*
1886 Lee, George James, F.R.Met.Soc.
Central Jones-street, Kimberley, Griuqaland West, Cape Colony, Cape of Good Hope.
1889 Lee, William Arthur.
38, *Strand, Calcutta.*
1889 Leigh, Abraham, M.D.
Hiawatha, Kansas, U.S.A.
1880 Letchford, Robert.
Prospect House, Woodford.
1866 *Lewis, Richard Thomas.
28, *Mount Park-crescent, Ealing, W.*
1883 *Lewis, William Jerauld, M.A., M.D.
30, *Gillett-street, Hartford, Conn., U.S.A.*
1885 Line, J. Edward, D.D.S.
26, *E. Main-street, Rochester, N.Y., U.S.A.*
1880 Lingard, Alfred.
St. Ermin's Mansions, Westminster, S.W.
1882 Livingston, Clermont.
22, *Great St. Helen's, E.C.*
1888 Loveland, Bradford Churchill, M.D.
Clifton Springs, Ontario Co., N.Y., U.S.A.
1866 Lovibond, Joseph William.
St. Anne-street, Salisbury.
1854 *Lubbock, Sir John, Bart., M.P., F.R.S., F.L.S., F.G.S., *Trust. Brit. Mus., &c.*
High Elms, Bromley, Kent.
1881 Luck, Harry Courtnay, F.R.G.S.
Brisbane, Queensland, care of Mr. E. Luck, 70, *Stamford-street, S.E.*
1887 Lynd, William.
21, *Bloomsbury-street, W.C.*
1879 Lyon, Thomas Glover, M.D.
39, *King-street, E.C.*

1888 Macer, Robert.
23, *Wingmore-road, Loughborough Junction, S.W.*
1867 McIntire, Samuel John.
14, *Hettley-road, Uxbridge-road, Shepherd's Bush, W.*
1861 Mackrell, John.
High Trees, Clapham-common, S.W.
1888 MacMunn, Charles Alexander, M.A., M.D.
Oakleigh, Wolverhampton.
1884 McMurrich, J. Playfair, M.A.
Clark University, Worcester, Mass., U.S.A.
1884 Mainland, George Edward.
Glenthorpe, Woodside-lane, North Finchley, N.
1848 Makins, George Hogarth, M.R.C.S., F.C.S.
Danesfield, Upper Lattimore-road, St. Albans.

Elected.

1884 Malley, Abraham Cowley, B.A., M.B.
Munslow, Craven Arms, Salop.

1886 Mallory, Maitland L., M.D.
69, *N. Fitzhugh-street, Rochester, New York, U.S A.*

1886 Manbré, Alexandre.
15, *Alexandra-drive, Liverpool.*

1859 *Manchester, William Drogo, Duke of, F.Z.S.
1, *Great Stanhope-street, Mayfair, W., and Kimbolton Castle, St. Neots, Hunts.*

1889 Mann, Rev. Albert, jun., M.A.
Newark, N.J., U.S.A.

1867 *Manning, William.
21, *Redcliffe-gardens, South Kensington, S.W.*

1887 Mantle, Alfred, M.D.
Cromarty House, Stanley, Durham.

1885 Manton, Walter Porter, M.D.
83, *Lafayette-avenue, Detroit, Mich., U.S.A.*

1883 Marriott, Edward Dean.
90, *St. Ann's Well-road, Nottingham.*

1888 Martin, Charles James, B.Sc.
Demonstrator of Physiology, King's College, W.C.

1873 Martin, Nicholas Henry, F.L.S.
29, *Mosley-street, Newcastle-on-Tyne.*

1889 Martin, William Edward Reseigh
8, *Lincoln's Inn, Birmingham.*

1879 Maskell, William Miles, J.P.
Museum, Wellington, New Zealand.

1886 Mason, Alfred H., F.C.S.
46, *Jewin-street, E.C.*

1878 *Mason, Philip Brookes, F.L.S
Burton-on-Trent.

1884 Massee, George.
41, *Gloucester-road, Kew.*

1889 Mather, Enock, M.A., M.D.
57, *Station-road, Masborough, Rotherham, Yorkshire*

1857 May, John William, *Consul-General of the Netherlands.*
Arundel House, Percy-cross, Fulham-road, S.W.

1867 Mayall, John, jun., F.Z.S.
224, *Regent-street, W.*

1888 Mayhew, Edward William Alfred Augustus, F.L.S., F.C.S.
Ivy Lodge, Fremantle, West Australia ; care of T. Farries, Esq., 12, *Coleman-street, E.C.*

1886 Mayne, James.
203, *Oxford-street, Sydney, New South Wales.*

1882 Mead, Walter Haughton
65, *Wall-street, New York, U.S.A.*

1856 Meade, Hon. Robert Henry, F.R.G.S.
Foreign Office, and 24, *Upper Brook-street, W.*

1884 Meek, Benjn. Owen, M.R.C.V.S. Lond., F.L.S., F.R.Met.Soc.
Post-office, Sydney.

1885 Meek, Rev. George, B.A. (Cantab.).
12, *Hornby-street, Heywood, Lancashire.*

Elected.

1885 Melhuish, John, L.R.C.P. (Lond.), M.R.C.S., L.S.A.
5, Crossfield Road, Belsize Park, N.W.

1879 *Mercer, A. Clifford, M.D.
40, Montgomery-street, Syracuse, N.Y., U.S.A.

1883 Mercer, Frederick Wentworth, M.D.
2600, Calumet-avenue, Chicago, Ill., U.S.A.

1884 Mestayer, Richard Liron, A.S.C.E.
Symington Villa, Parramatta-road, Ashfield, near Sydney, N. S. Wales.

1877 Michael, Albert Davidson, F.L.S.
Cadogan Mansions, Sloane-square, Chelsea, S.W.

1886 Miles, Manly, M.D.
Lansing, Michigan, U.S.A.

1884 Miller, Rev. Alexander Vincent, B.D.
St. Charles College, St. Charles-square, Notting-hill, W.

1880 Millett, Fortescue William.
The Parsonage, Marazion, Cornwall.

1883 Moffat, William Tweeddale.
Romsey, Victoria.

1851 Moreland, Richard, jun., M.I.C.E.
3, Old-street, St. Luke's, E.C., and 4, The Quadrant, Highbury, N.

1883 Morgan, Joseph B.
Stand House, Childwall, Liverpool.

1880 Morris, Galloway C.
East Tulpohocken-street, Germantown, Philadelphia, Pa., U.S.A.

1878 Morris, John, F.Z.S.
13, Park-street, W.

1876 Morris, William, M.D.
Care of The Commercial Banking Company of Sydney, Sydney, New South Wales.

1880 Morris, William, jun.
5, Vicarage-gardens, Kensington, W.

1884 Mullins, George Lane, M.A., M.D.
209, Macquarie-street, Sydney, New South Wales.

1888 Mummery, John Howard.
10, Cavendish-place, W.

1879 Nachet, Alfred.
17, Rue St. Séverin, Paris.

1880 *Nesbitt, Henry, F.R.G.S.
12, Victoria-villas, Kilburn, N.W.

1887 Nevins, Reginald Theophilus Graham.
Pembroke Lodge, Hildenborough, Tonbridge.

1880 Newman, Thomas Prichard.
54, Hatton-garden, E.C.

1881 Newton, Charles Read.
Kempside, Kursiong, Darjeeling, India.

1884 Nixon, Philip Charles.
Oporto, Portugal.

Elected.
1849 Noble, John, F.R.H.S.
50, *Westbourne-terrace, Hyde-park, W., and Park-place, Henley-on-Thames.*
1855 *Noble, Captain William, F.R.A.S.
Forest Lodge, Maresfield, Sussex.
1882 Noble, Wilson.
43, *Warrior-square, St. Leonard's-on-Sea.*
1885 Norman, George, M.R.C.S.E.
12, *Brock-street, Bath.*
1886 Norris, Albert.
Fern Acre, Urmston, Manchester.
1889 Nuttall, George Henry Falkiner, M.D.
University, Göttingen, Germany, and San Francisco, California, U.S.A.

1867 *Oakley, John Jeffryes.
24, *Sussex-gardens, Hyde-park, W.*
1887 Ochsner, A. J., Ph.D., M.D.
300, *S. Wood-street, Chicago, Ill., U.S.A.*
1883 Offord, John Milton.
15, *Loudoun-road, St. John's-wood, N.W.*
1878 O'Hara, Lieut.-Col. Richard.
West Lodge, Galway.
1882 Ollard, John Alexander.
Barnesfield, Stone, Greenhithe, Kent.
1879 Ord, William Miller, M.D., F.R.C.P., F.L.S.
37, *Upper Brook-street, Grosvenor-square, W.*
1876 Osler, William, M.D.
University of Pennsylvania, Philadelphia, Pa.. U.S.A.
1840 Owen, Sir Richard, K.C.B., D.C.L., M.D., LL.D., F.R.S., F.L.S., F.G.S., F.Z.S., *Coll. Reg. Chir. Hib. et Soc. Reg. Edin. Soc. Honor., Ord. Boruss.* "*Pour le Merite*" *Eq., Inst. Fr. (Acad. Sci.) Par. Adsoc. Extr. Acadd. Imp. Sci. Vindob Petrop., et Soc. Imp. Sc. Nat. Hist. Mosq., Acadd. Reg. Sci. Berol., Taurin., Matrit., Holm., Monach, Neapol., Bruxell, Bonon., Inst. Reg. Sc. Amstelod., Socc. Reg. Sc. Hafn., Upsal., Acad. Amer. Sc. Bost. Socius, Soc. Philomath, Paris, Corresp., Geor., Florent., Soc. Sc. Harlem., Trajectin, Phys. et Hist. Nat. Genev. Acadd. Lync. Romæ, Patav., Panorm., Gioen. Nat. Scrutat. Berol., Instit. Wetter, Philad., Nov.-Ebor., Bost. Acad. Reg. Med. Paris., Soc. Imp. et Reg. Med. Vindob. Adsoc. Extr.*
Sheen Lodge, Richmond Park, Mortlake, S.W.
1865 *Owen, Major Samuel Richard John, F.L S., *Assoc. of King's Coll. Lond.*
Ventnor, Isle of Wight.
1879 Oxley, Frederick.
8, *Crosby-square, E.C.*

1882 Palmer, Henry.
East Howle, Ferry-hill, Durham.

Elected.

1881 Parker, Robert John.
Launceston, Tasmania.

1879 *Parker, Thomas Jeffrey, B.Sc.
University of Otago, New Zealand.

1861 Parkinson, William Coulson.
18, *Carleton-road, Tufnell-park, Holloway, N.*

1884 Parsons, Frederick Anthony.
90, *Leadenhall-street, E.C.*

1862 Paton, George Lauchland.
40, *Wilkinson-street, Clapham-road, S.W.*

1883 Peach, Robert.
North Park-road, Harrogate.

1882 Peal, Charles Nathaniel, F.L.S.
Fernhurst, Mattock-lane, Ealing, W.

1888 Pearce, George.
Brabourne Haigh, Highwood-hill, N.W.

1866 *Peek, Sir Henry William, Bart.
Wimbledon House, S.W.

1884 *Peek, Honourable Mrs.
Rousdon, Lyme Regis.

1888 Penman, William A., M.I.C.E.
5, *St. Andrew-square, Edinburgh.*

1852 *Perigal, Henry, F.R.A.S.
9, *North-crescent, Bedford-square, W.C.*

1853 *Peters, William, F.R.A.S., F.R.B.S., F.Z.S.
The Bungalow, Horsham, Sussex.

1886 Phillips, Reginald W., B.A. (Cantab.), B.Sc. (Lond.).
University College of North Wales, Bangor.

1882 Pickels, William Edward.
Box 128, *G.P.O., Adelaide, S.A.*

1866 *Pickersgill, William Cunliffe, F.R.H.S.
77, *Marina, St. Leonard's-on-Sea.*

1861 Pidgeon, Daniel.
Walsingham House, Piccadilly, W.

1881 Pilley, John James.
Old College, Dulwich, S.E.

1855 Pillischer, Moritz.
88, *New Bond-street, W.*

1887 Pinkney, Robert.
Green Park Chambers, 90, *Piccadilly, W.*

1864 Pittock, George Mayris, M.B. (Lond.).
23, *Cecil-square, Margate.*

1883 Plimmer, Henry George, M.R.C.S. (Eng.), L.S.A. (Lond.).
Wunderbau, 1, *West-hill, Upper Norwood, S.E.*

1879 Plomer, George Daniel.
48, *Springfield-road, St. John's-wood, N.W.*

1889 Plyer, Charles Whiting
22, *West* 60*th-street, New York, U.S.A.*

1879 Pochin, Percival Gerard.
Care of Messrs. J. Brown and Co., Atlas Works, Sheffield.

1882 Pocklington, Christopher.
22, *Cunliffe-villas, Manningham, Bradford.*

Elected.
1875 Pocklington, Henry.
41, *Virginia-road, Mount Preston, Leeds.*
1867 Potter, George.
66, *Grove-road, Upper Holloway, N.*
1884 Potts, John.
Thorn Tree House, Macclesfield.
1880 Powell, Thomas Hugh.
18, *Doughty-street, Mecklenburg-square, W.C.*
1881 Power, E. Strickland, R.N.
99, *Finborough-road, West Brompton, S.W.*
1888 Pratt, William Henry.
27, *Regent-street, Nottingham.*
1885 Pray, Thomas, jun.
P.O. Box, 2728, *Boston, Mass., U.S.A.*
1867 *Prescott, Sir George Rendlesham, Bart., F.Z.S.
Isenhurst, Hawkhurst.
1885 Preston, Henry Berthon.
54, *Lexham-gardens, Kensington, W.*
1887 Pringle, Andrew.
Cromwell House, Bexley Heath, Kent.
1840 Pritchard, Rev. Charles, M.A. (Cantab.), F.R.S., F.R.A.S., F.G.S., F.C.P.S., *Savilian Professor of Astronomy, Oxford.*
9, *Keble-terrace, Oxford.*
1879 Pritchard, Urban, M.D., F.R.C.S., *Professor of Aural Surgery in King's College, London.*
3, *George-street, Hanover-square, W.*
1879 *Puleston, Sir John Henry, M.P.
7A, *Dean's-yard, Westminster, S.W.*
1868 Puttick, Alfred James.
26, *King-street, Covent-garden, W.C.*

1874 Radford, William, M.D.
Sidmouth.
1886 Rae, James, M.D.
Drummond-place, Stirling, N.B.
1868 *Ramsden, Hildebrand, M.A. (Cantab.), F.L.S.
26, *Upper Bedford-place, Russell-square, W.C*
1889 Ratcliffe, Joseph Riley, M.B.
Highfield, Manchester-road, Burnley.
1888 Raymond, F.
Army Veterinary Department, Woolwich, S.E.
1884 Redding, Thomas B., M.A., Ph.D.
Newcastle, Henry Co., Indiana, U.S.A.
1864 Reeves, Walter Waters.
32, *Geneva-road, Brixton, S.W.*
1886 Remington, Joseph Price, Ph.G.
1832, *Pine-street, Philadelphia, Pa., U.S.A*
1861 *Richards, Edward.
1, *Bessborough-gardens, Southsea.*
1881 Rideout, William.
Seymour-road, Astley Bridge, near Bolton.

Elected.

1881 Robinson, Joseph B.
Devonshire House, Mossley, Lancashire.

1888 Robinson, Tom, M.D.
9, *Prince's-street, Cavendish-square, W.*

1871 Rogers, John.
4, *Tennyson-street, Nottingham.*

1867 *Rogerson, John.
Post Office Box, 214, *Barrie, Ontario, Canada.*

1882 Rookledge, John.
Union Bank, Easingwold, Yorkshire.

1852 *Roper, Freeman Clark Samuel, F.L.S., F.G.S., F.Z.S.
Palgrave House, Eastbourne.

1880 Rosling, Edward.
Melbourne, near Chelmsford.

1886 Ross, James Alexander, M.D.
Stangrove, Park-road, Bromley, Kent.

1883 *Rosseter, Thomas B.
Fleur-de-lis, Canterbury.

1888 Rousselet, Charles F.
308, *Regent-street, W.*

1881 Rowe, Thomas Smith, M.D.
1, *Cecil-street, Margate.*

1887 Rowley, Rev. Charles Henry, Ph.D.
Westford, Mass., U.S.A.

1879 Ruffle, George William.
29, *Nelson-square, S.E.*

1887 Rutherford, John, J.P.
6, *Wellington-street, St. John's, Blackburn, Lancashire.*

1862 *Rylands, Thomas Glazebrook, F.L.S., F.G.S., F.R.A.S.
Highfields, Thelwall, near Warrington.

1853 *Sanders, Alfred, M.R.C.S., F.L.S., F.Z.S.
Care of S. F. Langham, Esq., 10, *Bartlett's Buildings, Holborn Circus, E.C.*

1883 Saunders, William, F.L.S.
188, *Dundas-street, London, Ontario, Canada.*

1879 Sawyer, George David.
55, *Buckingham-place, Brighton.*

1885 Schultze, Edwin A.
P.O. Box 56, *New York, U.S.A.*

1888 Schulze, Adolf, F.R.S.E.
2, *Doune-gardens, Kelvinside, Glasgow.*

1880 Scott, Dukinfield Henry, F.L.S.
The Laurels, Bickley, Kent.

1845 Shadbolt, George.
Beechcroft, Camden-park, Chislehurst, Kent.

1857 Sharpe, George Young.
16, *Lansdowne-road, Notting-hill, W.*

1885 *Shelley, Lieut., A.D.G., R.E.
Rockcliffe Hotel, Simla, N.W.P., India.

1880 Shenstone, James Chapman.
13, *High-street, Colchester.*

Elected.	
1867	Shepheard, Thomas. *Kingsley Lodge, Chester.*
1889	Shore, Thomas William, M.D., B.Sc. (Lond.), L.R.C.P., M.R.C.S., F.L.S. 13, *Hill-side, Crouch-hill, W.*
1871	Sigsworth, John Cretney. 20, *Tedworth-square, Chelsea, S.W.*
1881	Sillem, Louis Augustus. *Laurie-park, Sydenham, S.E.*
1859	*Silver, Lieut.-Colonel Hugh Adams, Assoc.Inst.C.E. *Abbey Lodge, Chislehurst, Kent.*
1866	Simpson, Rev. David, M.A. (Cantab.). *Tour de Bellevue, Antibes, Alps Maritimes, France.*
1885	Skelton, John L. 376, *West Monroe-street, Chicago, Ill., U.S.A.*
1862	Slack, Henry James, F.G.S. *Ashdown-cottage, Forest-row, Sussex.*
1864	*Smith, Basil Wood, F.R.A.S *Branch-hill Lodge, Hampstead-heath, N.W.*
1881	Smith, George John. 73, *Farringdon-street, E.C.*
1866	*Smith, Joseph Travers, F.R.B.S. 40, *Hertford-street, Mayfair, W.*
1889	Smith, Percy William Bassett, L.R.C.P., M.R.C.S., R.N. 20, *Sisters-avenue, Lavender-hill, S.W.*
1874	Smith, Rowland Dunn, M.R.C.S. (Edin.). 1, *Clapton-square, E.*
1888	Smith, Thomas Field. 12, *Campdale-road, Tufnell-park, N.*
1889	Smith, Rev. Thomas Northmore Hart, M.A. *Epsom College, Surrey.*
1866	*Sorby, Henry Clifton, LL.D., F.R.S., F.L.S., F.G.S., F.Z.S. *Soc. Min. Petrop., Soc. Holland, Harl. Socius. Acad. Sci. Nat. Philad. et Lyc. Hist. Nat. Nov. Ebor. Corr. Mem.* *Broomfield, Sheffield.*
1887	Southall, Rev. George. *Osborne House, Dovercourt, Essex.*
1864	*Spawforth, Joseph. *Sandall-cottage, Hornsey-rise, N.*
1877	Spencer, James. 121, *Lewisham-road, Lewisham, S.E.*
1886	Spiers, Rev. William, M.A., F.G.S. 16, *Harley-street, Hull.*
1854	Spurrell, Flaxman, L.R.C.P. (Edin.), F.R.C.S., &c. *Belvedere, S.E.*
1882	Squance, Thomas Coke, M.B. 4, *Beauclerc-terrace, Sunderland, Durham.*
1882	Stearn, Charles H. *Selwood House, Mayow-road, Forest-hill, S.E.*
1861	Stephenson, John Ware, F.R.A.S. 186, *Clapham-road, S.W.*

Elected.

1882 Sternberg, George Miller, M.D.
Johns Hopkins University, Baltimore, Md., U.S.A.

1860 Steward, James Henry.
406, *Strand, W.C.*

1867 Stewart, Prof. Charles, M.R.C.S., F.L.S.
Conservator of the Hunterian Museum, Royal College of Surgeons, Lincoln's Inn Fields, W.C.

1884 Stodder, James Chesterman.
5, *West-broadway, Bangor, Maine, U.S.A.*

1867 Stoker, George Naylor.
Laboratory, Inland Revenue Office, Somerset House, W.C.

1887 Stratford, William, M.D.
245, *W. Fifty-second-street, New York, U.S.A.*

1871 Stuart, John.
112, *New Bond-street, W.*

1879 Stubbins, John, F.G.S.
Inglebank, Headingley, Leeds.

1884 Sudduth, W. Xavier, M.D.
1725, *Arch-street, Philadelphia, Pa., U.S.A.*

1863 *Suffolk, William Thomas.
143, *Beulah-hill, Upper Norwood, S.E.*

1888 Sutcliffe, Frederick William.
226, *Rochdale-road, Oldham, Lancashire.*

1880 Swift, James.
81, *Tottenham Court-road, W.C.*

1889 Sykes, Mark Langdale.
98, *New Lane, Winton, Manchester.*

1880 Symons, William Henry, F.C.S.
130, *Fellowes-road, South Hampstead, N.W.*

1881 Tacey, William G., L.R.C.P.
18, *North-parade, Bradford.*

1884 Tarn, William.
94, *Lancaster-gate, Hyde Park, W.*

1888 Tate, Alexander Norman.
9, *Hackin's Hey, Liverpool,*

1880 Teasdale, Washington, F.R.A.S.
Rosehurst, Headingley, Leeds.

1870 *Tebbitt, Walter.
Marlborough-house, Mount Sion, Tunbridge Wells.

1887 Tebbs, Henry Virtue.
1, *St. John's-gardens, Notting Hill, W.*

1884 Terry, John.
8, *Hopton-road, Streatham, S.W.*

1880 Thacker, John A., M.D.
121, *Seventh-street, Cincinnati, Ohio, U.S.A.*

1883 Thomas, Benjamin Walden.
27, *Portland Block, Chicago, Ill., U.S.A.*

1884 Thomas, Henry, M.D.
12, *Nevill-crescent, Llandudno.*

Elected.
1886 Thomas, John Davies, M.D., F.R.C.S.
North-terrace, Adelaide, South Australia; care of H. K. Lewis, 136, *Gower-street, W.C.*
1858 *Thompson, Frederick, F.A.S.L.
South-parade, Wakefield.
1889 Thompson, Henry George, M.D., J.P., F.R.C.S.I.
86, *Lower Addiscombe-road, Croydon.*
1880 Thompson, Isaac Cooke, F.L.S.
Woodstock, Waverley-road, Liverpool.
1888 Thompson, John.
48, *Woodside-terrace, Rishton-lane, Bolton, Lancashire.*
1883 Thompson, John Tatham, M.B.
23, *Charles-street, Cardiff.*
1888 Thomson, Frederick Whilley.
11, *Park-road, Halifax, Yorkshire.*
1885 *Thomson, J. Arthur, M.A.
30, *Royal Circus, Edinburgh.*
1881 Thomson, William.
Royal Institution, Manchester.
1889 Thorpe, Vidal Gunson, M.R.C.S., R.N.
H.M.S. "Belleisle," Kingstown, Dublin.
1888 Thurston, Edgar.
Superintendent, Government Central Museum, Madras, India.
1883 Townend, Walter.
Lightcliffe, near Halifax, Yorkshire.
1871 *Townsend, John Sumsion.
Stamford Lodge, St. John's, Sevenoaks.
1883 Trinks, C. Henrich.
40, *Ainger-road, N.W.*
1852 Truman, Edwin, M.R.C.S.; *Dentist to Her Majesty's Household.*
23, *Old Burlington-street, W.*
1877 Tulk, John Augustus, M.A. (Cantab.), M.R.C.P. (Lond.).
Cowley House, Chertsey.
1889 Turner, Clifford Winslow, M.R.C.S., F.L.S.
4, *Cowper-street, New Leeds, Leeds, Yorkshire.*
1879 Turner, William Barwell, F.C.S.
55, *Reginald-terrace, Chapeltown-road, Leeds.*
1884 Turton, George F.
Claremont-road, Sherwood-rise, Nottingham.
1882 Tuttle, Albert Henry, M.Sc.
University of Virginia, Charlottesville, Va., U.S.A.
1888 Tyas, Walter Henry.
Oakbank, Blackley, Manchester.
1863 Tyer, Edward, C.E., F.R.A.S., F.R.G.S., Assoc.Inst.C.E.
Ashwin-street, Dalston, E.
1858 *Tyler, Charles, F.L.S., F.G.S.
Elberton, New West End, Hampstead, N.W.
1862 *Tyler, George, F.R.G.S.
317, *Holloway-road, Holloway, N.*
1863 *Tyler, Sir James, F.L.S., F.Z.S., F.R.B., and R.H.S.
Pine House, Holloway, N.

Elected.

1862 *Tyler, Rev. William, D.D.
247, Hackney-road, E.

1886 Tyson, Thomas Balinforth.
21, Montague-street, Worthing.

1885 Underwood, Arthur Swayne, L.D.S., M.R.C.S.
11, Bedford-square, W.C.

1887 Underwood, Edward F., M.D.
Fort, Bombay, India.

1882 Van Brunt, Cornelius.
319, *East 57th-street, New York, U.S.A.*

1860 *Vanner, William.
Camden-wood, Chislehurst, Kent.

1840 *Van Voorst, John, F.L.S., F.Z.S.
1, *Paternoster-row, E.C.*

1888 Veitch, James Herbert.
Royal Exotic Nurseries, King's-road, Chelsea, S.W.

1880 Vernon, John.
16, *Park-road, Forest Hill, S.E.*

1879 Vezey, John Jewell.
55, *Lewisham High-road, S.E.*

1863 *Vicary, William, F.G.S., F.R.Met.S.
The Priory, Colleton-crescent, Exeter.

1879 Vize, Rev. John Edward, M.A.; *Hon. Mem. Woolhope Naturalists' Field Club, Hon. Corr. Mem. Cryptogamic Society of Scotland.*
Forden Vicarage, Welshpool.

1881 Vorce, Charles Marvin.
5, *Rouse Block, Cleveland, Ohio, U.S.A.*

1884 Wales, William.
53, *Nassau-street, New York, U.S.A.*

1863 Walker, Frederick.
Heywood, Tenby.

1885 Walker, William C.
Utica, New York, U.S.A.

1882 Wall, John L.
338, *Sixth-avenue, New York, U.S.A.*

1884 Walmsley, William H.
1016, *Chestnut-street, Philadelphia, Pa., U.S.A.*

1867 Walters, James Hopkins, M.R.C.S.
43, *Castle-street, Reading.*

1885 Walton, Frederic Robert Brooke.
1, *Claremont Bank, Shrewsbury.*

1881 Ward, Edward.
249, *Oxford-street, Manchester.*

1869 Ward, Frederic Henry, M.R.C.S.
Springfield, near Tooting, S.W.

Elected.

1862 Ward, John Whitely.
South Royde, Halifax.

1881 Ward, R. H., M.D.
53, *Fourth-street, Troy, N.Y., U.S.A.*

1883 *Warner, Rev. Arthur George.
1, *Sumner-place, South Kensington, S.W.*

1885 Warner, Edmond.
Southend, Eltham, S.E.

1882 Warnock, James.
93, *Reade-street, New York, U.S.A.*

1883 Waters, Arthur William, F.L.S.
Royal Microscopical Society, 20, *Hanover-square, W.*

1879 Watson, Thomas E.
St. Mary's Lodge, Goldtops, Newport, Mon.

1881 Watson, Thomas P.
313, *High Holborn, W.C.*

1878 Watts, Rev. G. E., M.A.
Kensworth Vicarage, Dunstable.

1872 Webb, Henry Richard, J.P.
Merivale, St. Albans, Christchurch, New Zealand.

1889 Weed, Clarence Moore, M.Sc.
Columbus, Ohio, U.S.A.

1887 Weightman, Alfred Ernest, Surg. R.N.
H.M.S. "Garnet," care of Postmaster, Aden.

1886 Weir, Walter, M.B., F.R.C.P. (Ed.).
Gatestone, Upper Norwood, S.E.

1887 Weld-Blundell, Herbert.
Wellington Club, 1, *Grosvenor-place, S.W.*

1887 Wellington, Richard Henslowe.
38, *Fellowes-road, South Hampstead, N.W.*

1861 Wells, John Robinson, M.D., F.R.C.S.
4 *Pierrepoint Road, Springfield Park, Acton.*

1886 West, Charles.
7, *Park-row, Blackheath, S.E.*

1884 West, Charles E., M.D., LL.D.
138, *Montague-street, Brooklyn, N.Y., U.S.A.*

1884 West, James.
4, *Henrietta-villas, Winkfield-road, N.*

1852 West, Tuffen, F.L.S.
Frensham, near Farnham, Surrey.

1885 *Western, Edward Young.
27, *Craven-hill-gardens, W.*

1885 Western, George.
2, *Lime-villas, West Hill-road, Wandsworth, S.W.*

1861 Westwood, William Henry.
Oatlands-park, Weybridge.

1885 Wethered, Edward, F.G.S.
5, *Berkeley-place, Cheltenham.*

1882 Whaite, Frederick A.
Fine Art Galleries, Bridge-street, Manchester.

1868 Wheldon, John.
58, *Great Queen-street, W.C.*

Elected.	
1889	Whelpley, Henry Milton.
	2647, *Olive-street, St. Louis, Mo., U.S.A.*
1850	White, Charles Frederick, F.L.S.
	3, *Amherst-road, Ealing, W.*
1867	White, Thomas Charters, M.R.C.S., L.D.S.
	26, *Belgrave-road, S.W.*
1886	White, Wallace S.
	128, *W. Main-street, Kalamazoo, Michigan, U.S.A.*
1886	*Whitehead, Ralph Radcliffe.
	Borden-wood, Milland, Liphook, Hants.
1889	Whitelegge, Thomas.
	Australian Museum, Sydney, New South Wales.
1867	Whitelock, Rev. Benjamin, M.A. (Cantab.).
	Lealands, Groombridge, Sussex (near Tunbridge Wells).
1866	*Whitling, Henry Townsend, M.R.C.S.
	53, *High-street, Croydon.*
1885	Whitney, James E.
	Rochester, N.Y., U.S.A.
1883	Whitson, James, M.D.
	13, *Somerset-place, Glasgow.*
1879	Whittell, Horatio Thomas, M.D., M.R.C.S.
	Board of Health, Adelaide, South Australia.
1880	*Whitworth, Benjamin.
	11, *Holland-park, W.*
1866	Wight, James Ford.
	Grazeley, Gipsy-hill, Upper Norwood, S.E.
1886	Wilkins, Thomas Smith.
	Uttoxeter.
1879	Williams, George.
	135, *Coningham-road, Shepherd's-bush, W.*
1884	Williams, John Michael.
	156, *Chatham-street, Liverpool.*
1879	Willmott, Collis.
	Triangle, Hackney, E.
1881	Wills, George Sampson Valentine, F.L.S.
	Arundel Lodge, 112, *Tulse-hill, S.W.*
1884	Wilson, Anne (Mrs.).
	3, *Portland-terrace, Regent's-park, N.W.*
1857	Wilson, Richard, M.R.I.
	69, *Cornhill, E.C.*
1857	*Wiltshire, Rev. Thomas, M.A., F.L.S., F.G.S.
	25, *Granville-park, Lewisham, S.E.*
1889	Winder, Bartlett Wrangham, F.C.S.
	5, *Wharncliffe-road, Sheffield.*
1861	Winstone, Benjamin.
	53, *Russell-square, W.C.*
1888	Wolff, Arthur J., M.D.
	71, *Capitol-avenue, Hartford, Conn., U.S.A.*
1881	Wood, Benjamin William.
	53, *Gloucester-street, Sheffield.*
1842	Wood, Frederick, F.R.C.S.
	12, *Lewis-crescent, Kemp Town, Brighton.*

Elected.	
1879	Woodall, Robert. 6, *Copthall-court, E.C.*
1850	*Woodhouse, Alfred James, L.D.S. 1, *Hanover-square, W.*
1878	Woods, George Arthur, L.R.C.P., M.R.C.S., &c. 57, *Houghton-street, Southport.*
1880	*Woodward, Bernard B., F.G.S. 23, *Batoum-gardens, West Kensington-park, W.*
1880	*Woodward, Henry, LL.D., F.R.S. 129, *Beaufort-street, Chelsea, S.W.*
1889	Wright, Charles Henry. *Royal Herbarium, Kew.*
1882	Wright, John. *The Lodge, Whitton, Suffolk.*
1888	Wright, George Henry. *Care of Messrs. Eyre & Spottiswoode, Great New-street, E.C.*
1882	Wright, R. Ramsay, M.A., B.Sc. *The University, Toronto, Canada.*
1881	Wright, Theodore R. 17, *Clifford's-inn, E.C.*
1885	Wythe, Joseph H., M.D. 965, *West-street, Oakland, California, U.S.A.*
1859	Yool, Henry, F.Z.S. *Oakfield, Weybridge.*
1887	Young, Walter Plomer. *Hertford-house, Albert-road, Battersea-park, S.W.*
1889	Zeiss, Roderich, M.D. *Jena, Germany.*

HONORARY FELLOWS.

Elected.	
1878	Abbe, E. *Jena.*
1879	Agassiz, A. *Cambridge, Mass., U.S.A.*
1888	Allman, G. J. *Parkstone.*
1879	Archer, W. *Dublin.*
1879	Balbiani, E. G. *Paris.*
1879	Beneden, P. J. van. *Louvain.*
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Philadelphia, Academy of Natural Sciences of
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(Pisa.) Società Toscana di Scienze Naturali.
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SPAIN.

(Madrid.) Sociedad Española de Historia Natural.

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The Journal is issued on the second Wednesday of
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1889. Part 1. FEBRUARY. { To Non-Fellows, Price 5s.

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CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

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(principally Invertebrata and Cryptogamia),

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WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

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APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1 \cdot 00$).	*Water* ($n = 1 \cdot 33$).	*Homogeneous Immersion* ($n = 1 \cdot 52$).	White Light. ($\lambda = 0 \cdot 5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0 \cdot 4861\ \mu$, Line F.)	Photography. ($\lambda = 0 \cdot 4000\ \mu$, near Line h.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·739
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·746
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·741
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·763
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·775
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·787
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·800
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·813
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·826
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·840
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·855
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·870
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·885
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·901
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·917
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·935
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·952
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·971
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·990
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·010
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·031
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·053
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·075
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·099
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·124
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136

Numerical Aperture. ($n \sin u = a.$)	Corresponding Angle ($2u$) for Air ($n = 1·00$).	Water ($n = 1·33$).	Homogeneous Immersion ($n = 1·52$).	Limit of Resolving Power, in Lines to an Inch. White Light. ($\lambda = 0·5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0·4861\ \mu$, Line F.)	Photography. ($\lambda = 0·4000\ \mu$, near Line h.)	Illuminating Power. (a^2.)	Penetrating Power. ($\frac{1}{a}$)
0·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
0·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
0·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
0·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43,179	·116	2·941
0·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3·125
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
0·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
0·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
0·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
0·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
0·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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104	2 inches	17	2 10 0					
105	1½ inch	23	2 10 0	30	48	90	120	150
106	⅔ inch	25	2 0 0	70	112	210	280	350
107	⅔ inch	32	2 10 0					
108	½ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
112	⅕ inch	120	4 10 0	250	400	750	1000	1250
113	⅛ inch	130	5 0 0	400	640	1200	1600	2000
114	$\frac{1}{10}$ imm.	180	5 5 0	500	800	1500	2000	2500
115	$\frac{1}{15}$ imm.	180	8 0 0	750	1200	2250	3000	3750
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153	½ inch	38	1 5 0	90	116	205
154	¼ inch	80	1 5 0	170	220	415
155	⅛ inch	110	2 5 0	250	330	630
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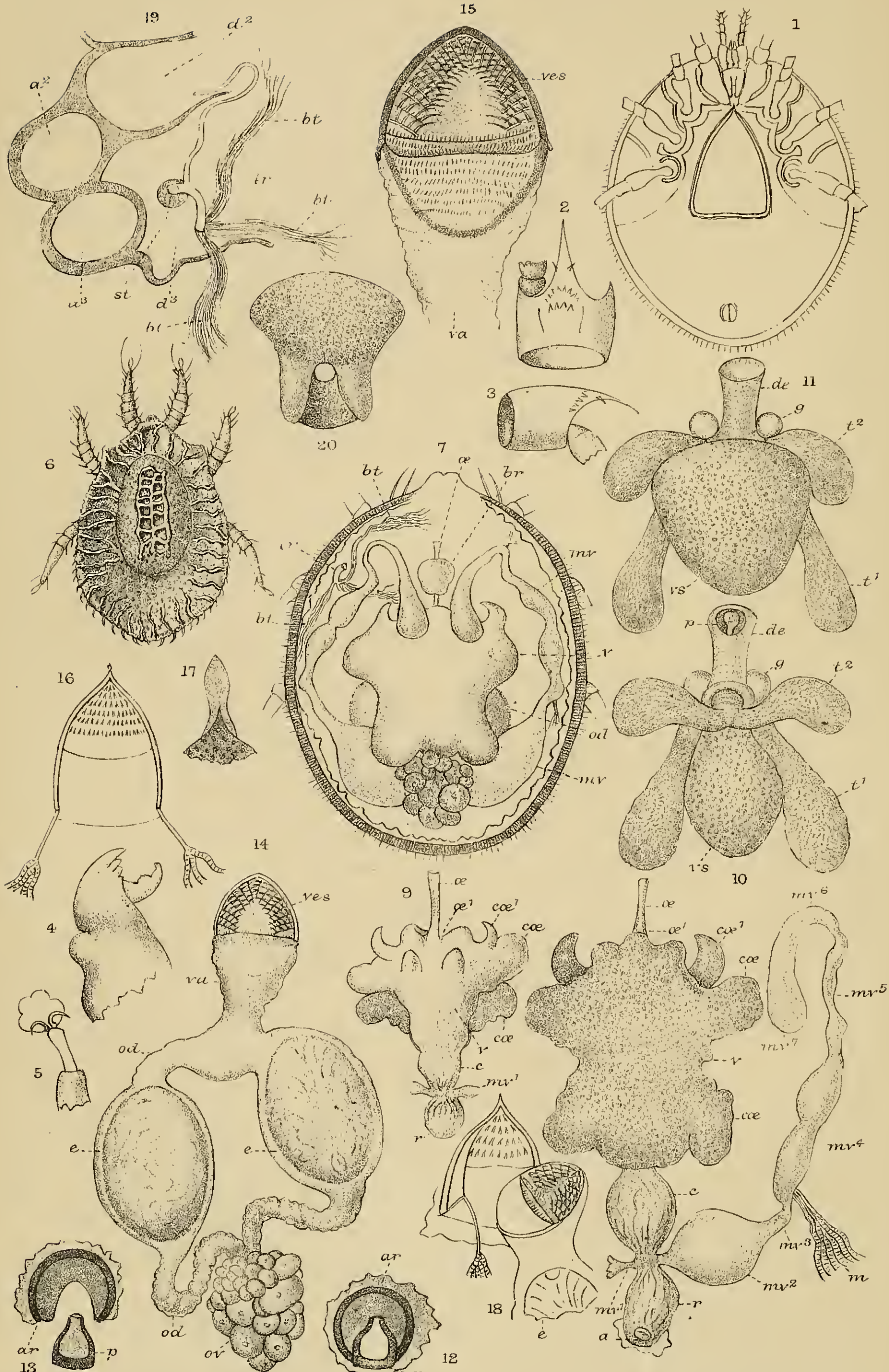

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Anatomy of Uropoda Krameri.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1889.

TRANSACTIONS OF THE SOCIETY.

I.—*Observations on the Special Internal Anatomy of Uropoda Krameri.*

By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S., &c.

(*Read 9th January*, 1889.)

Plate I.

The anatomy of the exo-skeleton, and of the trophi, of *Uropoda* has already been studied and figured by M. Megnin,* who selected *U. vegetans* for his purpose; and in many particulars by Dr. Kramer; † and lately in the undermentioned paper by Herr W. Winkler. I therefore confine these observations to the internal anatomy, and I shall only mention such parts of the external structure as it may be

EXPLANATION OF PLATE I.

œ, Œsophagus. *œ*¹, Enlargement of same before entering the ventriculus. *v*, Ventriculus. *c*, Colon. *r*, Rectum. *a*, Anus (seen through the rectum from the transparency of the latter). *cæ*, Larger cæca of the ventriculus. *cæ*¹, Smaller ditto. *mv*, Malpighian vessels. *mv*¹, Ditto, narrow neck where the vessel arises. *mv*², Ditto, enlarged chamber. *mv*³, Ditto, narrow part between the chamber and the lateral enlargement. *mv*⁴, Ditto, lateral enlargement. *mv*⁵, Ditto, anterior narrow portion. *mv*⁶, Ditto, reflexed portion. *mv*⁷, Ditto, blind end. *m*, Muscles with tendinous attachments. *m*¹, Attachment to the side of the body. *t*¹, *t*², Testes. *v s*, Sack-like organ (vesicula seminalis ?). *g*, *g*, Oil-glands. *d e*, Ductus ejaculatorius. *p*, Penis. *ar*, Protecting armature of same. *ov*, Central ovary. *od*, Oviducts. *e*, *e*, The fully, or nearly fully, developed eggs contained therein. *va*, Vagina. *ves*, Vestibule. *g p*, Genital plate. *br*, Brain (so called).

All the figures represent *Uropoda Krameri.*

Fig. 1.—Under-side of adult female × 55. The genital plate would fill up the genital aperture exactly. The small space necessarily left between the two in the figure is to keep the lines distinct.

„ 2.—Epistome and oral tube of adult, seen from above, × 175. The basal joints of the palpus are indicated on the left side only.

„ 3.—The same, seen from the side; same amplification.

„ 4.—Chelate portion of the right mandible of adult male, seen from the right (outer) side, × 350.

* "Mémoire sur l'organisation et la distribution zoologique des Acariens de la Famille des Gamasidés," Journ. de l'Anat. et de la Physiol. (Robin), 1876, pp. 288-336.

† "Zur Naturgeschichte einiger Gattungen aus der Familie der Gamasiden,' Archiv für Naturgesch., 1876, pp. 28-105.

necessary shortly to refer to, in order to explain the organs connected with them.

The *Uropodinæ* are a subfamily of the *Gamasidæ*, but are in many important respects exceptional: the position of the first pair of legs, the coxæ whereof are inserted within the oral tube, the position of the male genital organ, and the slender mandibles form well-marked distinctions. The general appearance also is different from that of most of the *Gamasidæ*, so much so indeed that Hermann * included the species discovered by him (*U. cassideus*) in his genus *Notaspis*; a genus intended to be entirely composed of what we now call *Oribatidæ* (Latreille's earlier name of *Oribata* having excluded Hermann's *Notaspis*).

During the summer of 1888, when staying at a farmhouse in Derbyshire, I found *Uropoda Krameri* (Canestrini)† in great abundance on the floors and walls of an old barn used for storing hay. This

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Fig. 5.—Claw and caruncle, highly magnified.
„ 6.—Larva.
„ 7.—General view to show the arrangement of the principal internal organs of the adult female, × 65. The whole of the dorsal chitinous plate has been removed, except the striated band round the periphery, and a small portion within this, which is shown by its broken outline. The masses of fatty matter and almost all the muscles have also been removed. For the sake of clearness, the respiratory system is shown on the left side only, and the tendons and commencement of the muscles whereby the Malpighian vessels were attached to the dorsum and side, are shown on the right side only.
„ 8.—Alimentary canal and Malpighian vessels seen from above, × 70. The drawing is made from a large and apparently well-nourished specimen immediately after dissection. The Malpighian vessel is shown on the right side only, its commencement being indicated on the left.
„ 9.—The alimentary canal seen from below, × 70. This drawing was made from a smaller and possibly less well-nourished specimen, after the dissection had been partially prepared for permanent preservation.
„ 10.—Internal sexual organs of adult male seen from above, × 70.
„ 11.—The same from below; same amplification.
„ 12.—Penis in its ordinary position resting in its armature, × 175.
„ 13.—Penis withdrawn from its armature, × 175.
„ 14.—Internal genital organs of adult female seen from below, × 70.
„ 15.—Vestibule looking straight upwards into the mouth from below, × 160.
„ 16.—Genital plate seen from within, × 75.
„ 17.—Point of the same, showing the thin lanceolate termination, × 300.
„ 18.—Genital plate and vestibule, × 70. General view to show the relative size, and the mode in which they would fit against each other. The vestibule is turned to the right and backward; the oviduct being thereby twisted.
„ 19.—Respiratory system of the left side, highly magnified, seen from within the body. ac^2, acetabulum for reception of 2nd coxa. ac^3, ditto for 3rd coxa. d^2, depression for reception of 2nd leg. d^3, depression for reception of 3rd leg. *st*, stigma. *pt*, peritreme. *tr*, main tracheal stem. *bt*, *bt*, *bt*, bundles of fine tracheæ.
„ 20.—Brain (so called), and œsophageal ganglionic collar. The hole near the centre is where the œsophagus passed through; it has been removed.

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* 'Mémoire aptérologique,' Strasbourg, 1804.

† I believe the species to be *U. Krameri*; I have not, of course, Professor Canestrini's type specimen to compare the anatomy, but the creature appears to agree with his description and with Professor Berlese's drawing, which is stated to be taken from that specimen. 'Acari Miriapodi e Scorpioni Italiani,' fasc. xi.

seemed to me a favourable opportunity for ascertaining something about the internal anatomy. As I investigated the matter I found it very interesting; especially from the numerous resemblances to the corresponding organs in the *Oribatidæ*, which I had previously studied. The main features of the internal structure turned out, as might be expected, to be essentially of the Gamasid type, still there were found to be many points in which there was an approach to the organization of the *Oribatidæ*; thus showing that the external resemblance which deceived Hermann was accompanied by certain modifications of the internal parts, producing a condition somewhat intermediate between the types of the two families.

The investigations were carried on entirely by dissection, in the same manner as I had previously conducted those relative to the *Oribatidæ*.* Preparations of the actual organs therefore remain in my possession for reference, and as proofs of the correctness of these notes. All dissections have been frequently repeated.

Upon my return to London, I found that during my absence an important and excellent paper upon the anatomy of the *Gamasidæ* had been published by Herr Willibald Winkler.† This paper, although it principally treats of the anatomy of the genus *Gamasus*, deals also to a lesser extent with that of *Uropoda obscura* (Koch). Herr Winkler's investigations were clearly prior in date to mine, but of course mine were conducted, and this paper written, and the drawings made in entire ignorance of them. Under these circumstances our observations necessarily cover a portion of the same ground; but on the other hand, large parts of the two works do not overlap. Herr Winkler's treatise is greatly devoted to the histology of the subject and to the mouth-parts, the nerves, &c., which I have not touched upon; while I think a good deal will be found in the following pages that has not been included in Herr Winkler's investigations, and, indeed, many of the organs may differ, or may not exist, in the species which he has selected. I thought at first that it would be better to eliminate from this paper snch portions as were covered by the German memoir, but I found that doing so would render the remainder obscure, the connection of subjects being broken. I have therefore thought it best to retain them, making this acknowledgment of Herr Winkler's priority, but I have usually mentioned where he has described the same thing, and of course I have pointed out any differences which have struck me, although these are not numerous nor specially important.

General Arrangement of the Organs. Fig. 7.

When the dorsal shield, and the fatty matter which underlies it are removed from *Uropoda Krameri*, and the muscles of the mandibles, &c., so far cut away as to enable the operator to see the other parts clearly, the arrangement of the principal organs is found to be that

* 'British Oribatidæ,' Ray Soc., 1884, p. 142.
† "Anatomie der Gamasiden," Arbeit. Zool. Inst. Univ. Wien, vii. (1888) pp. 317–45.

shown in fig. 7, which is a female; but it must be remembered that no two specimens agree exactly in the relative size, shape, and arrangement of the various organs; indeed the two sides rarely absolutely correspond. Moreover, in consequence of the highly elastic and extensile nature of some of the parts, considerable differences occur in the appearance of the same side of the identical specimen from time to time; the general arrangement is, however, naturally always similar. The mouth-opening in *Uropoda* is in the ventral plate, some little distance from the point of the rostrum, and consequently the alimentary canal does not commence at the anterior end of the body-cavity, the space in front of it being occupied partly by muscles and tracheæ, and being partly unoccupied. The ventriculus may be seen lying nearly centrally and occupying a large portion of the entire space; the œsophagus proceeding from it forward and slightly downward. The great supra-œsophageal ganglion is seen in the central line near the ventriculus, while the hinder portion of the canal is entirely concealed by the central ovary. A very large Malpighian vessel on each side may be seen, usually filled with white opaque matter. The posterior ends of these tubes are concealed beneath the central ovary, while the vessels run at the side of, or slightly under, the ventriculus, but extend as far forward as the mouth-opening, or even a little beyond its commencement; and then turn sharply backward so as to fall over the anterior edge of the ventriculus and lie upon it. The larger eggs in the oviducts may commonly be just seen, below all the above-named organs, projecting at about the middle of the ventriculus. The tracheæ will also be seen, arranged at first in three principal bundles, and then separating out, as explained below.

The Alimentary Canal. Figs. 8–9.

The canal has a great general resemblance to that of the *Oribatidæ*, but is composed of finer and more delicate tissues, which renders it very difficult to get the whole canal out perfect without breaking it, although there is comparatively little difficulty in dissecting it out in pieces.

There can scarcely be said to be any pharynx in the sense of an enlarged chamber, such, for instance, as the pharyngeal sac of Huxley in *Scorpio;* a hardly perceptible widening of the œsophagus before it enters the mouth-cavity being all that exists; but if the anterior portion of the œsophageal tube, i. e. the portion to which the dilator muscles for suctorial purposes are attached, although scarcely if at all enlarged, is to be regarded as a pharynx; which appears to be the mode in which Herr Winkler uses the term in this instance, then of course it would exist, but not be distinctly divided off from the œsophagus. This is practically a question of nomenclature: I have used the word "œsophagus" for the whole, which appears to agree with its use by MacLeod, Henkin, Nalepa, and others, in other families.

The œsophagus (*œ*) is long, about half the length of the ventriculus, and is quite straight and very thin and small in diameter; it has exceedingly delicate, semitransparent walls, without the conspicuous circular bands of muscle so commonly found embracing the corresponding part in the Oribatidæ. The œsophagus proceeds upward and backward from the mouth to the anterior edge of the ventriculus, which it enters on the ventral aspect of that viscus, and a trifle behind its anterior margin. There is a slight enlargement of the œsophagus before entering the ventriculus, but not anything of the nature of a proventriculus, or sucking stomach. During life, slow, regular, peristaltic movements may sometimes be seen passing along the œsophagus in a backward direction.

The ventriculus varies considerably in form; it is a large organ in comparison to the size of the creature, occupying nearly half the length, and nearly two-thirds of the width of the body. It is compressed dorso-ventrally. The principal mass is more or less trapeze-shaped, the anterior margin is, however, always somewhat the wider, and appears more so than it really is in consequence of the arrangement of the cæca. The hind-margin is rounded (fig. 8), or prolonged in the central part (fig. 9), so as to extend somewhat backward. The whole organ is much stronger and more muscular than any other part of the canal. The cæca of the ventriculus, particularly during life, are comparatively shallow, and widely open; often almost losing the character of cæca and becoming mere lobes or pockets. They are arranged as follows, viz. there are four principal lobes (*cæ*), these proceed from the dorsal level, and are rounded projections of the corners of the ventriculus, irregular in form, and often having the outlines more or less divided into secondary very shallow lobes, or wrinkles. Of these four lobes the anterior pair project outward, while the posterior pair are directed rather backward, and often have a tendency to curl inward. The anterior margin of the ventriculus, between the front pair of larger lobes, is almost wholly occupied by five smaller lobes; the three central of these are rounded and very shallow, and are indeed little more than undulations; they proceed from the dorsal part of the anterior edge. The remaining pair are a little longer, although still short, and are curious horn-like structures curving toward the median line and pointed ($cæ_1$); they arise from the ventral part of the anterior edge. In addition to the eight above named there are usually a pair of small, rounded, mamillary projections from the ventral surface (fig. 9).

In the large size of the ventriculus, and the shortness of the cæca which proceed from it, the ordinary Gamasid type seems to me to be departed from. In the genus *Gamasus*, &c., the ventriculus is often a comparatively small and narrow organ, which appears as if its chief office were to form a point of communication between its own enormous cæca and the hind-gut. These cæca often extend quite from the anterior to the posterior extremity of the body, and are irregularly placed, intertwining with the Malpighian vessels to some extent, and forming the largest and most conspicuous organs of the body. The large ventriculus of *Uropoda Krameri* much more resembles that of some of the *Oribatidæ.* It is true that in the latter family also the cæca, although only two, are usually large, and form much more important organs than in *Uropoda Krameri*; but in the typical forms of the genus *Damæus* (*Oribatidæ*) the cæca are in a similar condition, having become mere lobes of the ventriculus, even less developed than in the *Uropoda* here spoken of. The ventriculus is the "Mitteldarm" of Winkler. Kramer in 1876 * indicated somewhat of this difference between *Uropoda* and *Gamasus.* Winkler is inclined to deny it, but Winkler's *Uropoda*, which he speaks of as having long cæca to the ventriculus, must be very different from *U. Krameri*, of which species I have dissected large numbers, and always found the ventriculus in the condition above described.

There is not any small intestine in *Uropoda Krameri*; the colon proceeds direct from the ventriculus, arising from the ventral surface of that organ, very near to, but not quite at, the posterior margin. The colon is almost globular, but not quite, being slightly elongated; it is directed almost perpendicularly downward; it is sharply constricted, both anteriorly where it arises from the ventriculus, and posteriorly where it communicates with the rectum. These constrictions are like gatherings-in of the walls of the canal, appearing folded or wrinkled at these points as if a loose sack were drawn in by a circular tie. A very short and narrow neck connects the colon with the rectum; it is this neck which receives the Malpighian vessels, as mentioned hereafter. The rectum is very similar to the colon, usually a trifle smaller and less globular in form; it is also less sharply constricted at the posterior end where it surrounds the anus (fig. 8), which is a very small lenticular opening in the chitin of the ventral plate. It can be closed by somewhat chitinized folds of the inner cuticle, and is protected exteriorly by an elliptical chitinous ring in the ventral plate; this ring touches the anal opening at the ends, but not at the sides.

I have purposely left the above description of the hind-gut as I wrote it before seeing Winkler's paper. I have adopted the same nomenclature as I formerly employed relatively to the *Oribatidæ.* I find, however, that what I call the colon Winkler calls the hind-gut ("Enddarm"), and what I call the rectum he also states to be the rectum, but he usually calls it the excretionary collecting bladder ("Sammelblase der Excretionorgane"), and he considers it to be a portion of the excretionary system (Malpighian vessels), not of the alimentary canal.

It would probably be more convenient if words such as "rectum," "colon," "œsophagus," &c., which are used in describing the higher animals, were excluded from works on the lower creatures, such as the *Arthropoda*, altogether; but if this be not done the question of

* "Zur Naturgeschichte einiger Gattungen aus der Familie der Gamasiden," Archiv für Naturgesch., 1876, p. 63.

nomenclature becomes somewhat arbitrary, and is probably of little importance so long as it is clearly indicated exactly what the organs are like; but the question of whether the sack-like organ adjoining the anus is a portion of the alimentary canal or of the Malpighian vessels is possibly more substantial. There cannot be any doubt that the organ in question is, so to speak, a cloaca, into which both the systems discharge, and which conveys the excremental matter from both to the anus. In the *Gamasidæ* the amount of matter discharged by the Malpighian vessels is large, and that furnished by the canal is small compared to what it is in the *Oribatidæ* and many other families; thus the former is sometimes in excess in the contents of the organ in question. Herr Winkler also gives histological reasons for considering this viscus to be part of the former system; but on the other hand, the hind-gut of *Uropoda Krameri*, as I have so frequently seen it, if this organ, which I call the rectum, be included as part of it, agrees almost exactly with that of the *Oribatidæ*; in which family the Malpighian vessels do not exist in this situation, and do not communicate with this organ nor with the hind-gut at all. Moreover, this rectum, as I call it, follows what I call the colon in the ordinary manner in the species I am treating of, and constantly, indeed usually, contains balls of the rejected portions of the digested food, similar to those in the colon, and similar to those found in the rectum of the *Oribatidæ;* also it seems to me more consonant with one's ordinary ideas to consider the viscus by which the alimentary canal discharges to the anus as being the rectum in the usual sense of the word. I think, therefore, that this organ should be regarded as primarily a portion of the alimentary canal, although functioning as a cloaca. I do not gather from Herr Winkler's description at what exact point the canal and Malpighian vessels discharge into this organ, which I call the "rectum," nor how the discharged matter passes through it to reach the anus; but if I understand his drawings correctly, there must be some difference in these respects between his species and *Uropoda Krameri.*

The Excretory System. Fig. 8.

This is entirely of the *Gamasus* type, and does not in any way resemble that of the *Oribatidæ;* it consists of two very long sack-like organs, which may probably be correctly called Malpighian vessels (fig. 7, *m v*); they are arranged bilaterally, one on each side of the body, and are usually more or less filled with opaque white excremental matter from end to end. These vessels arise, one on each side, from the narrow neck of the alimentary canal which connects the colon with the rectum. Each vessel commences with a short tubular portion of small diameter (fig. 8, $m\,v^1$), which, indeed, is a necessity to enable it to spring from the very constricted part of the alimentary canal where it is placed. This narrow part leads into an elliptical chamber ($m\,v^2$), which is far the largest portion of the vessel in diameter and capacity; it is often as large as, or larger than, either the colon or rectum. From this chamber a second narrow portion ($m\,v^3$), which is considerably longer than the first, but not so sharply defined, leads to a lateral enlargement slightly constricted in the middle ($m\,v^4$); this portion is in shape like two elongated pyriform organs with their larger ends together and fusing; but, of course, the lumen is continuous. From this enlarged lateral portion another narrow part ($m\,v^5$) of the vessel, much longer than the previous narrow parts, and more undulated, runs forward nearly to the articulation of the second leg. Up to this point the Malpighian vessel has been placed at the side of, or slightly under, the ventriculus: the extent to which it passes under varies in different specimens, and probably in the same specimen at different times, depending on the relative distension of the canal and the Malpighian vessels respectively, and on the precise form and position of the latter, which are not by any means constant. After attaining the point to which it has been described, viz. about the articulation of the second leg, the course of the vessel entirely changes; it turns sharply upward and then backward, so that it folds over the anterior edge of the ventriculus, and the remainder of the vessel is a reflexed portion ($m\,v^6$), which lies upon the ventriculus and runs straight backward. It gradually enlarges towards its distal end, which is blind and rounded ($m\,v^7$). A powerful fasciculus of muscles (m) which arise from the sides and dorsal cuticle, are inserted by tendinous attachments into the wall of the vessel just behind the lateral enlargement, and probably assist in the peristaltic movements. The vessel is also attached to the side of the body at m^1, but in this case apparently merely as a tie, not by muscles of any importance. The peristaltic movements and the transfer of excretory matter, of course, proceed from the blind end of the vessel toward the rectum, and are stronger than those of the canal; this is usual in the *Gamasidæ,* but the movement is not so strong as in *Dermanyssus,* and many other members of the family. The Malpighian vessels are generally more or less distinctly seen through the dorsal shield in living specimens, and are the most conspicuous organs in the body; they are equally conspicuous in the nymphs and larvæ, and may even be clearly seen in the advanced embryo while still within the egg, and at that early period they are already filled with the white matter.

The Reproductive Organs.

This system is another of those which bears a strong resemblance to that of the *Oribatidæ*, but naturally there are differences of considerable importance, as will be seen in the following description.

As in most other families of the *Acarina*, these organs, during the period of activity and maturity, are extremely large in proportion to the whole size of the creature; so much so that they often appear to push all the other organs out of place; this, as might be anticipated, is more especially the case with the female when the eggs are ripe.

The annular form of the system, taken as a whole, which is so well known in the *Arachnida*, and which is so conspicuous in that of the *Oribatidæ*, is equally clearly shown in the female of *Uropoda Krameri;* but in the male this form is more lost, in consequence of the absence of the long vasa deferentia which form an element of the ring in the *Oribatidæ*. Probably it is only those who know how the ring is formed in the males of the last-named family who would recognize some vestige of it in those of the *Uropoda*.

The Male. Figs. 10–13.

The male organs lie almost immediately below the ventriculus; they consist of a central chamber, six more or less sack-like organs, and a large single duct leading to the penis. The most conspicuous of these is the central chamber (*v s*), a large heart-shaped organ compressed dorso-ventrally, and having the broader end turned forward; this organ is the nearest to the ventral level, the other parts of the system lying slightly above it. I take it to be partly glandular in its office, and also to some extent to function as a vesicula seminalis; in which case it would agree with the corresponding organ in the *Oribatidæ;* and this appears to be Winkler's view with regard to the organ in his species, *U. obscura*; in which case, however, the organ appears from his description to be more globular.

Four long, sack-like, glandular organs (t^1, t^2) take their origin immediately above the central chamber, and near its anterior margin. They do not appear to communicate directly with the central chamber, but all seem to open into a small median antechamber. The sacks are pyriform, smallest where they enter the antechamber, and largest at the blind, free ends. One pair, which are usually somewhat the larger, are nearly straight, and are directed almost backward. The corresponding organs in *U. obscura* are regarded by Winkler as being the true testes. The second pair, the mouths of which are placed above those of the first pair, are more curved, or comma-shaped; they are directed almost transversely across, and partly under the central chamber; their distal ends curve backward. If these correspond to the second pair of sacks figured by Herr Winkler in his diagram he regards them as accessory glands, not testes; but as he only mentions four sacks in his species, and I find six in mine, it is probable that his accessory glands correspond to the smaller sacks (oil-glands) mentioned immediately below, and that the pair of organs now treated of are rather to be regarded as a second pair of testes; at all events they greatly resemble the first pair. In addition to these four there are the two other sacks above referred to (*g*), they are much smaller and almost globular. These organs have thin walls, and contain only a highly refractive oily liquid. They are placed one on each side of the ductus ejaculatorius, and apparently communicate with the small median antechamber. Somewhat similar organs exist in a few of the *Oribatidæ*, but not in all.

The ductus ejaculatorius, as it may probably be called, is a large, straight tube, running forward and downward in the median line; it enlarges a little, gradually, before reaching the external genital armature, which it surrounds. The penis (*p*) is a short, chitinous, pyriform or gourd-shaped organ, situated exteriorly on the ventral surface in the median line, between the coxæ of the third pair of legs. It is protected by a chitinous armature (*ar*) formed of a circular ridge, sufficient of the circle being cut away to admit the broad end of the penis, and of a thinner, but still stout, lamina within the circle. This lamina is also cut away to fit the penis, the distal end and edge of which, however, when the organ is not in use, slip under the edge of the lamina, the whole organ then presents the appearance of a chitinous ring surrounding a thin circular plate with a gourd-shaped opening in it; the chitin of the penis, when seen through from the side, being much thinner than that of the lamina. This is represented by figs. 10, 12, while fig. 13 shows the intromittent organ withdrawn previous to erection.

The Female Organs. Figs. 14–18.

The female reproductive organs consist of a central ovary; two long, paired oviducts; an unpaired vagina; and the vestibule. The organs, as before stated, practically form a ring; and they greatly resemble the corresponding parts in the *Oribatidæ*; but there is one very marked difference, viz. the entire absence of the long, protrusible, and collapsible ovipositor, which forms so conspicuous a feature of the system in that family; and its replacement to some extent by the vestibule, which, however, is strictly an internal structure. The central ovary (figs. 7–14, *ov*) is placed in the median line, almost at the posterior end of the body; it naturally varies in size and form, but it most commonly has the general appearance of a bunch of grapes with the small end the nearer to the posterior margin of the body. This ovary looks as though entirely composed of eggs in an early stage of development; the eggs are not by any means all the same size, but it seems strange that, in all specimens which I have dissected, the smaller eggs have been clustered round the entrance to the oviducts, while the larger eggs were chiefly at the hinder end and periphery of the ovary; this would be comprehensible enough if the eggs were placed dehisced into a body-cavity, but this does not appear to be the case; one is therefore led to suggest that the eggs may possibly work backward along the periphery of the mass, and then forward to the mouth of the oviduct through the centre of the mass. Even the largest eggs in the ovary show the nucleus clear and undivided, not the least sign of yolk-division. The oviducts are thin, transparent tubes of moderate length, and considerably curved or undulated, but they cannot be called convoluted. They are evidently very capable of distension and contraction, and when not distended by eggs are generally strongly corrugated. They almost always contain two eggs (*e, e*), one on each side. I have not ever seen more than one egg in each oviduct at once, sometimes I have found the oviduct on one side without any egg in it. These eggs are extremely large in proportion to the size of the creature; the chorion is thin and almost transparent, and the embryo within may generally be seen, often apparently fully-formed and ready to emerge; but I have not ever noticed any motion of the embryo as a whole, the position with the legs folded closely to the body being always the same. Winkler appears only to have found a single, short, unpaired oviduct in *Gamasus*; he does not say what there was in his species of *Uropoda*. The two oviducts of *Uropoda Krameri* terminate in the median line, where they enter the short, and rather wide, azygous vagina (*va*). This organ is also much corrugated, and is evidently capable of considerable distension, it terminates in the vestibule (*ves*). I have again used the nomenclature which I employed when I described the corresponding parts in the *Oribatidæ*. What I call the "vagina" Winkler calls the "uterus." I avoided that term because it conveyed to my mind the idea of an organ wherein the ovum was matured or developed; now this is not the case with the part in question; the development of the egg within the body, after leaving the ovary, takes place entirely in the oviduct; the passage through what I call the "vagina" must be very rapid, for I have not ever found an egg in it either in *Uropoda Krameri* or in the Oribatidæ, although I have dissected very large numbers. As the oviduct of Winkler's *Gamasus* is unpaired it is not easy to say for certain where the corresponding part ends, and where the part corresponding to his "uterus" begins in *Uropoda Krameri;* possibly his "uterus" may include the homologue of a portion of the oviducts of my species, particularly as he says that the egg is to some extent matured in it. What Winkler calls the "vagina," apparently corresponds to what I call the "vestibule," but the organ in *Uropoda Krameri* differs greatly from anything which Winkler describes in his species; it is singular and somewhat complicated, it may, perhaps, be said to be broadly lenticular in the general form of the chitinous bar which surrounds its mouth, and which would be called a "ring" if it were round; but it is not truly lenticular, because, although the curved sides meet sharply so as to form a point anteriorly, yet they meet more vaguely so as to form a curve posteriorly. A little behind the centre is a slight chitinous projection from the exterior of the bar on each side, and from the inside of the bar, just opposite the projection, a much slighter bar runs across the ring. The transverse bar, although its direction is straight, as regards its course across the body, yet curves upward a little in a direction perpendicular to the ring. This transverse bar practically forms the thickened edge of the plate hereafter mentioned as forming the roof of the vestibule. An extension or continuation of the thin membranous walls of the vagina is attached round the outside of the chitinous ring, and a stouter convex portion stretches across, and entirely covers the hinder half of space inclosed within the ring; thus the whole organ looks like an old-fashioned watch-pocket. This will be understood most easily from figs. 14, 15. It must be remembered that those figures are drawn as though the spectator were looking straight upward from below. In consequence of this formation only the anterior half of the ring is really open for the passage of the egg, but it is, of course, possible that at the moment of the egg passing the transverse bar may bend a little and the membrane stretch a little; but even then the opening would be very much smaller than the egg that has to pass through it. The inside of the parietes of the pocket is provided with several transverse rows of long, closely-set teeth or villous processes, not probably hard enough to be properly called teeth or spines, but yet stronger and firmer than ordinary hairs. The roof of the vestibule above the open (anterior) half of the ring is covered by a thin chitinous plate, of which the transverse bar before mentioned forms the posterior edge. The median portion of this plate is plain, without processes, the plain part forms about one-third of the width. The outer portion, all along the lateral and anterior regions of the plate, is occupied by a series of radiating lines of processes similar in nature to those above described, but larger. Sometimes these processes spring from slight ridges, and the part of the plate which carries them is slightly convex, although the form of the plate taken as a whole is concave. The large, but more or less soft, egg must be forced through the comparatively small opening of the vestibule and between all these processes. I am not able to say with certainty what the office of these processes is, as I have not ever succeeded in seeing one of the creatures in the act of oviposition. Winkler suggests that the office of certain scattered chitinous spines, which he found in what he calls the "vagina," is to hold, and prevent the escape of, the spermatophores or balls of spermatozoa which he found in that organ. I am fully aware that some species of the genus *Gamasus* are fecundated by the introduction of spermatophores into the genital opening of the female; indeed, in the year 1886 I pointed out that this was the case in at least one species of the genus, and I also described the process by which it was effected, which I had been fortunate enough to observe.* I can scarcely think, however, that the retention of spermatophores is the sole office of so elaborate an organ as the vestibule of *Uropoda Krameri*; an organ very different apparently from the female genital opening in Winkler's species; particularly as I have not noticed spermatophores or balls of spermatozoa in the vestibule of *Uropoda Krameri*. Three possible further uses suggest themselves, viz. firstly, that the processes are simply to exclude dust, &c.; this, however, is not altogether probable, as the vestibule is covered exteriorly by the closely fitting genital plate; and, moreover, neither this idea nor that of retention of spermatophores, would explain the presence of similar processes on the inside

* "Observations upon a Species of *Gamasus* supposed to be unrecorded," Journ. Quek. Micr. Club, ii. (1886) pp. 263–4.

of the genital plate (as mentioned below). Secondly, the processes may hold the egg in position so as to assist in its being forced out by spasmodic contractions of the vagina. Thirdly, it is not impossible that *Uropoda Krameri* may be ovo-viviparous, the young larva escaping from the egg at the moment of deposition. If this be so, the forcing of the egg through the narrow opening of the vestibule, between these numerous processes, would probably serve to break and strip off the thin chorion of the egg, allowing the larva to escape. This last explanation is rendered more probable by the very advanced state of development in which the eggs are found in the oviducts, and also by the fact that where I found this *Uropoda* so plentifully there were numerous larvæ and nymphs, but I was not able to find any eggs. I tried keeping a number of the *Uropoda* in confinement in a cell, but I did not get any eggs. The creatures, however, are difficult to keep in good condition in confinement, which may possibly explain the absence of eggs from my cell.

The genital plate (fig. 16; and figs 1, 18, *g p*) is the external door in the ventral surface by which the egg, or larva, if the creature be ovo-viviparous, emerges from the body of the mother. It is a triangular plate with curved sides, and is slightly convex externally and concave internally. Its lateral margin is thickened and slightly turned in. The posterior edge is almost straight, with very slightly rounded corners. At this hinder edge the plate is attached on the interior to the ventral plate by the quasi-membranous lining common to both; thus a ginglymus hinge is formed. The genital plate exactly fits into the opening in the ventral plate, but the anterior end of the genital plate is prolonged so as to form a long chitinous point; this has not any opening or depression in the ventral plate to receive it, but lies wholly outside the latter. The lateral edge of this genital plate has a thin, chitinous, curved, more or less triangular lamina standing on edge slightly within the lateral margin of the inner side of the plate (fig. 16); the broad part of this lamina is the hinder part, and to its upper angle the occlusor muscles of the plate are attached by tendons which unite to form one long and very substantial tendon, which is inserted at the above-named point of attachment, in the manner so frequently found in the *Acarina*, especially the *Oribatidæ*. The size of the genital plate is really surprising; it occupies almost the whole space between the legs; its posterior edge is considerably behind the coxæ of the fourth pair of legs, while its anterior point reaches those of the first pair of legs, and almost touches the singular tactile organ found in most *Gamasids*, and which Kramer has called the ventral palpus ("Bauch-Täster"), and Winkler considers to be the labium. Of course this plate greatly more than covers the opening of the vestibule, indeed that opening only corresponds to about the anterior half of the genital plate. This anterior portion of the genital plate is strengthened by a thin interior plate about the size and shape of the opening of the vestibule; and all this plate, except a small part at the hind margin, is thickly set with processes similar to those described as arising from the interior of the vestibule. In fig. 18 the genital plate and vestibule are shown. They have been artificially turned rather away from each other on their left sides, the vestibule being somewhat twisted on the vagina. The drawing is intended to give an idea of how they would fit against one another if the vestibule were allowed to return to its natural position facing the genital plate.

The Respiratory System. Fig. 19.

So far as is known, in all *Gamasidæ* the breathing-organs are tracheæ; those from each side communicate with the exterior by a single stigma, which is usually placed between the second and third pairs of legs. This stigma does not open directly to the exterior, but into a long tubular peritreme in the thickness of the chitinous cuticle. This peritreme varies in form according to the species, and is often much undulated or tortuous; it most frequently opens to the exterior in front of the second pair of legs.

In the typical species of the genus *Uropoda*, and indeed in all species if Kramer's definition of the genus be adopted, the ventral plate has large shallow depressions in it within which the respective legs, when folded up, can be laid so as not to project below the body. These depressions are wide, and there is one for each leg of the second, third, and fourth pairs; they occupy almost the whole of the ventral surface of the body between the coxæ of the legs and the lateral margin. Being wide, the depressions come close together, and are only divided from each other by a ridge formed by the narrow strip of the ventral plate which is not depressed. These depressions —if that word can be allowed—are bendings-in of the ventral plate; so that although each depression is concave when seen from without, yet it is convex when the ventral plate is seen from the dorsal side, i. e. from within the body (of course in order to see it thus it must be dissected off, or else the dorsal plate and all the principal interior organs must be removed). When seen thus, what from the exterior appear ridges between the depressions assume the form of narrow trenches between convexities.

The stigma on each side of *Uropoda Krameri* is situated in a small plate-like thickening near the middle of the interior of the depression for the third leg. The peritreme (fig. 19) runs diagonally forward and outward until it reaches the trench (the ridge externally) which divides the depressions for the third and second legs; the peritreme runs along the side wall of this trench and turns round the end of it in a hook-like manner, terminating by a very fine ending in the depression for the second leg.

From the stigma a short, single tracheal trunk curves backward and upward (into the body); from the hinder end of the trunk the whole of the tracheæ which supply the body proceed. The tracheæ are long and excessively fine; they are *entirely unbranched*, being only simple tubes of extreme tenuity. This unbranched condition of the tracheæ is similar to that of the same organs in the *Oribatidæ*, although the number of tracheæ is far larger, and each trachea much finer, in the *Uropoda* than in the *Oribatidæ*, but it is not always nor, I think, usually, found in the *Gamasidæ*. I have not examined any large number of species belonging to this family, for the purpose of ascertaining this point, but certainly in *Dermanyssus*, the tracheæ, although not branching so frequently as they usually do in insects, do branch in a very clear and decided manner, sometimes dichotomously, sometimes into three branches, and almost always enlarge so as to form a slight swelling immediately before branching. Herr Winkler expressly notices the branching of the tracheæ in the genus *Gamasus*, which agrees with the cases where I have noticed the tracheal system in the same species. Herr Winkler does not mention the unbranched condition in *Uropoda*, probably he did not examine it for that purpose, or else his species differs from mine.

The tracheæ of *Uropoda Krameri*, when they start from the end of the tracheal trunk, are in three bundles (*bt*), one of which is directed forward, one backward, and one across the body. Each bundle might easily be mistaken for a single trachea, but if a bundle be lifted up with a hair and allowed to fall on a minute drop of water then all the tracheæ will float and spread out, and the whole will present the appearance of a skein of floss-silk which has been separated by a puff of wind. Of course the bundles finally separate and supply the various parts of the body.

The walls of the tracheæ are extremely delicate. I have not been able to trace any spiral filament or thickening merely by looking at the tracheæ, but probably some kind of spiral structure might be demonstrated by other methods.

The Brain, or Œsophageal Ganglia. Fig. 20.

As is usual in the *Acarina*, the great ganglia in *Uropoda* are round the œsophagus. A very large supra-œsophageal ganglion (the so-called brain in the *Acarina*) lies immediately above the œsophagus near where it enters the ventriculus; this "brain" is compressed dorso-ventrally, and has a somewhat convex anterior margin which is considerably wider than the hind margin. From under the edge of the supra-œsophageal ganglion a very wide commissure runs perpendicularly downward on each side of the œsophagus, and joins a sub-œsophageal ganglion which is large, but considerably smaller than the supra-œsophageal ganglion. These ganglia and commissures are so substantial, and so closely joined together, that they form a solid collar round the œsophagus, the commissures, if commissures they be, not being distinctly differentiated, and with care the œsophagus may be pulled out from the centre of the nervous collar, which then shows a distinct and well-defined hole, or tunnel, through which the œsophagus passed.

II.—*List of Desmids from Massachusetts, U.S.A.*

By Wm. West, F.L.S., Lecturer on Botany and Materia Medica at the Bradford Technical College.

(*Read* 14*th November*, 1888.)

Plates II. and III.

Mr. John M. Tyler, of Amherst College, Massachusetts, has kindly sent me a few tubes of Algæ from the neighbourhood of Amherst, in which I have noted the Desmids detailed in the following list. Other interesting Algæ were also present, with which I may deal at some future time. I also tender my thanks to my son, Mr. G. S. West, for much help during the preparation of this paper. Some of the Desmids I believe to be quite new, and there are several interesting varieties and forms.

The figures have been drawn from nature to a uniform scale of 400 diameters except where otherwise stated.

Hyalotheca dissiliens (Sm.) Bréb. Frequent.
„ „ var. *hians* Wolle.
Desmidium Swartzii Ag. Sparingly.
Penium digitus (Ehrenb.) Bréb.
P. oblongum de By.

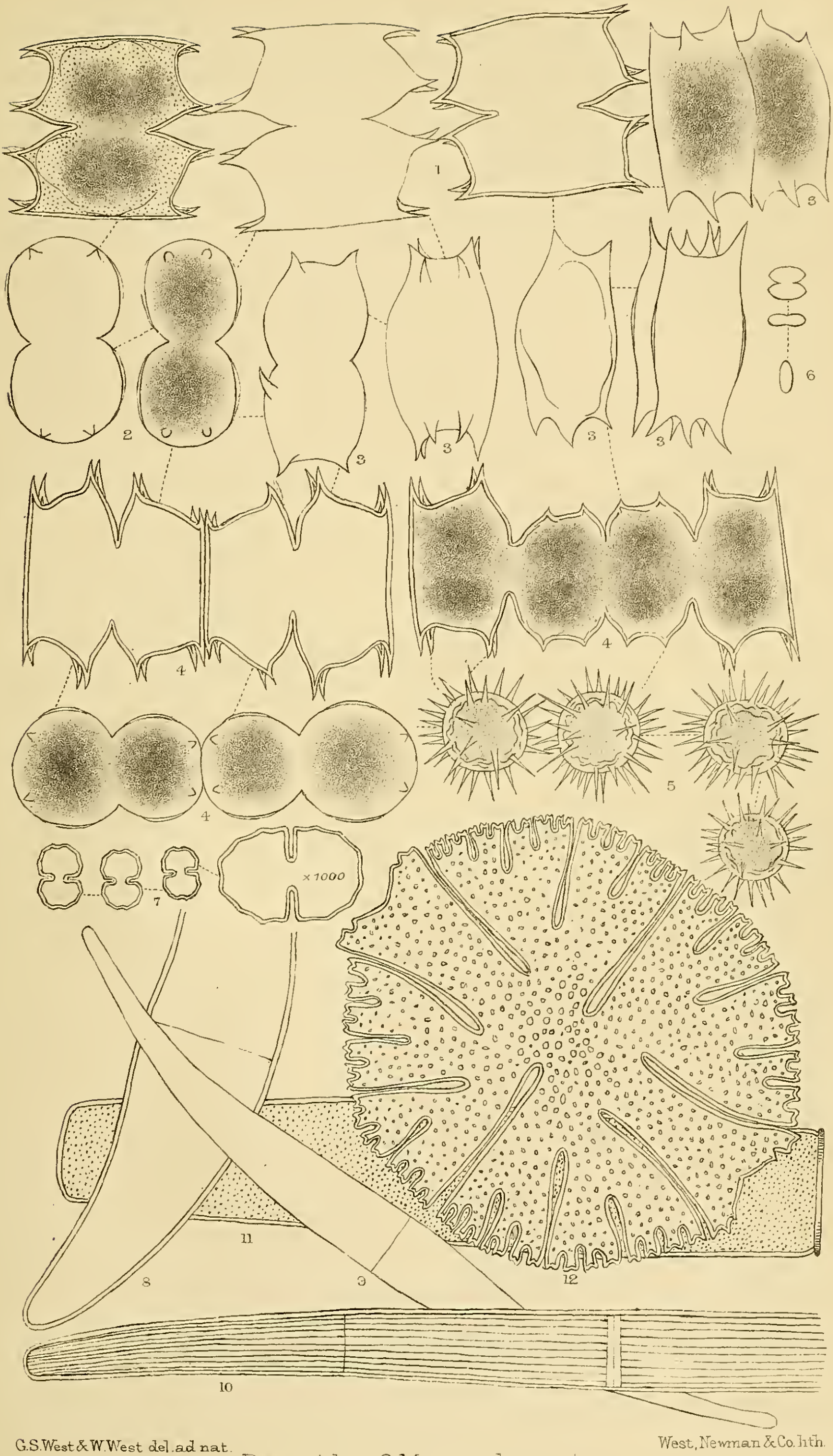
EXPLANATION OF PLATES II. and III.

Plate II.

Fig. 1.—*Xanthidium Tylerianum* nov. sp. Front view × 400.
„ 2.— „ „ „ Side view × 400.
„ 3.— „ „ „ End and other views × 400.
„ 4.— „ „ „ Dividing fronds × 400.
„ 5.—Zygospores of some desmid to which no semi-cells were attached × 400.
„ 6.—*Cosmarium pygmæum* Arch. ? × 400.
„ 7.— „ *Meneghinii* Bréb. forma *octangularis* Wille, var. *β simplicissimum* Wille × 400, the right-hand fig. × 1000.
„ 8.—*Closterium Leibleinii* Kütz., var. *curtum* nov. var. × 400.
„ 9.— „ *rostratum* Ehrenb. var. *brevirostratum* nov. var. × 400.
„ 10.— „ *subdirectum* nov. sp. × 400.
„ 11.—*Docidium Trabecula* (Ehrenb.) Naeg. × 400.
„ 12.—*Micrasterias radiosa* Ralfs, var. *punctata* nov. var. × 400.

Plate III.

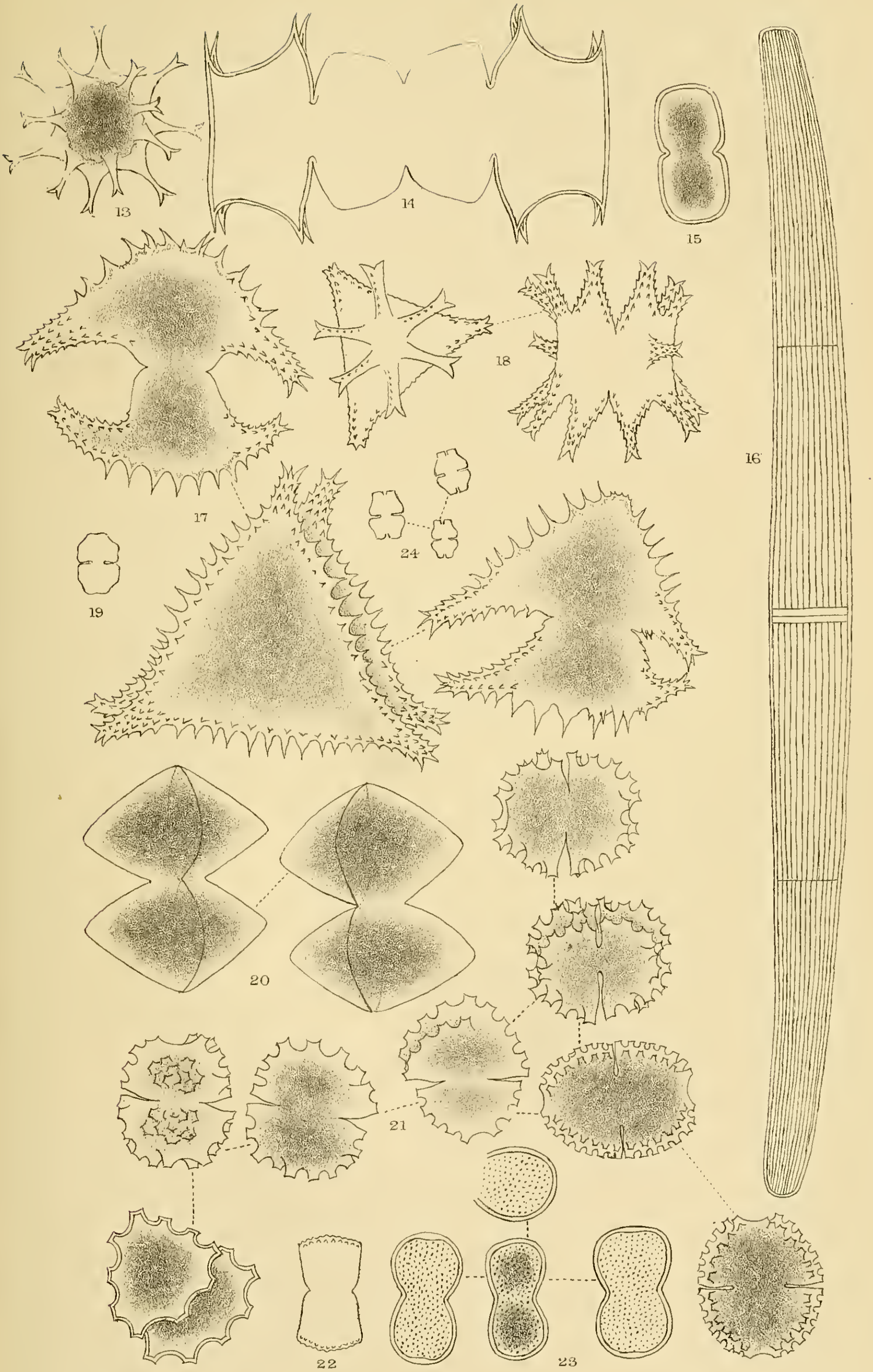
„ 13.—Zygospore of some desmid unattached to semi-cells × 400.
„ 14.—*Xanthidium Tylerianum* nov. sp. Dividing frond, the young semi-cells of which have not yet begun to develope spines, × 400.
„ 15.—*Calocylindrus Cucurbita* Kirch. × 400.
„ 16.—*Closterium subdirectum* nov. sp. × 400.
„ 17.—*Staurastrum Sebaldi* Reinsch, three views × 400.
„ 18.— „ *eustephanum* Ralfs, two views × 400.
„ 19.—*Cosmarium læve* Raben., var. *septentrionale* Wille × 400.
„ 20.—*Staurastrum angulatum* nov. sp. × 400.
„ 21.— „ *spongiosum* Bréb. × 400.
„ 22.— „ *Meriani* Reinsch × 400.
„ 23.—*Cosmarium Cordanum* Bréb. × 400.
„ 24.—*Eu istrum binale* Ralfs, forma *minor* × 400.



G. S. West & W. West del. ad nat.

West, Newman & Co. lith.

Desmids of Massachusetts.



G. S. West & W. West del. ad nat.

West, Newman & Co. lith.

Desmids of Massachusetts.

P. margaritaceum Bréb. Frequent.
P. polymorphum Perty.
P. Brebissonii (Meneg.) Ralfs.
P. crassa de Bary.
P. rupestre Kütz.
Closterium lanceolatum Kütz.
C. subdirectum nov. sp. Frond about fifteen times longer than broad, gently tapering, the middle portion nearly straight, slightly curved towards the ends, which are truncate with rounded corners, cytoderm finely striate, with three distinct transverse sutures.
Breadth 26–27 μ, length 390–400 μ.
This is very like *C. directum* Arch., but larger and not so finely striate. It is also larger than *C. intermedium* Ralfs, and less curved, and differs from any form of *C. didymotocum* Corda in being more slender. Figs. 10 and 16. Very sparingly.
C. lunula Ehrenb.
C. Cucumis Ehrenb.
C. acerosum (Schrank) Ehrenb., var. *elongatum* nov. var. Much narrower than the small examples of usual form, and not at all striate. Sparingly. Breadth 15–16 μ, length 290–300 μ.
C. strigosum Ehrenb.
C. striolatum Ehrenb. Abundant.
C. costatum Corda.
C. acutum Bréb.
C. Dianæ Ehrenb. Abundant.
C. Jenneri Ralfs. Frequent.
C. Venus Kütz. Frequent.
C. parvulum Naeg.
C. Ehrenbergii Meneg.
C. Leibleinii Kütz. Frequent; breadth mostly 40–50 μ.
C. Leibleinii Kütz., var. *curtum* nov. var. This was compared with undoubted specimens of *C. Leibleinii*, and exactly agreed with them in the central part of the frond, *but differed as shown in the figure by its shortened ends.* It looks like a miniature *C. Ehrenbergii*, many of which were present of the usual size. Fig. 8. Breadth 46–48 μ.
C. rostratum Ehrenb.
C. rostratum Ehrenb., var. *brevirostratum* nov. var. This is a variety I have often noticed in other gatherings; *it differs from the usual form in its short and less attenuated beak.* Fig. 9.
Docidium nodulosum Ralfs.
D. Archerii Delp. Only one specimen of this was seen.
D. Trabecula (Ehrenb.) Naeg. This seems to be so variable a species that I have figured a semi-cell of one of the

forms noticed which differs from any of Wolle's figures in not tapering so much towards the ends. Fig. 11.

Is this species correctly synonymized with *D. Ehrenbergii* Ralfs? After examining thousands of the latter in my own British gatherings, I have never yet seen an example without the minute tubercles at the ends, and these are always absent in the American examples, which are also generally stouter.

Calocylindrus Cucurbita (Bréb.) Kirch. I have given a figure of this, as Wolle's figure is so different from the examples I saw, which are like our British ones both as to form and size. Fig. 15.

C. curtus (Bréb.) Kirch.

C. pseudo-connatus Nord.

Cosmarium Cordanum Bréb. Occasionally seen. As the figures published successively by Joshua, Turner, and Wolle are not from the U.S., I have appended a drawing, fig. 23; I believe this is new to the U.S. Flora.

Cosmarium Cucumis Corda.

C. granatum Bréb.

C. tinctum Ralfs.

C. nitidulum De Not.

C. pseudonitidulum Nord.

C. læve Raben.

C. læve Raben., var. *septentrionale* Wille. This will be a new variety to the U.S. Breadth 15 μ, length 20 μ. Fig. 19.

C. Meneghinii Bréb., forma *octangularis* Wille, β *simplicissimum* Wille. A form like the figure of the shaded semi-cell in 'Bidrag til Kundskaben om Norges Ferskvandsalger,' pl. i, fig. 11. Four different examples are shown in Fig. 7.

C. undulatum Corda, var. *crenulatum* Wolle. Breadth 22 μ.

C. Naegelianum Bréb.

C. pyramidatum Bréb.

C. galeritum Nord.

C. triplicatum Wolle. Frequent.

C. punctulatum Bréb. Plentiful.

C. Botrytis Meneg.

C. octhodes Nord.

C. orbiculatum Ralfs.

C. amœnum Bréb.

C. Phaseolus Bréb.

C. pygmæum Arch.? This is certainly a different *Cosmarium* from any other in the list, and to me it seems nearest the species to which I have doubtfully referred it, though it differs in some respects from the figures which I have seen.

If it be this species it will be new to the United States. Fig. 6.

C. Broomei Thwaites. Abundant.

C. speciosum Lund.

Xanthidium Tylerianum nov. sp. Semi-cells oblong-trapezoid, sometimes oblong-subquadrate, with two pairs of slightly curved short spines on each side of the semi-cell, projecting from widened bases at right angles to the longest axis of the frond, ends elliptic or subelliptic with the spines projecting at the sides. Side view of semi-cells subrotund, no spines showing in the periphery, central protuberances obscure. Empty cells show that the protuberances are very faintly beaded with about eleven granules. Cytoderm faintly punctulate or sometimes smooth. Length–70 μ. Breadth of broadest part without spines, 55–60 μ. Breadth of narrowest part without spines, 42–52 μ. Breadth of broadest part with spines, 70–80 μ. Breadth of isthmus, 20–25 μ. Fig. 1 front view. Fig. 2 side view. Fig. 3 end and other views. Figs. 4 and 14 dividing fronds.

Associated with this were some zygospores; but none of them were attached to the semi-cells of *any* species. I append figures of four examples of the one mostly seen, fig. 5. Another solitary example was noticed, different from the others, but still not attached to empty semi-cells. Fig. 13.

The *Xanthidium* was certainly the most abundant species present, and there were plenty of empty semi-cells. The next species in point of quantity present was *Micrasterias truncata* Ralfs, *Staurastrum spongiosum* Bréb. being next; a few empty semi-cells of the last two species were seen. Other species sparingly present in the same gathering were *Euastrum verrucosum* Lund, *Cosmarium Cordanum* Bréb., *Cosmarium triplicatum* Wolle, *Cosmarium læve* Raben., and *Staurastrum Sebaldi* Reinsch.

Arthrodesmus convergens (Ehren.) Ralfs.

Euastrum oblongum (Grev.) Ralfs. All specimens seen were of different form from British examples.

E. verrucosum Lund. Abundant.

E. verrucosum Lund., var. *alatum* Wolle. Intermediates between this variety and the type were also noticed.

E. binale Ralfs, forma *minor*.* I have noticed this form before in gatherings from Maine, most examples being about 9 μ in breadth, and 11 μ in length; in this gathering additional examples up to 12 μ in breadth were noticed. Three examples are shown in fig. 24.

E. crassicolle Lund.

E. elegans Kütz.

* *Vide* Journ. Bot., Nov. 1888, "The Desmids of Maine."

Micrasterias radiosa Ralfs, var. *punctata* nov. var. This differs from the usual forms of *M. radiosa* in having a distinctly punctate cytoderm with the division of the lobes more like those of *M. papillifera* Breb., especially the ultimate ones. The general outline is also more angular. The deeper incisions of the frond are more in accordance with the figures in Cooke's 'British Desmids' than Wolle's figures. This species was compared with typical *M. papillifera* Bréb. from the same district, but the latter was quite different in showing the rows of dots bordering the chief incisions, as well as in its different size, margin, and shape. The specimen figured had an eighth part of the teeth of the denticulate periphery doubly notched. Fig. 12.

M. papillifera Bréb. Frequent.

M. rotata Ralfs.

M. fimbriata Ralfs.

M. Americana Kütz.

M. crenata Ralfs.

M. truncata Ralfs.

Staurastrum muticum Bréb.

S. angulatum nov. sp. Semi-cells smooth rhomboid, with a faint indication of an obscure mucro, end view triangular with concave sides. Length 76–78 μ. Breadth 60 μ. Breadth of sinus 17–18 μ. Seen very sparingly. Fig. 20.

S. polymorphum Bréb. Both trigonal and tetragonal end views were seen; the processes were narrower than usual.

S. muricatum Bréb.

S. rugulosum Bréb.

S. punctulatum Bréb.

S. pygmæum Bréb. Abundant.

S. alternans Bréb.

S. Meriani Reinsch. This was the typical form agreeing with both Reinsch's figure and that of Wolle, not like that of Cooke in 'British Desmids.' The end view was pentagonal. One is shown in Fig. 22.

S. Sebaldi Reinsch. This seems to be a variable species, as Wolle remarks, so I deemed it worth while to give figures representing the only form I saw. This is nearer to Wolle's figures than the original ones of Reinsch, the end view has the processes longer than they are shown in the figures given by Wolle. I have British examples of this species collected by Wills, J. H. Lewis, and my son G. S. West, in all of which the arms are very much longer in end view, as figured in Cooke's 'British Desmids' as var. *ornatum* Nord. Fig. 17.

S. teliferum Ralfs. This was fine and like the form I find in Britain as figured in Cooke's 'British Desmids,' not like the form figured by Wolle; the front view showed the spines almost evenly distributed.

S. Brebissonii Arch.

S. echinatum Bréb.

S. hirsutum Bréb.

S. furcigerum Bréb.

S. eustephanum Ralfs. I have given an end view and a front view of this from different specimens as it is such a variable species. Fig. 18.

S. spongiosum Bréb. This was frequent and variable, so I have given figures from eight different examples that were seen. Fig. 21. The measurements are in microns.

This list includes 84 species and 5 varieties and forms.

III.—*Reproduction and Multiplication of Diatoms.*

By the Abbé Count F. Castracane, Hon. F.R.M.S.

(*Read 9th January*, 1889.)

It is now about thirty years since I first entered upon the study of Diatoms; and from that time down to the most recent discoveries I have followed the progress of photography, desirous of making a serious use of this marvellous art; from the conviction of the value of its employment for the purpose of faithfully reproducing diatoms enlarged under the Microscope. This I at first did only for my enjoyment, contenting myself with communicating to my friends the results obtained. The encouragement received from my friends and from experts, and the desire expressed by such as De Notaris, Cesati, Brébisson, and Meneghini, overcame my reluctance to make known the modest results of my studies; so that since 1867 I have imposed upon myself the duty of publishing my observations. From that time not a year has passed without my contributing notes which may be found in the English quarterly and monthly microscopical journals, the Proceedings of the Italian Society of Cryptogamists, and in various other Italian and foreign publications; but chiefly in the Proceedings of the Accadémia Pontificia dei nuovi Lincei, in which I have taken part as an ordinary fellow since 1867.

During these first years I was fortunate in making some remarkable observations on the act of reproduction of a *Podosphænia*, which induced me to devote special study to the biological laws of the diatoms. As the result of this, on being invited to take part, in 1874, in the International Botanical Congress at Florence, I presented on that occasion a memoir on the process of reproduction in diatoms, which was published in the Proceedings of that Congress. In the publication of this memoir I ought, in the opinion of Dr. Pfitzer, to have made the remark that, while my conclusions were founded on positive observations in certain cases, I was not in a position to generalize from them. After this, enlarging my connections with the most famous microscopists, I had often the satisfaction of seeing myself spoken of in the journals as a specialist in diatomology; and finally, I was most unexpectedly invited to report on the diatoms collected in the 'Challenger' expedition.

Nevertheless, I frequently met with works on diatoms more or less complete, in which I found a restatement of views on the mode of reproduction and multiplication, incorrect on points of some importance, which I had persuaded myself that I had confuted. Far from wishing to impose my ideas merely because I am myself profoundly convinced of their truth, that which I have always desired, and have expressly proclaimed (though hitherto ineffectually), is that my opinions should be discussed in the interests of Science and of Truth, which ought to be the sole, or at least the first, aim of our studies. There is nothing

I desire more than to be convinced when I am in error; and if it is shown to me that I have not offered sufficient proof of any of my opinions, I will endeavour to give more forcible and convincing arguments for them. Having had the high honour of being elected an Honorary Fellow of your Society, I venture to hope that the Society will examine and discuss my views on a subject so important and so strictly germane to its scope; and with this object I will endeavour to give as clear and concise a *résumé* of them as possible.

Diatoms, like all vegetable organisms, are reproduced by conjugation or bisexual fecundation, and are multiplied by deduplication or autofission. Reproduction is common to all living organisms, but multiplication by fission belongs only to some organic types; thus all diatoms are reproduced as a consequence of fecundation, while only certain generic types exhibit multiplication by fission.

Speaking in the first place of multiplication by deduplication; this process, actually observed in many cases, has been claimed to be a general one, as if it were common to all diatoms. It is well known that this process commences with the subdivision of the nucleus and of the cytoblast, followed by the bipartition of the protoplasmic sac by the formation of a double wall which extends to the centre from the inner periphery of the connecting ring, constituting two new valves, each of which is in front of one of the primitive valves. The fact that this ring is double, or rather is composed of two zones, each of which proceeds from one of the valves, and one of them inclosing the other, constitutes the *emboitement* of diatoms which, if not absolutely common to all types, is evident in many genera. It is therefore strange that so acute and careful an observer as W. Smith, notwithstanding that, especially in the figures of the Naviculaceæ, he indicates by a double line on the zonal side the extreme edge of the two rings, yet has no clear idea of them; since, instead of recognizing, as the consequence of the deduplication, the progressive diminution of the frustules, he speaks of the increase in size of the young frustule resulting from the fission.*

The most exact description of the constitution of the diatom-cell, that of Dr. E. Pfitzer, in his work, 'Untersuchungen über Bau und Entwicklung der Bacillarien,' also demonstrates, with the help of diagrammatic figures, how the process of autofission leads necessarily to a decreasing scale of magnitude in the offspring, until so minute a size is reached as to be incompatible with the biological conditions of the species. In this I agree altogether with Pfitzer, if, in truth, the diatom within its siliceous walls is incapable of increase in size and of the widening of its walls so long as they are under the influence of life. Although this property has been attacked by some, I am unable to understand the disinclination to admit a fact about which there does not seem to me the least doubt.

In 1874 there was held in Florence an International Botanical

* 'Synopsis of British Diatomaceæ,' i. Introduction, p. xxvi.

Congress, to which I presented a note with the title, "The Theory of the Reproduction of Diatoms," and which appeared in the Proceedings of that Congress. In this memoir I adduced many arguments and proofs to demonstrate the power of increase and extension of the siliceous walls of living diatoms; but I do not think it will be necessary to reproduce more than one of the many proofs adduced. In vol. ii. of Smith's 'Synopsis,' plate lii. fig. 335, are represented several sporangial frustules of *Orthosira Dickiei* Thw., of which the equatorial diameter is increased by one-third, while the polar diameter has, in elongating, occupied the cavity of several adjacent cells, expanding its base, forcing its surface of contact to become folded on itself, and dilating in proportion. No one will accuse these figures of inexactness or exaggeration, since they were drawn by Tuffen West to illustrate the classical work of W. Smith. Having, moreover, the first century of the 'Diatomacearum species typicæ' of Dr. Th. Eulenstein, I have been able to compare the above-named figure with the preparation of the same species, and found them to agree perfectly. This observation confirms what was long ago established by von Mohl, that the cytoderm of diatoms is not a solid wall, but rather an organic membrane impregnated with silica, and therefore that, as long as it remains under the influence of life, it will be in a condition capable of increase and expansion. Dr. Pfitzer, in denying this power to the walls of diatoms, when the progeny has reached the minimum size, invokes the intervention of the process of conjugation, which is not multiplication, but rather true reproduction, and of which we shall speak directly.

The process of autofission is cherished especially by botanists, for it is what usually takes place among unicellular algæ, to which class diatoms belong, and has been actually observed in a great number of cases among them. When fission takes place in a diatom, it is the general opinion that, of the two valves formed in the centre of the mother-cell, each is the exact counterpart of the valve which faces it, on which it is stereotyped, reproducing it in its form and in its minutest details. From this, as it seems to me, follows the impossibility of autofission in (1) those genera in which the valves are not exactly alike, as *Cocconeis* and *Achnanthes*; (2) those in which the two valves, although alike, yet in uniting, cross the axes of the figure, such as *Campylodiscus*; (3) those with similar valves, but arranged in such a way that the homologous parts alternate, as *Asterolampra* and *Asteromphalus*. It may be noted that, as far as has at the present time been brought under my notice, none of the numerous cases of fission that have been observed among diatoms controvert my view. Hence I feel myself authorized to say that if the multiplication of diatoms takes place actually by autofission, this fission can take place only in certain genera, and that therefore it must be regarded rather as the exception than as the rule. This is worth making known; since not unfrequently naturalists of good repute, when treating of organisms imperfectly known or but recently discovered, allow themselves too easily to be drawn on to generalizations without carefully examining whether these generalizations will stand criticism, although founded on well-ascertained particular facts.

The same tendency has contributed to retard the progress of our knowledge of the reproduction of diatoms, which is the principal function of all living beings, but which, in respect to diatoms, has been relegated to a secondary position subordinate to autofission, which I can never regard as reproduction, but simply as an extension of the life of the individual. As Dr. Pfitzer does not admit that the siliceous cell of diatoms can increase in size; and, recognizing at the same time, as the consequence of autofission, the successive diminution of the young frustules, when they have thus arrived at their minimum dimensions, he ingeniously brings in at this point the intervention of sexual conjugation, resulting in the production of an auxospore, the purpose of which would be the formation of one or two sporanges. According to Pfitzer these have the sole purpose of giving birth to two sporangial frustules which repeat the typical form, but in larger dimensions, with the object of again commencing another descending series, until the offspring are reduced to the minimum size.

I feel compelled to say that this theory is ingenious, but not true. I say that the theory is not true because, supported by the authority of Prof. H. L. Smith and of Dr. Wallich, I regard the sporangial frustule not as a normal, but rather as a monstrous form, which is incapable of multiplying by deduplication, and is only destined for a transitory purpose, that of the incubation of the sporules received by it. This explains the fact that in the gatherings of *Cymbella* (*Cocconema*) *lanceolata* Ehrb. there are a few large specimens of uniform size, amongst a very large number of small ones of various dimensions, but which cannot constitute a continuous series with the former. In the same way, among *Stauroneis gracilis* Ehrb., *S. Phœnicenteron* is to be met with, which being, according to Prof. H. L. Smith, nothing but the sporangial frustule of *S. gracilis*, has always, in the same gathering, a uniform size, larger than that of this species, which, on the contrary, varies greatly in size. Similarly, another argument against Dr. Pfitzer's theory, at least in the general sense in which some apply it, is the fact that the sporanges, as often happens with the lower forms of vegetable life, frequently reproduce the species by means of gonidial sporules, without having recourse to the formation of sporangial frustules or of anything equivalent to them. Demonstration of this seems to me to be afforded by the memorable observation of Thwaites reported in vol. ii. of Smith's 'Synopsis,' on Plate A, drawn *ad naturam* by Tuffen West, where are to be seen sporanges of *Epithemia turgida* Ktz. containing a number of round corpuscles, perfectly definite and of uniform size, which it seems to me impossible to interpret otherwise than as sporules. In such a way it becomes easy to understand the formation of cysts inclosing broods of diatoms which would be produced from these sporules, while the sporange would increase in size and become the cyst, as may be seen on Plate B in *Synedra radians* W. Sm., and on Plate C in *Cymbella* (*Cocconema*) *cistula* Hemp.

It has been proved by Rabenhorst's observations on *Melosira varians* Ag. and O'Meara's on *Pleurosigma Spencerii* W. Sm., as well as by similar observations of my own on a *Podosphænia,* that these round and well-defined corpuscles must be considered as sporules or gonidia, whether they are inclosed in the sporange as in the case above mentioned, or whether they occupy the whole or a part of the cavity of the normal sporangial frustule, as may be seen in some of the figures in the plates to which reference has been made. In all these cases these corpuscles were seen to escape from the mother-cell, as represented by Rabenhorst in fig. 18, pl. x. of his 'Die süsswasser Diatomaceen.' I, being unable to draw, have described the whole minutely, pointing out that these corpuscles are marked by very fine lines, a proof of the presence of an inclosing membrane; and that, turning round at the moment of their escape, they present a profile alternately round and linear, which prevents the possibility of their being monads or similar Infusoria. While preparing a monographical work on a very interesting Italian deposit from the middle Miocene, I have already met with four specimens of *Coscinodiscus punctulatus* Ehrb., which show how death overtook them at the moment when they were giving birth to a numerous progeny. In fact my frustules with radiating dots are seen to be surrounded by numerous round impressions, which cannot be regarded in any other light than as sporules or embryonal forms, destined to develope and to grow while reproducing the typical form. This has demonstrated to me, in opposition to my previous view, that diatoms contain silica even in the embryonal condition—at least that this is the case with *Coscinodiscus punctulatus,* as otherwise these impressions could not have been preserved.

If I am asked what is my view of the process of reproduction in diatoms, I reply, without the least hesitation, that the processes may be—and in fact are—very different according to the genus, even if not also according to the species. I have myself seen several of these processes, and I therefore wish to guard myself altogether from being drawn on to generalize by starting from any special case, however well established, even when such generalization should agree with my preconceived ideas. It is necessary that such a rule be constantly observed in undertaking any new researches, for, in the adoption of a provisional hypothesis for the purpose of grouping together isolated facts, the progress of our knowledge would be at least retarded if the provisional hypothesis were regarded as an established fact.

The extraordinary advance of geology during recent years, in consequence of the gigantic works in opening canals, in making entrenchments, and in piercing mountains for the establishing of new roads of communication, and the frequent marine expeditions for scientific purposes, have induced microscopists to occupy themselves almost exclusively with the discovery of new types of diatoms. But how much more important is the daily observation of the diatoms which occur in quantities in every spring and in every ditch, noting diligently every phenomenon which they present? This is the recommendation which I make to those young observers who, when commencing the study of diatoms, have come to me for advice. Those who accept this advice will very frequently have the opportunity of observing that the endochrome presents different aspects in the same species, being sometimes scanty, and sometimes so abundant as to occupy the whole of the cell-cavity, where it is arranged in imperfect plates or in irregular granules, while sometimes the same species has its endochrome organized in numerous small masses of uniform shape and size. Similar differences are familiar to every one; but I do not know that any one has at present attempted an explanation of them. Mr. W. Smith himself has indicated it in one of the coloured figures of the frontispiece of the two volumes of the 'Synopsis,' more especially in that to vol. ii.; but I do not know that he refers to it in the text. As long ago as 1873 I ventured an explanation of the phenomenon in the memoir "On the Diatoms of the Coasts of Istria and Dalmatia," published in the Proceedings of the Accadémia Pontificia dei nuovi Lincei, xxvi., sittings 5 and 6, where I argued, from the appearance presented by *Striatella unipunctata* Ag., the central mass of which had a stellate form consisting of a group of numerous distinct fusiform corpuscles, and reaffirmed the view that this condition of the endochrome, as well as the more frequent state which occurs in very many diatoms, of a differentiation into round masses of uniform size, is the prelude to the formation of sporules or gonidia. This view of mine passed unnoticed at the time; but I am, on my part, continually confirmed in the correctness of this opinion.

In this state of things it is my most ardent desire and my warmest wish that the Royal Microscopical Society of London, which has done so much service to microscopy, both by the impulse it has given to the perfecting of the Microscope, and by having pointed out the best use to make of it, and the great number of its applications, should institute a searching examination of the views I have formulated on the more important biological phenomena of diatoms, these views being entirely the result of my studies and of my observations. A Society so illustrious, and which has among its members naturalists and microscopists of the highest eminence, in taking into consideration this request of mine, will exercise the most weighty influence on the progress of diatomology, which is connected with so many other studies, and in which there are still so many points of controversy. For my own part, far as I am from believing that, after examination and discussion, any of my views will not be proved to be correct, it will nevertheless be to me useful, and therefore pleasant, to assist in the discovery of truth, and to admit the weak side of my explanations, whether in themselves or in the arguments which I have brought forward.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Movements of Protoplasm.‡—Herr G. Quincke attempts to explain the movements of protoplasm in the cells of plants and in lower animals, by comparing them to the movements observed at the contact surfaces of various fluids. These are the results of surface tensions between the fluids directly or between substances formed in their chemical interaction. A drop of oil placed in a weak alkaline solution is said to present close resemblance to a living Amœba in the movements caused by the formation, solution, diffusion, &c., of soap on its surface. A solution of albumen is observed to act like alkaline solution. What Quincke calls "albumen soap" is formed—the result amœboid movements. The author ingeniously applies these observations to the explanation of the protoplasmic movements in *Elodea*, *Nitella*, *Tradescantia*, *Trianea*, &c. He similarly discusses the form and movement of certain Protozoa, of food-vacuoles, contractile vacuoles, &c. A viscid particle covered with oil and placed in water will exhibit amœboid movements, and smaller particles will be drawn into it as to a Protozoon. The streaming of pseudopodia demands only that there be a thin coating of oil outside and that the granules be albuminous. A mass of albumen covered with oil draws in through the oily covering bubbles of water, which collapse in forming some new substance, and resemble, in a curiously exact way, the contractile vacuoles of *Stentor* and such like forms.

Placenta of Rabbit.§—M. J. Masius communicates a preliminary account of conclusions reached regarding the modifications of the

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Biol. Centralbl., viii. (1888) pp. 499–506.

§ Bull. Acad. R. Sci. Belg., xvi. (1888) pp. 317–25.

uterine mucous membrane during gestation and the constitution of the placenta. The conclusions are briefly as follows:—(1) The uterine mucous membrane thickens, forms papillæ covered with epithelium and separated by crypts and glands. (2) Neither glands nor uterine epithelium share in formation of the placenta. The ends of the glands persist throughout gestation, papillæ and epithelium degenerate. (3) The vessels of the mucous membrane become surrounded by increasing sheaths of cellular elements. (4) The endothelium of such vessels degenerates, the nuclei break up, and chromatic granules fill the cavity of the vessels. (5) Leucocytes at first present in the mucous membrane, pass through certain changes in the middle stages, and are lost. (6) Before the attachment of the embryo, two layers in the embryonic ectoderm are distinguishable—a deeper of cylindrical cells, a superficial of irregular elements and clusters of nuclei. To the basis afforded by the uterine mucous membrane this superficial layer becomes united. It then developes enormously and forms a multinuclear mass into which the deeper layer sends processes including ectoderm and somatopleure.

The maternal capillaries enter this multinuclear layer of fœtal origin, lose their endothelium, and are continued into a system of numerous lacunæ without definite walls. The allantois forms a richly vascular connecting axis, round which allantoic villi are formed. The maternal blood in the lacunæ is separated from the vascular villi only by the multinucleated protoplasmic layer.

The rabbit's placenta is thus of fœtal origin formed by allantoic villi ramifying in a tissue derived as above described. In the same tissue the vessels of the uterine mucous membrane, formed into a system of lacunæ, are also included. A complete memoir, with figures and details, is forthcoming.

Neurenteric Canal in the Rabbit.*—Prof. C. Giacomini has investigated the neurenteric and the anal canals in the embryo of the rabbit. (1) At two different epochs, there are two connections between the ectodermic and endodermic surfaces—viz. the neurenteric and the anal canals. (2) These communications are ephemeral, and speedily disappear in consequence of the modifications at the two extremities of the primitive line. (3) They are intimately associated with the development of the primitive line, or rather of the primitive groove. Hardly has the primitive line become apparent and begun to extend backwards, than the anterior connection or neurenteric canal becomes patent. When the primitive line has attained its maximum development in length, the posterior connection or anal canal developes. These connections are both produced by a bending inwards of the ectoderm to meet the endoderm. The anterior invagination precedes and evokes the mesoderm; the posterior invagination is formed when the mesoderm has already been developed between the primary layers. The former is therefore primary and essential, the latter secondary or dependent upon the special conditions of development. Prof. Giacomini inclines to the hypothesis that the two communications at the ends of the primitive line and groove are together homologous to the single blastopore, and that in the ideal ancestral vertebrate medullary canal and gut had a common external aperture, the blasto-neuro-pore.

* Arch. Ital. Biol., x. (1888) pp. 273-94 (1 pl.).

Markings of Mammals.*—Prof. G. H. T. Eimer continues his interesting studies on the markings of mammals. In previous papers he has dealt with cats, dogs, civets, hyænas, &c.; the present (6th) paper, which is well illustrated, discusses bears, martens and allied forms. It is well known that Prof. Eimer regards these markings as important indices of the history and relations of the animals. They seem in reality like the most external finger-posts of the constitutional progress. The individual in this, as in other particulars, recapitulates the history of the race. The males usually gain the new qualities first. New features appear on definite parts of the body, and spread in a fixed and definite path. They may disappear as in an orderly phantasmagoria and a new procession begins. The new features generally appear in the hind quarters; on the fore-parts the old features linger longest. This Eimer calls the postero-anterior order of succession. Along with this an undulatory series from below upwards is also sometimes demonstrable. The above observations apply in part to birds, reptiles, butterflies, &c., as well as to mammals. In the latter, a longitudinal striping is the original state, from a modification of this spots arise, then cross stripes, and often uniformity of colouring.

Colour of Birds' Eggs.†—Mr. A. H. S. Lucas discusses how the colouring of birds' eggs has been acquired, and how it comes to be protective or otherwise beneficial. He considers that the effect of the surroundings, during the time of the formation of the shell, upon the mental or nervous constitution of the bird, is a very important factor in determining the colouring of the eggs. Numerous illustrations of this are noted. Any variations of value in rendering the eggs less conspicuous are seized on by natural selection and transmitted by heredity. Individuals at the present day are influenced in part by the surroundings, but mainly restricted by the tribal habits of generations. Hence there is sufficient adherence to type to make an experienced collector tolerably sure of the species of a bird to which a particular egg belongs, while, at the same time, there are considerable differences even between eggs of the same clutch.

Development of Germinal Layers and Notochord in Rana fusca.‡—Dr. O. Schultze has made an examination of the early developmental stages of *Rana fusca*. He finds that there is no bilaminate gastrula-stage, the rudiments of the middle and inner germinal layers arising cotemporaneously by invagination. The middle layer, as well as the dorsal wall of the archenteron, arises from the ectoblast, and at the dorsal lip of the blastopore all the three layers pass into one another; in the lateral and ventral parts of the blastopore the covering layer of the outer germinal layer is distinctly continuous with the endoblast, while the basement layer of the ectoblast passes uninterruptedly into the mesoblast. About the end of the invagination-period the fused portions of the outer and median layer which are seen at the dorsal lip grow in the direction of the dorsal median line, and so form the primitive stripes of the embryo of the frog. Anteriorly to this the earliest rudiment of the notochord is formed as a thickening of the mesoblast. The whole length

* Humboldt, vii. (1888) pp. 1–9 (11 figs. and 1 pl.).
† Trans. Roy. Soc. Victoria, xxiv. (1888) pp. 52–60.
‡ Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 325–52 (2 pls.).

of the notochord is derived from the mesoblast; the spinal ganglia are formed from the peripheral parts of the medullary plate.

In *Rana* there are no paired rudiments of the mesoblast, and no chorda-endoblast as described by O. Hertwig; the cœlom theory does not, therefore, apply to the Anura.

Development of Germinal Layers, Notochord, and Mid-gut in Cyprinoids.*—Prof. W. Reinhard, in face of the numerous contradictory statements as to the early embryological history of Bony Fishes, has made an investigation into the development of *Leuciscus erythrophthalmus.* Sections of non-fertilized eggs showed that the yolk was covered by a layer of protoplasm which was collected in large quantities on one side. In the early phases of segmentation the nuclei are of the character described by Kowalevsky in *Carassius auratus.* The author believes that the periblast is formed from the ingrowing cells of the blastodisc; these ingrowing cells are amœboid, and possess a power of movement; they appear to become arranged in such a way as to give the whole periblast the form of an uninterrupted protoplasmic layer with nuclei scattered therein; these may increase by direct division.

In no well-preserved specimen was anything like a segmentation cavity observed, and so far the observations of Kowalevsky are confirmed; the cavity figured by Wenckebach seems to be an artificial product. The outer layer of the blastodisc which forms the covering layer does not seem to be invaginated, as List asserts. It and the periblast completely cover the yolk, and this layer persists for a long time.

In later stages of development the periblast makes its way between the higher-lying cells, and reaches the covering layer; this can only be explained by supposing that the covering layer forms the true ectoblast, by the thickening of which the nerve-tube is formed, and that the cells which lie above the periblast must be regarded as mesoblast, This last, which forms at first a continuous layer, divides later into two lateral masses. An aggregation of some of its cells gives rise at one point to the notochord, which developes from behind forwards.

The mid-gut appears to be formed thus; the boundary between the mesoblastic cells and the periblast is, at first, horizontal; some of the cells of the mesoblast from either side make their way into the yolk, and also press upon the periblast; in this manner they give rise to a cavity filled by periblast. The cells more to the periphery of this space elongate, and take on the form of the epithelium of the developed mid-gut. This tract does not arise in the form of a solid cord. It closes from behind forwards. The hind-gut is developed earlier. The last signs of the periblast disappear when they are taken up by the development of blood-vessels.

Origin of Species.†—Prof. G. H. T. Eimer's recent work on the Origin of Species is in part an elaboration and application of results previously reached by the author in his observations on the variation of the wall lizard.‡ The full title of the present work, of which only the first instalment is yet published, is suggestive as to its contents—" *The*

* Zool. Anzeig., xi. (1888) pp. 648–55.

† 'Die Entstehung der Arten auf Grund von Vererben erworbener Eigenschaften, nach den Gesetzen organischen Wachsens. Ein Beitrag zur einheitlichen Auffassung der Lebewelt,' i. Th., 8vo, Jena, 1888, 461 pp. (6 figs.).

‡ 'Ueber das Varieren der Mauereidechse,' Berlin, 1881, 281 pp. (3 pls.).

origin of species through the inheritance of acquired characters, according to the laws of organic growth."

It is not possible to summarize the concrete details of Prof. Eimer's work; the chief conclusions may be resumed as follows:—(1) Variations are shown to occur along definite, determinate lines of development; not towards all points of the compass in arbitrary fashion, but in a few directions, "as if on a determined plan." (2) The conditions of variation are found on the one hand in internal or constitutional changes, on the other in environmental influences. The interaction of the external forces and the physico-chemical changes of the growing organism is the basis of variation. (3) As organisms progressively develope in accordance with "the laws of organic growth," literally growing into their places, species are but the stations in the progressive march. The same laws hold good for the variations of the individual as for the establishment of varieties and species. (4) "Constitutional impregnation" or "conservative adaptation" is the organic result of persistence in a given direction under similar conditions. (5) Variations due to environmental influence are certainly transmissible, and may modify the organism so as to originate new species without the help of Natural Selection. (6) Use and disuse may similarly condition new characters, which persist without Natural Selection. The latter has only a subordinate rôle; growth and the environment explain almost all.

In his introduction, Prof. Eimer criticizes the Darwinian postulate of indefinite variations; emphasizes the deficiencies of an ætiology which does not discuss the primal conditions of variation, and maintains that the utilitarian principle, which does not explain the origin of new qualities, only partially at most accounts for their increase and dominance. His observations, detailed in the body of the book, lead him to conclude that "variations occur throughout in perfectly definite, and only in a few directions, and are due to physico-chemical conditions in the interaction between the material composition of the body and external influences."

The first chapter is chiefly occupied with criticisms of Weismann and Nägeli. In the second chapter the author enters into the heart of the subject. The directions of variation are few and definite; the new characters, so to speak, crystallize out from the internal conditions of growth, and may be useful, indifferent, or even hurtful. By "internal" or better "constitutional" conditions, the author does not mean that the causes of modification are to be found in a fundamental "vital force," but simply in the physical and chemical processes involved in the very composition of the organism.

In opposition to Weismann and others, it is important to notice such conclusions as the following, of which the concrete evidence must again be left out:—"In my opinion the physical and chemical changes which the organism experiences during its life through the influence of the environment, and which it transmits, are the first conditions of modification, and of the origin of species. From the material thus supplied, the struggle for existence may select."

All variations express themselves simply as growth. "Just because the organic modification depends upon physico-chemical processes, the result, as in the inorganic crystal, is definite," and can only express itself in definite directions. "The origin of species follows exactly the same laws as ordinary growth; it is the consequence of unceasing variable growth of the world of organisms under variable conditions. The heterogeneous links of this growing chain of organisms persist as species. Varieties and species are essentially nothing but groups of forms which have remained at various stages of a progressive development." The stoppage of forms at various levels, the author terms *Genepistasis*—the still-standing of the form.

As to the special means which determine the difference in the directions of evolution, and cause division into species, Prof. Eimer takes the following six into account and discusses each in detail:—(1) direct external influence; (2) strengthening through function or the reverse; (3) struggle for existence—an indirect influence; (4) saltatory development or sudden variations arising as the result of correlation in kaleidoscopic fashion; (5) "constitutional impregnation" or "conservative adaptation" due to continued persistence under the same conditions; (6) sexual intermingling.

Space does not permit a review of the succeeding chapters which give part of the evidence. They discuss adaptation; acquired characters; disuse of organs, degeneration and panmixia; the acquisition and inheritance of intellectual characteristics; the development of organs and systems; the laws of growth. Enough has been said to indicate the standpoint of the author and the importance of his endeavour to demonstrate more perfectly "the unity of organic nature." A second volume of evidence and historical matter is promised.

Divergent Evolution through Cumulative Segregation.*—In an elaborate paper the Rev. J. T. Gulick follows up some previous communications, in which he has maintained that "separation without a difference of external circumstances is a condition sufficient to insure divergence in type." The abundance of technical and unique terminology, combined with the intrinsic complexity of the inquiry, renders it very difficult to present a brief summary without injustice to the patient author.

The importance of separation was suggested by a study of Sandwich Island terrestrial molluscs. Under one set of external conditions diververgence of type was observed to occur in a way which did not appear to be explicable by Natural Selection. The explanation seemed to the author to lie in "a law rising out of the very nature of organic activities, a law of segregation, bringing together forms similarly endowed, and separating them from their neighbours." It is this drawing of like to like, in its manifold forms and influences, which Mr. Gulick has set himself to analyse. He does not raise the question of the conditions of variation, but simply postulates a "frequency of deviation from an average." Nor are the problems of direct environmental action, or of hereditary transmission, at all discussed. The whole inquiry is concerned with the forms and influences of segregation. Mr. Gulick's position differs considerably from Wagner's insistence on isolation, for the latter depended solely on migration and geographical barriers, while the separation and segregation dealt with by the author are much wider. His principle of segregate breeding is allied rather to Spencer's law of segregation. The author differs also from Romanes, who has in his "Physiological Selection" theory laid emphasis on the separating

* Journ. Linn. Soc. (Zool.), xx. (1888) pp. 189-274. Cf. criticism by A. R. Wallace in 'Nature,' xxxviii. (1888) pp. 490-1.

influence of mutual sterility. Gulick's segregation is again a much wider conception, including many other separating factors; nor does he restrict its operation "within the limits of specific distinctions."

In preliminary chapters, after historical matter and much-needed definitions of terminology, Mr. Gulick endeavours to show that divergent evolution is not explained by natural selection, nor by the "advantage of divergence of characters," nor by natural selection plus great difference in external conditions, nor in fact by selection of any kind whatever.

The fundamental law to which he calls attention is expressed in the following formula:—"Cumulative segregation produces accumulated divergence; and accumulated divergence produces permanent segregation; and the segregate subdivision of those permanently segregated produces the divisions and subdivisions of organic phyla." Segregation may be produced by man (*rational*), or by nature outside of man (*responsive*), and both these may be intensified by other principles of independent transformation (*intensional*). Or again, he classifies segregation as "*environal*" (relation to environment), "*reflexive*" (inter-specific relations), and "*intensive*" ("enhanced by one or more forms of intension").

The author seeks to show (1) that there is "in nature a law of cumulative segregation," and granting this, (2) that "cumulative segregation will produce accumulated divergence, without any selection in the sense that natural selection is selection," in fact "that without segregation no divergence of type will arise." (3) He proceeds to analyse the conditions of cumulative segregation as A, *Environal*—industrial, chronal, spatial, fertilizational, artificial (with subdivisions); as B, *Reflexive*—conjunctional, impregnational, and institutional; and as C, *Intensive*, with eight subdivisions.

As an analysis of the conditions of association and isolation the memoir possesses great interest, not a little spoilt by the elaborate and ugly terminology. The author certainly cannot be charged with depreciating the complexity of the inquiry. The reader will naturally seek for more information as to the existence of cumulative segregation as "a law in nature," and for more evidence and explanation of the continued divergence of forms after they have been so separated or segregated. Still the paper mainly professes to emphasize the importance of inquiring into the conditions and effects of segregation, and in so doing is valuable.

Heredity.*—Prof. M. Nussbaum sums up his views on the problems of heredity. The homology of the germinal cells, their early differentiation and relative isolation, the phenomena of regeneration, the transmission of acquired characteristics, and the like, are discussed in a manner with which the previous work of this author has made us familiar. "The constancy of the species depends upon the uninterrupted descent (Jaeger's continuity of the germinal plasma); the variability depends upon the interaction of intrinsic and extrinsic forces. Selection is a consequence of this interaction, since it always rests with the numerical strength of the forces, whether the individuals and their germinal material persist, change, or perish."

* 'Ueber Vererbung,' 8vo, Bonn, 1888, 23 pp.

Organs of Aquatic Locomotion.*—Dr. P. C. Amans examines the characters of the organs of aquatic locomotion. He finds that there are two great groups of them, erectile machines, in which the vascular and connective systems play the principal part, and articulated machines formed chiefly of solid levers and muscles. The external form is that of a more or less elongated ovoid having a bilateral symmetry; the profile, which is the intersection of the surface by the plane of bilateral symmetry, is always itself asymmetrical; there may be an inflexion in the upper half as in some fishes, or in the lower half, as in *Pterotrachea*, *Dytiscus*, &c. The mechanical laws of swimming are discussed at great length, and a further essay is promised in which other factors of rapidly moving bodies will be considered.

Zoology of Victoria †—The sixteenth decade of Prof. F. M. M'Coy's Prodromus of the Zoology of Victoria contains accounts of Polyzoa by Mr. P. H. M'Gillivray, and of Crustaceans by himself. The Polyzoa are *Lagenipora tuberculata* and *L. nitens*, which, in the author's opinion, ought not to be placed in the same genus. *Lekythopora hystrix* has its peristome produced into a long, nearly cylindrical tube. In *Pœcilopora anomala* the mouth is so reversed that the oœcium appears to be below it. Four species of *Fasciculipora*—*F. gracilis*, *F. bellis*, *F. fruticosa*, and *F. ramosa*, are described and figured, as are also *Farciminaria aculeata*, *F. uncinata*, *F. simplex*, and the apparently common *Bracebridgia pyriformis*. *Palinurus Hügeli*, the Sydney crawfish or spiny lobster, is, for the first time, figured in its natural colours. The Yarra spiny crayfish is a variety of Shaw's *Astacopsis serratus* of the Murray; it is usually less than half the size of the Murray individuals, while the whole thorax and abdomen also are of an intense prussian-blue colour.

β. Histology.‡

Structure of Muscle.§—Dr. A. Rollett reports the results of his investigation of the fin-muscles of the sea-horse, and discusses striped muscle in general. The muscle of the fin of *Hippocampus antiquorum* is first described; Ranvier's description is rejected as incorrect, Rollett's previously published views are confirmed. The sarcolemma is widely separated from the fibrils by a granular mass—the "sarcoplasma," which is coloured red in gold-staining, and left pale when the fibrils are stained with hæmatoxylin. The transverse sections, of which large figures are given, show numerous arrangements of Cohnheim's areas into bands and circles, clearly marked and separated by wide spaces of sarcoplasma. In insects and crustaceans the areas were variously disposed, and much less sarcoplasma was present. The optical longitudinal sections of Hippocampus muscle have the usual appearance, except that wide bands of sarcoplasma intervene between the fibres and even fibrils. The dots and the transverse striæ are sections of the walls of sarcoplasma separating both fibres and fibrils. The sarcoplasma is to the muscle-elements as the wax honeycomb to the honey. Rollett gives full particulars of his various methods, materials, and results, and also describes the appearances seen by using the

* Ann. Sci. Nat., vi. (1888) pp. 1–164 (6 pls.).
† 'Prodromus of the Zoology of Victoria,' xvi. (1888).
‡ This section is limited to papers relating to Cells and Fibres.
§ Arch. f. Mikr. Anat., xxxii. (1888) pp. 232–66 (2 pls.).

polariscope. The main conclusion is that in all striped muscle the striæ represent sarcoplasma, a layer of which surrounds every fibril.

The second part of the paper gives a glance over what Rollett calls the "Muskelromantik," whose pages, he says, vie with fiction in their strangeness. He deprecates the withholding of criticism, and proceeds to a vigorous criticism of the network theory of muscle structure. Melland, Marshall, and van Gehuchten occupy a prominent place, and Ramon y Cajal, Carnoy, and Macallum have also their share. The existence of a network is denied *in toto*, except in so far as it represents the edges of Rollett's walls of sarcoplasma.

Structure of Spermatozoa.*—Herr E. Ballowitz communicates the results of his investigation of the minute structure of spermatozoa. He deals first with the general characters of bird spermatozoa. No less than forty-two species were examined. The spermatozoa of Passeres are made the subject of special discussion;—the structure of the lash, the development of the spiral fringe from the protoplasm of the spermatide, and the structure of the head are described in minute detail. In a second chapter the author similarly describes the spermatozoa of Natatores, Grallatores, Gallinacei, Columbinæ, Scansores, Raptatores, and *Caprimulgus europæus.* The fibrillar structure of the axial filament is especially emphasized. The movements of the sperms are also described. It may be concluded with certainty that the axial filament is the essential part of the lash and the definite seat of the contractility. The fibrillar structure, demonstrated by the author, is in the closest association with this contractility. It will be afterwards shown that other portions of the lash acquire a fine fibrillar structure when they become contractile.

Club-shaped Nucleoli.†—Herr S. M. Lukjanow describes peculiar club-shaped nucleoli from the mucous membrane of the stomach of the salamander. They appear, however, to be of wide occurrence. The author's study of these structures led him to regard them as stages preparatory to an emptying of the contents of the nucleolus. He also connects what he observed with phenomena of nucleolar movement.

Nervous System of Amphioxus.‡—Dr. E. Rohde reports the result of his histological observations on the nervous system of *Amphioxus*. The present memoir is in part a continuation of the author's investigation of the connection between the ganglion-cells and nerve-fibres in Chætopods. A brief summary of the general morphological facts is first given. The central nerve-strand has its largest diameter in the middle of the body; there are no swellings of any kind; the central canal is usually narrow in its larger dorsal portion; the anterior expansion is histologically distinguishable as a cerebral region. The central canal is surrounded by a usually simple layer of epithelial cells; the nervous elements consist of an internal ganglionic layer and a much larger external fibrous layer. From the dorsal portion 64 pairs of sensory nerves are given off, ensheathed at their origin by the connective tissue swathing the nerve-strand. They pass to the muscle-ligaments and to the skin. Entering the ligament the nerve divides into a ventral and a usually weaker dorsal branch. From the ventral side of the central system, alternating

* Arch. f. Mikr. Anat., xxxii. (1888) pp. 401–73 (5 pls.).
† T. c., pp. 474–8 (1 pl.).
‡ Zool. Beitr. (Schneider), ii. (1888) pp. 169–211 (2 pls.).

with the sensory nerves, arise the motor nerves. The bulk of the memoir is devoted to the histological results.

The central canal and the supporting elements.—The supporting elements of the central nervous system consist (*a*) of the conical epithelial cells which line the central canal and (*b*) of fibres. The apices of the conical cells are directed outwards and continued into threads, which either penetrate the central nervous system undivided and are inserted in the connective tissue sheath, or else ramify. In varying degrees the epithelial cells lose themselves in the fibres. Sometimes only the nucleus is left—the "supporting-fibre-nuclei." Along with the strong undivided processes of the conical cells, other nuclei, probably nervous, occur. Few conical epithelial cells occur in the dorsal portion of the central canal-wall; the fibrous upbreaking is less marked from above downwards. With these results the observations of other investigators are then contrasted.

The nervous elements of the nerve-cord.—The nerve-fibres, composing the greater part of the nerve-cord, and forming a ring round the ganglion-cells, are without medulla and of very varied strength. Very thin fibres predominate in the dorsal portion; those in the ventral half are thicker and more distant. Giant nerve-fibres among the latter are found in the same position all along the cord. The strongest, lying ventrally to the central canal, is unpaired; the others lie in three lateral paired groups. The intimate structure seems to consist of fibrils of extreme fineness, but of this only a trace was to be seen in the giant fibres. The fibres lie imbedded in the fine meshwork formed by the supporting elements; few lateral branches are given off, but a deceptive appearance of this is produced by the supporting elements. Bifurcation, however, frequently occurs.

The ganglion-cells vary greatly in size; small, medium, and giant forms occur here also. Among the small cells, unipolar and bipolar forms predominate. They lie for the most part beside the epithelial cells, and are very like them. The medium cells include all forms. The giant ganglion-cells are exclusively multipolar. They always lie at the boundary between the dorsal and median third of the central canal. Their processes stretch right and left into either half of the cord. They are relatively few in number. The processes of the giant cells are of two kinds, one set passing into fine nerve-fibres, the others—one from each cell—retain a large size as the giant nerve-fibres already noted. The most anterior ganglion cell gives origin to the median giant fibre—the largest of all—and to seven diminishing fibres only traceable for a short distance. The processes of the other ganglion-cells are described at length, and again the results of other investigators are brought into contrast with the author's.

The brain.—The central canal expands in front of the origin of the second pair of sensory nerves. A many-layered sheath of very closely packed cells and nuclei surrounds it. Some look like the typical conical epithelial cells, in their original position, or displaced outwards. Numerous cell-less nuclei (nerve-nuclei) occur; at the end of the nerve-cord they occur not only on the epithelial layer, but among the nerve-fibres, especially on the dorsal surface, and extend in part to the sensory nerves. In the epithelium of the ventricle, the supporting and the nervous fibres are hardly distinguishable from one another. Round the pigment-spot is a thick layer of small dark nuclei, passing posteriorly into the ordinary "nerve-nuclei." At the origin of the second pair of sensory nerves, there begins, above the central canal, a group of medium-sized multipolar ganglion-cells, which extends to the region of the fifth sensory nerve. In front of the posterior end of this dorsal group there begins on the ventral side a similar layer of medium-sized, but on an average rather smaller, ganglion-cells, which appear to be unipolar or bipolar. The two groups are connected by lateral ganglion-cells. These groups must be included in the brain. *The beginning of the cord is marked with tolerable exactness by the position of the most anterior giant ganglion-cell, and the first five pairs of sensory nerves are to be regarded as cerebral.* Previous investigations are then noted.

The sensory nerves, which alternate with one another, consist, like the dorsal portion of the central system, of delicate fibres. Especially near their origin "nerve-nuclei" are imbedded in the nerves. The spinal ganglia of higher Vertebrates are here represented by aggregations of these nerve-nuclei. They are more abundant on the posterior nerves. The 64th or most posterior pair of sensory nerves, behind the last muscle-segment, appears to have been overlooked by previous investigators.

The motor nerves, alternating with the sensory, and arising from the ventral side, consist of fibres somewhat less thick than the medium-sized elements which accompany the giant fibres of the ventral region. Two or more fibres are often apposed. Forking and lateral branching occur. The internal connection with the nerve-elements of the central system is still uncertain. Peripherally the motor fibres enter individually into connection wlth the muscle-plates. Details for the different regions are noticed. The motor-fibres often exhibit marked transverse striation like that of the longitudinal musculature. Most, however, are homogeneous. It appears most probable that the motor nerves are really the apparatus for the motor stimulus of the longitudinal musculature. It is possible that the transverse musculature may be innervated by "sensory" nerves.

B. INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Eyes of Gastropods and of Pecten.*—Dr. G. Kalide has a preliminary report on his investigations into the minute structure of the eyes of Gastropods and of *Pecten*. In the Prosobranchiata, of which *Nassa* may be taken as the type, the optic vesicle is separated from the surrounding connective tissue by a transparent basal membrane, into which the neurilemma of the optic nerve passes. The fibres of the optic nerve spread out in all directions; internally to them is the cellular layer of the retina, the components of which are arranged radially to the centre of the eye. The pigment layer is external to the zone of rods. The central cavity of the vesicle is filled by a transparent mass, which forms a lens anteriorly and a gelatinous vitreous body posteriorly.

The innervation of the retina was first made out distinctly in *Pterotrachea coronata*, where the retinal cells gradually diminish at their outer ends and pass gradually into nerve-fibres, which are lost in the expansion of the optic nerve; this arrangement has already been detected by

* Zool. Anzeig., xi. (1888) pp. 679-83, 698-703.

Grenacher in the eyes of Heteropods and Cephalopods. In the Prosobranchiata it is the unpigmented flask-shaped cells which present this arrangement; they closely resemble the retinal cells of the Heteropoda, and have at their base a large nucleus which colours intensely with carmine and hæmatoxylin. The homology is not affected by the fact that the retinal cells of Heteropods contain pigment, for the cells in Prosobranchs, which have been hitherto described as being devoid of pigment, are not altogether so. The pigmented club-shaped cells rest on the basal membrane by a filamentar stalk; this is not of a nervous nature, and these cells are not innervated and have no direct relation to the perception of light. The rods are very difficult to see, as they are destroyed by most of the reagents used for fixation; they are best preserved by placing fresh eyes for from five to ten minutes in strong formic acid, isolating pieces and teasing them carefully in a drop of water.

In *Nassa* the zone of rods consists of closely packed delicate columns, which are rounded off at their inner ends; they are longest at the fundus of the eye, and become shorter and shorter near the distal pole. The rods project into spaces of the vitreous body, which are separated from one another by thin partitions.

The connective framework discovered by Simroth in the vitreous body and lens does not consist merely of filaments, but of numerous stellate cells; these have a nucleus which does not always colour in the same way with carmine and hæmatoxylin; Patten seems to think that his retinophoræ (the rod-cells) have two nuclei, but if so he has mistaken the nucleus of a stellate connective-tissue cell for the second nucleus. The fibres from the rod-cells are not, as Hilger thinks, of a nervous nature; they do not end in the expansion of the optic nerve, but in the basal membrane.

The vitreous body is not, as has been generally supposed, completely structureless. If the pigment be removed by the action o chlorate of potash and hydrochloric acid, sections will show that the gelatinous mass has completely disappeared, and a plexus will be left of fine fibrils, in which cell-nuclei are scattered; the fibrils are processes of the cells to which the scattered nuclei belong. The vitreous body consists, therefore, of connective tissue formed of cells with numerous processes, and of a gelatinous intermediate substance. The lens has the same structure.

In his account of the eyes of Heteropods, the author confirms in many points the description given by Grenacher, to which he makes some additions. All the parts of the Gastropod eye are present in that of *Pecten*; but the retina is developed on the anterior side of the optic vesicle in correlation with the position of a lens peculiar to the eye of *Pecten*, which lies in front of the optic vesicle.

δ. Lamellibranchiata.

Influence of Light.*—M. R. Dubois describes the retraction of the siphon of *Pholas dactylus* under the influence of a beam of light. Even detached from the animal the siphon keeps this power for several days. The siphon as a whole is impressionable by light; the sensory structures must be diffusely scattered. The author has made numerous experiments on the relation between the muscular contraction of the

* Comptes Rendus Soc. Biol., v. (1888) pp. 714–6.

siphon and the nature of the light. The amplitude and the duration of the contractions have a definite relation, which is constant with a light of the same intensity at different distances. Lights of different colours give different results. Further details are promised after the use of a new recording apparatus.

Movements of Detached Gills.*—Mr. D. Macalpine gives an account of his observations on the movements of detached gills, mantle-lobes, labial palps, and foot in bivalve Molluscs. He asserts that all of these organs, when detached from the body, are capable of moving visibly and at a measurable rate of speed. The movement may be either rotatory or progressive. One labial palp was observed to make twenty-six revolutions at an average rate of 8⅓ minutes per round. A palp of the fresh-water mussel (*Unio*) continued to rotate for eight days. The gills travelled forward at the rate of two minutes to the inch. The movement of the mantle-lobes is rotatory, but a certain amount of forward movement occurs in the course of rotation. The foot, laid in sufficient water to cover it, exhibited motion of both kinds. The rate of rotation was a complete round in 6 hours 47 minutes, the average rate of progress 1 in. per hour. It retained its power of movement for at least 73 hours. "The gliding gill and the rotating palp, the moving mantle-lobe and the creeping foot, show what a stock of vital energy must be stored up in the soft-bodied mollusc imprisoned within the walls of the shell."

Development of Mytilus edulis.†—Prof. W. C. M'Intosh remarks that in one part of the estuary of the Eden the older mussels are covered with dense feathery masses of *Gonothyræa*, upon which the young mussels settle as soon as they quit pelagic life. The young are then from 1/71 to 1/21 in.; some show three gill-papillæ and others thirteen. An almost inexhaustible stock of young mussels could thus be obtained at an early stage for transporting to any fresh site. Young mussels may often be observed fixing themselves on various sites well adapted for aeration and food. It is not right to suppose that all the mussels found on a ship's bottom have, since the last "cleaning," grown to a given considerable size. Mr. Wilson (whose important report to the Scotch Fishery Board has been overlooked by some recent writers on the subject) has shown that mussels can leave their sites and fix themselves to new ones by a fresh secretion of byssus. In France, indeed, they are often artificially torn off.

Molluscoida.

α. Tunicata.

Monograph of Fragaroides aurantiacum.‡—M. C. Maurice has attempted to fill a lacuna in our knowledge of the Tunicata by preparing a monographic account of a species, a method universally recognized by zoologists as of the greatest value in advancing research. The form which he has selected lives in abundance at Villefranche-sur-mer, and is allied to Giard's genus *Fragarium*, of which *Fragaroides* may be regarded as a sub-genus. In discussing the orientation of the form the author points out that his terminology corresponds, so far as the right

* Trans. Roy. Soc. Victoria, xxiv. (1888) pp. 139–49.
† Ann. and Mag. Nat. Hist., ii. (1888) pp. 467–9.
‡ Arch. de Biol., viii. (1888) pp. 205–495 (7 pls.).

and left sides are concerned, with that of Milne-Edwards, and is exactly the reverse of that of Savigny, Hancock, and Lacaze-Duthiers. The dorsal surface looks upwards, the ventral downwards. The body is divisible into a thorax, which comprises the branchiæ, nervous system, and buccal and cloacal orifices; an abdomen, which contains the digestive tube; and a post-abdomen, in which are the gonads and the heart.

The first chapter deals with the colony. There is only slight adhesion between the common or external tunic and the subjacent epithelium; but this adhesion is more marked in some regions than elsewhere, as, for example, along the longitudinal lines, of which there are generally ten on either side of the body, and in the region of the buccal and cloacal orifices, where there is to be found the homologue of the reflected tunic of the simple Ascidians, in the form of a fold. The cloacal orifices of the various ascidiozooids do not open directly to the exterior, but into ramified ducts, which may be called a common cloaca. The anal "languettes" are not free, but are so placed as to keep the canal widely open. The constitution of the external tunic of *Fragaroides* is quite similar to that of various simple Ascidians, but there are no vacuoles. This tissue of cellulose is not, as most authors have hitherto supposed, a product secreted externally by the epidermic layer, but a transformed portion of the epidermic epithelium produces the cellulose internally. The epidermis is made up of several layers of cells, which give rise to cellulose.

When a member of a colony is about to die its body commences to break up in its anterior region; the boundaries of the cells become effaced, and the nuclei disappear; these remains of dead animals gradually disappear, because, as the author believes, the amœboid cells of the external tunic act as phagocytes. Another phenomenon of the same kind is to be seen in the mode of disappearance of the yolk in the urodele larva of this species. There is no trace of a colonial vascular system.

The yellow colour of the common tunic is solely due to the presence of numerous microscopic algæ, belonging, apparently, to the genus *Protococcus;* the orange-red colour of the Ascidians is the result of the combination of the colour of the algæ with that of the pigmented cells of the animals.

The second chapter deals with the body-wall; this is composed of epidermis, a connective-muscular framework, and a peribranchial epithelium; the first of these consists of the external tunic and the subjacent epidermal epithelium; the framework is a mass of connective tissue in which we may say that all the organs of the body are immersed; it is hollowed out by vast lacunæ in which the blood of the Ascidian circulates. The peribranchial epithelium has the same structure and properties as the epidermal, save that it does not secrete cellulose.

The buccal siphon is treated of in the third chapter; the buccal orifice is divided externally into lobes of a peculiar form, of which two are median and six are lateral in position. The layer of connective and muscular tissues is very rich in blood-lacunæ, and is traversed in all directions by muscular bundles; of these there are, for the greater part of the siphon, three layers, two longitudinal being separated by one transverse. The tentacular crown consists of a fold of the internal wall of the buccal siphon, which carries fourteen unequal tentacles. Ten of these are so arranged that a long and a small one alternate. A large lacuna extends along the anterior or dorsal surface of each tentacle. The hypoganglionic tubercle is only the orifice of the vibratile organ; it is situated in the prebranchial region on the mediodorsal line; the flat epithelium of the buccal siphon becomes ciliated on the vibratile organ. A ridge runs round the siphon and separates it from the branchia; it has an uninterrupted groove, which, on the ventral side, is in direct relation with the hypobranchial groove, and on the dorsal raphe forms a projection into the branchial cavity. The anterior lip of this groove has a flat epithelium, while the posterior has a characteristic ciliated epithelium similar to that which invests the two external lips of the hypobranchial grooves. There are no traces of mucous cells in this circumcoronal ridge.

The fourth chapter is devoted to the branchial cavity, which is first considered as an organ of respiration. It is in the form of an ovoid sac suspended in the peribranchial cavity, and its wall is pierced by thirteen to sixteen rows of stigmata, with about thirty stigmata in each row. The wall of the gill is of a very simple structure, and the blood passes through it in all directions; there are no traces of vessels, or even of regular lacunæ. True plates, which are really folds of the branchial wall, hang down into the branchial cavity; the author calls them interserial plates, and describes them as hanging down freely into the branchial cavity, which they seem to divide into a series of secondary chambers. Attached to them are medio-dorsal "languettes," the free ends of which form a small platform which carries vibratile cilia on the medio-dorsal line. The transverse bands of fundamental tissue which separate the rows of stigmata are not merely connected with the internal tunic by vascular trabeculæ, as in all other Ascidians, but they are directly fused with this tunic on either side of the hypobranchial groove for about a third of their extent. The peribranchial cavity becomes divided into a series of secondary cavities, all of which are open on the cloacal side and end by digitiform culs-de-sac on the side of the endostyle, where they penetrate into the tunic. In the interior of each of the interserial bands there is a pair of muscles which extend side by side through its whole extent. They are connected by numerous anastomoses with the longitudinal muscles of the internal tunic, with the fibres of which their fibres are continuous. The margin of the branchial clefts is invested in a very peculiar epithelium, which is called stigmatic; the cells are greatly elongated in the direction of the long axis of the stigmata, and each of them has a projecting crest on its long axis; this crest carries from fifteen to seventeen long vibratile cilia. These stigmatic cells are arranged in rows of six, and the cells of the same row are of exactly the same length.

The branchial cavity may also be considered as an organ of deglutition. The hypobranchial groove or endostyle extends all along the ventral surface of the branchia, forming a cul-de-sac at its anterior end; the vibratile epithelium of its lips is continuous with that of the posterior lip of the pericoronal groove. Posteriorly it also ends blindly, and here the epithelium is continued as far as the œsophagus. The epithelium is succeeded by two glandular regions, the first of which contains only one glandular mass, while the second has two; the cells at the base of the groove carry very long vibratile flagella. The mucus secreted by the groove is not voided all along the ventral raphe into the branchial cavity, but ascends towards the mantle to the pericoronal groove, where it forms a curtain which collects the nutrient particles and directs them towards the œsophagus. This arrangement is a proof of the homology of the endostyle with the thyroid gland of Cyclostomata and Selachians. The mediodorsal or interserial "languettes" are simple expansions of the interserial plates, and their function is to direct towards the entrance of the œsophagus the cord of mucus which is formed at the level of the pericoronal circle. They are not mobile, and act only by their vibratile cilia. The posterior raphe or retropharyngeal band is formed by a projecting crest which lies in the prolongation of the right lip of the endostyle, and extends from the posterior cul-de-sac of the hypobranchial groove as far as the œsophagus. Its left surface only is invested by a vibratile epithelium, which is directly continuous with that of the two lips of the endostyle.

The peribranchial cavity, which is the subject of the fifth chapter, is made up of a large undivided region situated in the mediodorsal line of the Ascidian, the cloacal cavity, and from thirteen to sixteen cæcal prolongations, which surround the branchia except in the medioventral line, for they do not extend underneath the hypobranchial groove. The investing epithelium is flat, and identical with that of the epidermis and of the gill. The cloaca receives the blood which comes from the gill as well as the excreta and genital products of the organism; the anus opens by a wide space in its lower part, and the genital ducts open just opposite the anus. The cloacal siphon, which has the same structure as the buccal, is placed in the upper part of the cloaca; it has, like it, transverse and longitudinal muscles, but the latter are not found in a dorsal appendage of the siphon, where they are represented by fibres given off from the transverse muscles. This fact is of some morphological importance, for it tends to prove that the muscles which encircle the entire body of *Doliolum*, and which also give off prolongations to the anal appendage of these animals, are, in Ascidians, homologous not with the circular muscles of the body, but with the transverse muscles of the siphon. When ova are produced, the hinder part of the cloaca dilates considerably, so as to form an incubating pouch in which the eggs are developed. The observations of the author tend to confirm the statement of MM. Van Beneden and Julin as to the origin of the layers of the peribranchial cavity. In *Fragaroides*, as in simple Ascidians, the parietal layer of the peribranchial cavity has an ectodermic, and the visceral layer an endodermic origin.

The digestive tube is described in the next chapter. It is placed altogether behind the branchial cavity, and is composed of œsophagus, stomach, and intestine; the last may be subdivided into duodenum, chylific ventricle, and rectum. The orifice of the œsophagus is elongated in such a way as to advance towards the posterior cul-de-sac of the endostyle; the vibratile cilia of its epithelium are prolonged into the interior of the cell as far as the deep granular mass, and the protoplasm becomes thickened around the base of each cilium. The cilia and their prolongations are broken up into small dots, which are set in regular lines transversely as well as longitudinally. The stomach is cylindrical in form, and is marked by eighteen to twenty grooves, the centre of which alone communicates with the cavity of the stomach; this is owing to the fact that both the œsophagus and the intestine project into the interior or the gastric cavity and form a kind of valve. These grooves must be looked upon as the homologues of the liver of more perfect Ascidians. The chylific ventricle is an ampullæform dilatation of the digestive tube, which communicates with the terminal intestine by a cleft. The epithelium of the rectum is ciliated. The intestinal gland is composed of a series of ramified tubes, which form a kind of reticulum on the surface of the rectum; they pass into a canal which opens into the stomach between the gastric lobes, and the product of their secretion aids in digestion.

The seventh chapter is divided into two parts, the first of which deals with the nervous system properly so called, and the second with the hypoganglionic gland and the vibratile organ. The true nervous system consists of an interoscular ganglion, a ganglionated end which goes to the viscera, and of nerves. The first of these, or brain, is situated on the mediodorsal line, is ovoid in form, and gives rise, anteriorly, to a pair of nerves which go to the buccal siphon, then to two or three pairs of lateral nerves, and lastly, to a large posterior nerve which runs for some distance above the ganglionated cord, and which innervates the cloacal siphon. Histologically speaking, the brain is made up of a peripheral zone, which is formed solely by uni- or bipolar ganglionic cells arranged in two or three irregular concentric layers, and of a central fibrillar mass in which a few nuclei are scattered. The visceral or dorsal ganglionic cord arises from the posterior and inferior part of the cerebral ganglion, and is continued along the mediodorsal line between the epithelium of the gill and that of the cloaca, and between the rectum and the œsophagus as far as the region of the stomach. It is formed of ganglionic cells and some nervous fibrils; there are never more than three or four ganglionic cells visible in one transverse section. This cord is surrounded by vast vascular spaces, and is accompanied along its whole length by two longitudinal muscles. The nerves are altogether fibrillar, and their fibres are continuous with the fibrillar substance of the brain. The posterior median is single owing to the fusion along part of their length of the two nerves which, in most other Ascidians, arise from the posterior region of the brain.

The hypoganglionic gland is almost as large as the brain and lies beneath it; it is provided with an excretory canal, which is connected with that of the enigmatic structure which is known as the vibratile organ. It is ovoid in form, and is composed of a number of cells with irregular contours; these are most regular near the periphery of the gland. In its upper part there is an elongated cavity, the roof of which is formed by an epithelium of cubical cells; this epithelium is that of the excretory canal of the gland. There are intermediate conditions between this gland reduced to a single cavity, and the compound tubular gland which is found in simple Ascidians. The excretory canal may be divided into three distinct regions; in the anterior part it is complete, but this is very short; in the median part it is reduced to a simple groove, while in the posterior region it is at first circular, but its cells are soon arranged without order, and we have at last nothing more than a mass of cells lying beneath the brain, and altogether similar to the ganglionic cells of the visceral cord.

The vibratile organ forms a funnel which acts as the continuation of the excretory canal, and it opens by an oval orifice on the mediodorsal line of the animal, in the centre of a projecting tubercle, which extends as far as the base of the large mediodorsal tentacle. Its cells carry long flagella. The hypoganglionic gland is neither mucous nor renal in function, and its true significance still remains to be discovered. As to the morphological character of the gland and of the vibratile organ, the author is inclined to think, with Roule, that Julin is right in regarding them as homologous with the hypophysis of Vertebrates. Before committing himself to this he would, however, like to see the organ in *Amphioxus* which is homologous with the hypophysis.

The eighth chapter deals with the muscular system, which is exceedingly well developed in *Fragaroides*. The longitudinal muscles are all lateral, and are inserted into an epidermal projection, the cells of which are specially modified. There are twenty longitudinal muscles on either side of the body. The transverse muscles of the gill have a number of anastomoses with the longitudinal. Around the buccal and cloacal orifices there are circular muscles, and the anus is provided with a sphincter. Each muscular bundle is made up of homogeneous fibres, which bear no traces of transverse striation. The fibrils are separated from one another by a protoplasmic mass in which are nuclei, and the whole is invested by a sarcolemma. They are of a mesenchymatous nature, although the Ascidians are enterocœlic.

The circulatory system or epicardiac organs form the subject of the ninth chapter. The epicardium is in the form of a wide median tube, and dorsally or ventrally to it there is a tubular prolongation of the pericardiac cavity. The heart, which is placed at the extremity of the post-abdomen, is curved and one of its horns is prolonged into the dorsal and the other into the ventral half of the post-abdomen. The membranes of the heart and of the investing pericardium are continuous with one another along a longitudinal cleft which lies on the convex surface of the heart. This cleft remains open and the cavity of the heart is in relation to the blood-lacunæ, not only at either extremity of the organ, but along the whole length of the cardiac raphe. The epicardium bifurcates posteriorly, and then ends blindly. Anteriorly it divides, at the plane of the stomach, into two tubes, the anterior ends of which are applied to the base of the branchial cavity. In the adult no orifices can be detected, but in young larvæ there are distinct communications between these tubes and the branchial cavity. The wall of the heart is formed by a simple layer of epithelio-muscular cells, and there is no trace of an endocardium. The circulation of the blood is not effected by the aid of vessels, but through simple lacunæ hollowed out in the connective tissue; the blood is transparent and carries a large number of free mesodermic cells which retain their primitive characters. The epicardiac plate plays a very important part in the circulation; the sac is connected with the wall of the body, and forms a partition which divides the post-abdomen into a dorsal and a ventral half. The two blood-currents are thus completely separated from one another, and the alternation of the beatings of the heart is of real use in distributing the oxygenated blood to the organs of the body.

The final chapter contains an account of the reproductive organs. *Fragaroides* is hermaphrodite, and the organs, ducts included, are closely connected with one another. The testis is made up of a very large number of lobes, each of which has an excretory ductule which opens into the vas deferens. In each lobe there is an epithelial layer of flattened cells, and an interior mass of rounded cells which become converted into spermatozoa. The ovary appears to begin to function at its hinder end, for there the largest ovules are found. The egg-cells are developed along two bands, so that there really seem to be two ovaries; this is a somewhat, though not altogether, similar arrangement to that described in *Clavelina rissoana* by MM. Van Beneden and Julin. The ova are provided with follicular cells; the author was not able to follow out the development of the cells of the testa, but he inclines to Kowalevsky's opinion that they owe their origin to the follicular cells.

Structure of Pyrosoma.*—M. L. Joliet, in a posthumous memoir on the structure and development of *Pyrosoma giganteum*, begins with a partial bibliographical account of previous researches, from that of Péron onwards. Then follows a diagnosis of the species:—I. Pyrosomata verticillata—*P. elegans;* II. Pyrosomata paniculata—*P. giganteum* and *P. atlanticum.*

The anatomical portion is unfortunately incomplete; the general features are described, and then the external structure and disposition of the component individuals, but after a brief note on the branchial sac this section comes to an end.

The blastogenesis is then discussed. As to the origin of the bud, the author concludes as follows:—Between the extremity of the endostyle and the epidermis there is a mesodermic layer which is continuous beneath with the reproductive tissue; the endostyle being prolonged approximates this layer to the epidermis; at this point the layer acquires fresh cellular activity, and forms a continuous stratum of cells. In the area of activity thickenings are produced which become the neural canal and the peribranchial canals. As the bud grows, however, and rises from its base, it loses thickness and cellular structure, and gradually acquires the form of a delicate sac, including the scattered nuclei which are seen almost throughout the adult. The organs which it has produced—genital glands, neural and peribranchial canals, appear isolated from one another.

The next section is devoted to a description of the stolon. The fact which rules the development of the bud is that its axis is not that of the stolon, but is perpendicular to it. The transformations are described, but must be followed on the plates. From the branchio-intestinal tube there are developed—the digestive canal, the branchial sac, and the inhalent orifice. Some details are added to the results of Huxley and Kowalewsky on this point. The "hyaline organ", the branchial sac, the "canal diapharyngien" which divides the latter into two chambers, the peribranchial pouches, the formation of the cloaca, are then described. An account of the heart and the respiratory apparatus completes the whole of the paper which the editor could regard as finally approved by the author.

A final chapter, less finished but still valuable, describes the nervous system. The ciliated sac is described, and its homology with the "hypophysis" of Ascidians accepted and corroborated. It is maintained that in *Pyrosoma* "gland and canal develope at the expense of the primitive vesicle, and the structure has thus quite a different origin from the hypophysis of Vertebrates which is produced by an invagination of

* 'Études anatomiques et embryogéniques sur le Pyrosoma giganteum, suivies de recherches sur la faune de Bryozoaires de Roscoff et de Menton,' Paris, 1888, 112 pp. (5 pls.).

the primitive buccal cavity." The author would extend this conclusion to other Tunicates, and criticizes the arguments of E. van Beneden and Julin. The ciliated sac is most probably an olfactory organ, as many authorities believe. Finally, the author has described the ganglion and the distribution of the nerves. Transverse sections of the ganglion exhibit two distinct layers: the outer composed of small rounded cells pressed together, the inner consisting of finely granular and amorphous substance. The nerves which spring from the ganglion are described in three groups—superior or anterior, lateral, and inferior or posterior.

Alternation of Generations in Salpa and Pyrosoma.*—Dr. L. Joliet left among his unpublished papers another contribution of interest. It discusses the alternation of generations in species of *Salpa* and *Pyrosoma*. The lamented author corroborated the observations of Kowalcwsky and defended the old theory of Chamisso—of a true alternation of generations —against the objections of Brooks and Todaro.

(1) The budding of *Salpa* is true budding, though complicated by the fact that the already differentiated organs take part in it, each on its own account. (2) The solitary form hitherto considered as asexual is rightly so called. It does not contain an ovary nor a hermaphrodite gland, but only the incipient rudiments of such a gland. (3) In the alternation of generations, proceeding by blastogenesis, the asexual form is produced sexually, and possesses a reproductive tissue, which may be only potential and undifferentiated, or quite recognizable and already differentiated. It is, however, unable to carry this on to complete development, and entrusts it for this purpose to another form, or to several successive forms produced by blastogenesis. Of these, the last at least is sexual. This formula may be applied to *Salpa*, *Pyrosoma*, other compound Ascidians, and to several hydroids.

β. Bryozoa.

Anatomy and Histology of Membranipora pilosa.†—Herr W. Freese commences his account of this Polyzoon with a description of its ectocyst, external appearances, and varieties, three of which are to be distinguished. The endocyst of adult animals merely forms a thin meshwork of protoplasmic filaments in which no cell-boundaries can be distinguished; in stained pieces the small masses of protoplasm are seen to be almost completely formed by large, round, or smaller oval nuclei with distinct nucleoli; the surrounded protoplasm is very small in quantity. The endocyst only exhibits a truly epithelial structure at the point where it extends over the rosette-plates; as in *Flustra membranacea*, there is an epithelium formed of cylindrical cells; this is unilaminate, and forms a lens-like stopper.

The so-called perigastric cavity or space between the ecto- and endocyst corresponds to the body-cavity of other animals; the parietal muscles, which are found in it, consist of from three to ten fibres in each bundle; the fibres are somewhat more delicate than those of the other free muscles, and stain less deeply. The author agrees with most of the recent histologists in refusing to ascribe, with F. Müller, a nervous nature to the funiculi laterales and funicular plate; and he agrees rather with Nitsche in thinking that the plate is an organ which serves to keep

* Op. cit., pp. 97–102. † Arch. f. Naturgesch., xlv. (1888) pp. 1–72 (2 pls.).

the enteric canal in a definite position relative to the zoœcium, and that the cords serve to convey stimuli from one animal to another, as the walls of the zoœcium are particularly thin at their points of insertion into the rosette-plates. In *Membranipora*, as in *Flustra membranacea*, the funicular plate consists of a plexus of spindle-shaped cells, of the same size as those of the cords.

The tentacular sheath is, histologically, a lamella, in which no cell-boundaries can be made out, although distinct cell-nuclei are deposited in it. Although the fibrous cords on the sheath do not appear to contain any nuclei, there can be no doubt that they are muscular. The vaginal sphincter has a more complicated structure in *Membranipora* than in the forms described by Nitsche or Vigelius. It is half as long as the invaginated part of the ectocyst; internally to the chitinous tube there is a layer of large cylindrical cells provided with distinct nuclei; in the lower and inner side of the diaphragm formed by the cylindrical epithelium there is a layer of circular muscular fibres, and the author thinks that there are also a few longitudinal fibres. Nitsche was incorrect in supposing that the tentacular sheath passes directly into the substance of the sphincter. The tentacles and the circular canal consist of three layers of tissue—the outer epithelium, the homogeneous cylinder which corresponds to the muscular tunic of phylactolæmatous Polyzoa, and the internal very loose investment of cells. The cylinder is the support of the whole tentacle; on the side turned away from the mouth it is drawn into two ridge-like processes, which pass at their base into the homogeneous lamella of the circular canal; from this canal a homogeneous membrane is continued to the enteric canal, of which it forms the outer, firm support. No distinct cells can be made out in the inner loose tissue, but scattered nuclei, surrounded by protoplasm, may be observed. Here Freese agrees with Salensky in thinking that the cavities of the tentacles and their circular canal represent a vascular system, although he has not been able to prove a connection between the circular canal and the body-cavity.

In a number of points the structure of the enteric canal agrees with that of the Flustræidæ.

Membranipora, like *F. membranacea*, has an organ which appears to be the homologue of what is undoubtedly the nerve-centre in the Phylactolæmata; it lies on the anal side of the circular canal, and has the form of a triaxial ellipsoid; the outer membrane does not appear to consist of cells, as described by Vigelius in *F. membranaceo-truncata*, but is a cuticular secretion of the internal substance. On the whole the author's account agrees very closely with the anatomical descriptions of the chief writers on the structure of the Polyzoa. The paper concludes with an account of the species found in the Baltic.

γ. Brachiopoda.

Modified Ectoderm in Crania and Lingula.*—Miss A. Heath has some observations on a tract of modified ectoderm in *Crania anomala* and *Lingula anatina*. This tract is found on the arms of *Crania*, over the whole of the sides of the tentacles and the fold which lie next each other, and at the outer base of the fold. When specially modified the portion lies in a groove in the subepithelial tissue, and the epithelial

* Proc. Biol. Soc. Liverpool, ii. (1888) pp. 95–104 (3 pls.).

cells may be seen frequently to end below in long colourless tails or threads which are in connection with a mass of tissue lying below them, and on the outside of the epithelial tissue. This mass consists of stellate cells, the points of the stars being produced into long colourless threads, which are in some cases connected with the threads from the outer columnar cells. Owing to the greater size of *Lingula* the modified epithelium is there larger and easier of detection; there are three regions of especially modified tissue on the arms. All these tracts probably correspond to the tracts of specialized tissue described as occurring in some articulate Brachiopods, and regarded as sense-organs. Their intimate connection with nerve-fibres and cells supports this view of their sensory nature.

Arthropoda.

α. Insecta.

Observations on Ants, Bees, and Wasps.*—Sir John Lubbock has published the eleventh part of his observations. He is of opinion that, though there may be nests of *Formica sanguinea* without slaves, an experiment which he has made seems to indicate that the slaves perform some important functions in the economy of the nest, though it is not yet determined what that function exactly is.

With regard to Ant-guests, he points out that Dr. Wasman has confirmed his observations, in opposition to Lespès, that, while ants are deadly enemies to those of other nests, even of the same species, the domestic animals may be transferred from one nest to another, and are not attacked. Attention is next drawn to Prof. Emery's observations on mimicry among ants.

With regard to the colour-sense, Prof. Graber has confirmed Sir John's observations on Ants and Daphnias, by which he showed that they are sensitive to the ultra-violet rays, by similar observations on earthworms, newts, &c. Light was found to act on decapitated earthworms, though the differences were not so marked; the same held good for newts, when their eyes were covered over, and Graber hence concludes that the general surface of the skin is sensitive to light. Forel has made some observations on ants, the eyes of which were carefully covered by opaque varnish, so that they were rendered temporarily blind.

From experiments made with *Platyarthrus*, which have no eyes, the author found that they made their way into the shaded portion of a partly covered nest, and he remarks that it is "easy to imagine that in unpigmented animals, whose skins are more or less semitransparent, the light might act directly on the nervous system, even though it could not produce anything which could be called vision."

Sir John's experiments lead him to differ from M. Forel, who believes that bees have a certain sense of direction. The power of recognizing friends is discussed at some length, but the explanation of the fact still remains obscure. The most aged insect on record is a queen of *Formica fusca* which lived for fifteen years; what is much more extraordinary is that she continued to lay fertile eggs; fertilization took place in 1874 at the latest, and there has been no male in the nest since then, so that the spermatozoa of 1874 must have retained their life and energy for thirteen years.

* Journ. Linn. Soc. Lond., xx. (1888) pp. 118–36.

The seeds of *Melampyrum pratense* are, as Lündstrom has recently pointed out, closely similar to the pupæ of ants, and he has suggested that this may be an advantage to the plant by deceiving the ants, and thus inducing them to carry off and so disseminate the seeds. The author's own observations show that *Formica fusca* appears to take no notice of these seeds, but that, under certain circumstances, they are carried off by *Lasius niger*.

The observations of Mr. and Mrs. Peckham on the special senses of wasps is referred to as containing conclusions which concur closely with those of Sir J. Lubbock.

A connected account of the author's observations is given in a recent work, 'On the Senses, Instincts, and Intelligence of Animals, with special reference to Insects,'* which will be found useful as a handbook of the subject with which it deals.

Termites.†—Prof. B. Grassi resumes the principal results of his observations on termites. (1) The nests of *Calotermes* contain individuals perfectly winged from the middle of July to the middle of November. The winged members are scarce in July, more so in November, but abundant in August and September. It seems evident that they do not leave the nest all at once. (2) About the middle of March, he found a nest of two individuals, male and female, without wings, and along with a number of eggs. (3) King, queen, and eggs of Calotermites, are usually found, with nymphs and soldiers, in the middle of June, in a dilatation of a gallery. (4) In care for the eggs and in other ways, *Termes lucifugus* appears to occupy a higher level than *Calotermes*. Both are inferior to bees in recognition of strangers. (5) The galleries of the Calotermites afford indication of the length of life of the colony inhabiting them. (6) Grassi has not been able to distinguish among Calotermites, either the nymphs of the second kind, or Fritz Müller's substitution queens. The characters of the individuals observed are discussed in detail. (7) From November to the end of June, the nests of *Termes lucifugus* appear to be without king or queen, and without eggs. (8) Various cases of termite habitations are discussed. (9) Facts are given to show that the termites swarm after the manner of bees, and that they make great preparations for swarming. Other interesting notes are communicated, proving the patient zeal of the observer.

Replacement of King and Queen of Termites.‡—Prof. B. Grassi has made some further observations on *Termes lucifugus*. He finds that a colony which has been deserted provides itself with a fresh royal pair by accelerating the maturation of the generative organs of a certain number of individuals which are capable of becoming winged imagines; this is probably effected by means of special food; the generative organs mature while the other important characteristics of the imago (especially the wings) develope much more slowly or do not appear at all. In this way individuals with ripe generative organs, but wanting the other marks of the adult, are raised to the royal throne. The individuals selected are probably those which, at the time of desertion, have their generative organs best developed. While the honey-bees have the

* 8vo, London, 1888, 292 pp. (118 figs.).
† Bull. Soc. Entom. Ital., xix. (1887) pp. 75-80.
‡ Zool. Anzeig., xi. (1888) pp. 615-8.

power of stopping the development of these organs, the Termites are able to hasten their maturation.

Poison-apparatus of Mosquito.*—Prof. G. Macloskie gives an account of the poison-apparatus of the Mosquito. There are two sets of glands, one on each side in the antero-inferior region of the prothorax; each consists of three glands, two of which are of the usual aspect of salivary glands, and resemble in structure, though they are not proportionately as long as the single salivary glands of the house-fly. The third or central gland of each set is evenly granular and stains more deeply than the others; it is this which, no doubt, has the function of secreting the poison. Each gland is traversed throughout by a fine ductule, and the three unite at the base to form a common duct, which is one of the branches of the veneno-salivary duct. The secretion of the lateral glands dilutes the poison. The single main duct passes to the reservoir at the base of the hypopharynx. The pressure on the surrounding parts is sufficient, when the mosquito inserts its piercing apparatus, to propel the poison through the tubular axis of the hypopharynx into the wound. The distal orifice of the hypopharynx is subapical and not exactly terminal; the tip is flattened and sharp so as to enter easily and enlarge the wound made by the adjoining organs.

δ. Arachnida.

Anatomy of Hydrodroma.†—Dr. R. v. Schaub gives a detailed account of the anatomy of this Hydrachnid, one of the characters of which is the possession of a small highly chitinized dorsal shield under the skin between the eyes.

The matrix of the chitin of the integument is a thin layer of homogeneous tissue, which is broken by irregular lacunæ; this matrix is also the seat of the pigment which is collected at nodal points, and contains distinct nuclei. The dorsal shield not only serves as the point of origin for a number of muscles, and especially those of the oral cone, but also as a protection for the subjacent sensory organs. The dermal glands, peculiar to the Hydrachnida, are, in *Hydrodroma dispar*, arranged in four longitudinal rows over the back; their tunica propria is extremely thin, and is supported by a network of thin chitinized ridges; the secretory cells are divided into two hemispherical groups; they open by a cleft, which is surrounded by a strong chitinous wall. On the legs there are a number of very variously formed chitinous setæ, all of which have an internal canalicular cavity, which, with the exception of the swimming hairs, is indicated by a thin layer of red pigment. The author does not agree with Haller in his division of the hairs into tactile and olfactory organs, though he has no doubt of their general tactile sensibility.

Like all other Hydrachnids, *Hydrodroma* has the basal joints of the pedipalpi fused to form a suctorial proboscis, which corresponds to the maxillæ, and incloses the mandibles; this apparatus is briefly described. Above it are a pair of oval orifices, which were first recognized by Kramer as the stigmata of the tracheal system; they lead directly into a tube which is 0·008 mm. thick, formed of colourless and homogeneous, but hard, chitin. The two tubes pass into air-reservoirs formed by the

* Amer. Natural., xxii. (1888) pp. 884–8.
† SB. K. Akad. Wiss. Wien, xcvii. (1888) pp. 98–154 (6 pls.).

basal joints of the mandibles; these are strong *f*-shaped capsules, 0·2 mm. long and 0·04 mm. broad, and widened out in saccular form in their middle. Some of the tracheæ which pass into the body from the air-chamber pass out directly, while others are derived from a chief tracheal trunk which breaks up. No trace of spiral marking could be detected on the tracheæ; they are thin tubes (0·0015 mm.), and traverse the body without further division; as they often form a close plexus around the organs, they may be considered to aid in keeping them in their place. It is probable that the setæ at the ends of the appendages have some share in respiration. There is no heart, and there are no blood-vessels. In transparent species of *Atax* it is very easy to observe how the muscular activity in the movements of the legs has an influence on the circulation of the blood in them.

The pharynx is a spindle-shaped tube, the wall of which is strengthened by chitin; this forms discs which are set at right angles to the long axis, and continued into the interior, so that the whole internal cavity is broken up into nine divisions, each of which is filled by a bundle of strong circular muscles. A very thin canal traverses the axis of the whole tube; and it is clear that it is by the alternate contraction of the circular muscles in each division that the tube is narrowed and widened; by these means the food is pumped into the œsophagus. The stomach appears to be very much like that of other Hydrachnids; with regard to the rectum, however, the author is in opposition to Croneberg.

The excretory organ is placed dorsally to the central cavity of the stomach, and, as it is partly covered by blind sacs, it lies in a complete groove. It is formed by a simple sac, the extent of which varies in different individuals. It passes into a cylindrical tube, which, like the rectum, is formed of longitudinal muscles, which are attached to the anal ring. The secreting cells are surrounded by a transparent homogeneous tunica propria, and have the form of spherical vesicles of different sizes; the secretion, which is always present in large quantities, appears to consist of a number of elongated or rounded corpuscles with concentric, highly refractive, bluish rings.

The nerve-centre of *Hydrodroma* is like that of other Hydrachnida; the few differences that obtain are carefully noted. The eyes appeared to deserve special study, and with them there were compared those of *Atax*, *Diplodontus*, and *Eylaïs*. In addition to the known two pairs of eyes, the author has found in *Hydrodroma* a fifth, unpaired, eye, which is very small, and is placed in the median depression of the dorsal shield. The minute structure of the eye is always on the same fundamental type, and the differences are confined to the chitinized tegumentary part which is converted into the lens, and to the relative positions of the eyes. Those of either side are always unequal in size, and the larger is always more anterior and nearer the middle line. A single optic nerve is given off from the brain, and this divides into two, at a varying distance from its point of origin. The end of each optic nerve passes into a number of club-like structures, which are united into a more or less conical cup, and correspond to the rod-cells. The chitinous lens is greatly thickened internally, and projects into the lumen of this cup. Each of the rods is invested in an extremely delicate envelope of connective tissue, below which are dark-violet pigment-corpuscles closely packed.

In connection with the eyes there is a specific dense organ in the form of a vesicle filled with rounded cells, containing a highly refractive nucleus of irregular form; the nerve which supplies this organ does not arise directly from the brain, but from the optic nerve about midway between the eye and the nerve-centre. *Hydrodroma dispar* has four of these organs, which lie in the depressions at the four angles of the dorsal shield. The direct connection of this organ with the optic nerve leads to the supposition that we have here to do with the vestiges of eyes.

After a short notice of the musculature, the author passes to the generative organs, as to which he has nothing essentially new to add to the descriptions given by Croneberg; a somewhat detailed description is, however, given.

ε. Crustacea.

Male Copulatory Organs on first Abdominal Appendage of some female Crayfishes.*—Herr D. Beyendal directs attention to some abnormalities in the appendages of the first abdominal segment of female crayfishes. He has observed that these appendages vary much in form; sometimes they were quite absent, some were spoon-shaped, and in a few they presented the characters of the male; the last were otherwise quite normally constituted females. The male appearance does not, therefore, seem to be any indication of hermaphroditism, nor is it a sign of a return to an earlier hermaphrodite stage. We have, in fine, to do rather with a well-marked case of the variations which are exhibited by useless vestigial organs. The cause of the possession of male organs is to be sought for in the influence of inheritance from its male parent by the female.

Indian Amphipoda.†—Mr. G. M. Giles, continuing his notes on the voyage of H.M.S. 'Investigator,' calls attention to the fact that he has as yet found only two species of Amphipods previously known. Since his last publication Mr. Giles has found eleven new species. A blind *Anonyx* which appears to feed on drift, an *Ampelisca*, a *Microdeutopus*, and a *Monoculodes* are described. An interesting form, which the discoverer calls *Concholestes dentalii* g. et sp. n., was found forming a distinct tube within Dentalium shells. Next comes a careful description, with seven figures, of *Amphithoe indica* Milne-Edwards. New species of *Atylus*, *Urothoe*, *Caprella* are recorded, diagnosed, and beautifully illustrated. Another form, which belongs to the family Platyscelidæ, will fit into no existing genus, and is named *Elsia indica* g. et sp. n.

New Family of Commensal Copepods.‡—M. E. Canu gives a note on the Hersiliidæ, a new family of commensal Copepods, which must be regarded as distinct from the Siphonostomata and the Peltidiidæ. The body is completely segmented, and the first thoracic somite is united with the cephalic ring; the anterior antennæ have seven joints, and are similar in the two sexes; the posterior antennæ are simple and have four joints. The mandibles have no palps nor any masticatory teeth; at their distal extremity they are provided with mobile accessory seizing pieces, and flattened plates, the edge of which may be denticulated or carry

* Bihang Handl. K. Svensk. Vet. Akad., xiv. (1888) iv. No. 3, 35 pp. (1 pl.), and Oefvers. af Forhandl. K. Svensk. Vet. Akad., 1888, No. 5, pp. 343-6.

† Journ. Asiat. Soc. Beng., lvii. (1888) pp. 220-55 (7 pls.).

‡ Comptes Rendus, cvii. (1888) pp. 792-3.

setæ. The rudimentary maxillæ are divided into an internal masticatory lobe, and an external palpiform lobe. The paragnaths are well developed and cover the mandibles. The maxillipeds are well developed, and the internal furnish important sexual differences. The thoracic appendages are biramose.

The new genera are *Giardella* (*G. callianassæ*), which is very abundant in the galleries of *Callianassa subterranea*, and *Hersiliodes* with three species; *H. Pelseneeri* was found in the tube of a Clymenid, *H. Thomsoni*, on the abdominal appendages of *Callianassa*, and the *Cyclops Puffini* of J. C. Thomson, found at Puffin Island.

Two new Copepods parasitic on Echinoderms.*—Dr. A. Rosoll gives descriptions of two new Copepods living parasitically on *Antedon* (or, as he calls it, *Comatula mediterranea*), and on *Asterias glacialis*; both appear to be rare, as each has only been seen once. The parasite of the former is called *Ascomyzon Comatulæ*; the female was 1 mm. long and 1/2 mm. broad. For the second a new genus *Astericola* is established, and the species is called *A. Clausii*; the inner branch of the fourth pair of feet is three-jointed and not two-jointed, as in *Doridicola* and *Stellicola*, and the head and thorax are fused, whereas in the allied *Lichomolgus* they are separate. The anterior antenna has, moreover, eight instead of six or seven joints.

New Parasite of Amphiura.†—Under this title Mr. J. Walter Fewkes gives a brief account of a Copepod, which he does not name; it makes its way into the brood-sacs of *Amphiura*, which it spays, the ovary being rendered amorphous; the Copepod leaves packets of ova, the development of which is assured when the possibility of offspring in *Amphiura* has been destroyed; well-formed Nauplii were observed in the sac.

Amœbocytes of Crustacea.‡—Dr. G. Cattaneo describes the amœboid cells in the blood of *Astacus fluviatilis*. (1) There are two principal forms—granular and hyaline. These are two stages of the same elements. (2) The granular cells are the more perfect and are functional; the hyaline cells are retrogressive. (3) The protoplasmic spherules within the heart and pericardium are simply the débris of the vascular elements. They do not pass again into the general circulation, but are found in the hepatic arteries, and in the tissue of the yellow glands undergoing adipose degeneration. (4) The function of the amœboid cells has no relation to hæmatosis, which is effected by the hæmocyanin and tetronerythrin dissolved in the blood-plasma. They serve rather, by means of the ferment represented by the refractive granules, to convert into albumin capable of assimilation, the peptones and a portion of the detritus. Their action as phagocytes was also observed. (5) The variations of the amœboid cells in diverse media and under reagents are described. An excess of water in the blood favours deformation and expansion of pseudopodia. Lowered temperature to 0° brings about plasmodia. Heightened temperature to 70° makes the cells diffluent.

* SB. K. Akad. Wiss. Wien, xcvii. (1888) pp. 181–202 (2 pls.),
† Proc. Boston Soc. Nat. Hist., xxiv. (1888) pp. 31–3.
‡ Arch. Ital. Biol., x. (1888) pp. 266–72. Cf. this Journal, 1888, p. 949.

Vermes.

α. Annelida.

Polychæta of Dinard.*—The Baron de Saint-Joseph continues his account of the polychætous Annelids found off Dinard. The Aphroditinæ often carry ectoparasites, thus *Pedicellina belgica* may be found under the elytra and on the back of *Hermadion pellucidum*, and *Trichodina Auerbachii* has been found on the elytron of *Halosydna gelatinosa*; numerous other cases are cited. These same worms may also live an epizoic life, thus *Malmgrenia castanea* lives near the mouth of *Spatangus purpureus*, *Hermadion assimile* lives round that of *Echinus esculentus*, and *Acholoe astericola* lives in the ambulacra of various species of *Astropecten*. The Polynoids appear to be specially commensal on other annelids.

The author's account of the various species differs considerably in length; among those most fully treated are *Halosydna gelatinosa*, *Harmothoe cœliaca* sp. n.; *H. maxillospinosa* sp. n., *H. picta* sp. n., and *H. arenicolæ* sp. n., the last of these was found on an *Arenicola marina*.

The Euniceidæ are next dealt with; the members of this family are interesting from the differences between the young and old forms, due to successive modifications in the setæ, jaws, number of eyes and cephalic appendages; in consequence of this, great care must be taken in the definition and delimitation of species. *Lumbriconereis labrofimbriata* and *L. paradoxa* are new. The name of *Labrorostratus* is given to a new genus in which the head has no appendages and the upper jaw is rudimentary, and which is allied to *Arabella*. From its habit the species is called *L. parasiticus*; it was found living in the body-cavity of Syllidians; it is not known how it reaches this situation. It is remarkable for its comparatively large size, being as much as 8 mm. long. A somewhat similar case of endoparasitism is the *Lumbriconereis* found in *Marphysa*. The characters of Claparède's genus *Drilonereis* are modified, and a new species, *D. macrocephala*, is described. The characters of *Arabella* are also emended, and *Maclovia* is regarded as a sub-genus. The same happens to *Paractius*. A remarkable new form, *P. mutabilis*, is described.

Among the Lycoridinæ *Leptonereis Vaillanti* sp. n. and its heteronereid forms are first described. The author does not agree with Claparède's view that only some of the species of Nereids have heteronereid forms; of the thirty-eight of the latter, twenty are known to have nereid forms, and he does not think it unlikely that others will be discovered.

The Phyllodocinæ are next discussed; the genus *Phyllodoce* is divided into the four sub-genera, *Genætyllis*, *Phyllodoce* (s. str.), *Anaitis*, and *Carobia*.

Phyllodoce (Carobia) splendens sp. n. is perhaps the most beautiful annelid found at Dinard. It has a yellowish brown head, the appendages of the head are yellow, and the cirri of a beautiful green, edged with yellow; the dorsal surface of the segments has a yellow background covered with a metallic azure with beautiful iridescence; the lower surface is deep brown with thin longitudinal rays of blue. Another new species is *P. (Carobia) rubiginosa*. *Eulalia Claparedii*, *E. splendens*, *E. ornata*, *E. trilineata*, *E. rubiginosa*, *E. fuscescens*, *E. venusta*, and *E. parva* are new. Other new species are *Etione incisa*, and *Mystides (Mesomystides) limbata*. The last group treated of is that of the Hesioninæ.

* Ann. Sci. Nat., v. (1888) pp. 141–338 (8 pls.).

Central Nervous System of Lumbricus.*—Herr B. Friedländer has investigated the minute structure of the central nervous system of the earthworm. As Faivre correctly stated, though he has been contradicted by Vignal, the short connectives between the closely applied ganglia of the ventral cord lie in front of the points of origin of the single nerves. In each ganglion there are a limited number of large, multipolar ganglion cells which are constant in position and have a peculiar chemical constitution; they are probably comparable to the median cells described by Hermann in *Hirudo* and by Kükenthal in *Travisia*. In each ganglion there are fibrous transverse bridges at the level of the point of origin of the nerves. With the exception of the first root of the double nerves, the lateral nerves have their fibres partly related to these transverse bridges; the first root of the double nerves has a more ventral, the second a more dorsal origin. There is in *Lumbricus* a median nerve running between the two chief cords of fibres. In each of these latter there are three groups of closely approximated, well-developed nerves; in the ventral group there is a specially thick nerve-tube. Near this last there is a differentiated tissue similar to the fibrils of the brain.

The sub-œsophageal ganglion is probably the product of the fusion of two ventral medullary ganglia. The investments of the neural canals are purely of the nature of connective tissue and are not to be compared to the myelin of the nerves of Vertebrates. They probably have, as a subsidiary function, the duty of preventing lesions of the ventral cord, on the contraction of the worm. The contents of the neural canals consist of processes of ganglionic cells which are probably fused with one another into a homogeneous mass. The two lateral neural canals begin at the hinder end of the ventral cord in the form of processes of two ventrally placed ganglionic cells of special character, but not of unusual size; in their further course they take up the processes of other ganglionic cells of similar character. Before their entrance into the neural canals the processes form complicated anastomoses with one another, as well as with the median canal. The nervous central substance of the brain differs essentially from that of the ventral cord. The proximal ends of the anteriorly directed nerves have a deposit of numerous small ganglionic cells which form the lobes of the brain. In more posterior transverse sections a fine fibrillar dotted substance placed centrally and ventrally and ganglionic cells may be seen. In sections stained with carmine, scattered nuclei of connective tissue which indicate the presence of a neuroglia-like supporting substance, may also be made out.

The ganglionic cells may be divided into several sets; the whole dorsal part of the brain consists of a cortical layer chiefly made up of ganglion-cells; these are remarkable for the difficulty with which they can be preserved, and it was quite impossible to make out the number of their processes. Most of them are very small, but some are larger, pyriform, and unipolar. There are, further, groups of large pyriform cells, and cells with extremely sharp contours, and very broad processes; the latter form a dorsal and a ventral fibrous cord, which only unite into one a short distance in front of their entrance into the œsophageal commissures. There appears to be here a complete crossing of the fibres.

The nervous central substance or dotted substances of Leydig

* Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 47–84 (2 pls.).

consists of coiled fibrils which appear to take their origin from the small ganglionic cells of the cortex of the brain; the constituents of this differ in their chemical characters, for while the chief mass becomes a bright brown with osmic acid, there is a part which stains more deeply.

Genital and Segmental Organs of Earthworm.*—Dr. G. Goehlich has reinvestigated the much studied genital and segmental organs of *Lumbricus terrestris*. The ovary is first described, and Claparède's account of oogenesis confirmed. The condition of the organ, and the absence of egg-laying in winter are noticed. The tube and the egg-receptacle are then discussed in detail; when eggs are to pass into the oviduct the author believes that the muscles of the receptacle contract, the ciliary activity of the funnel stops, that in the oviduct begins, and the eggs are laid. The oviduct and the cocoon are then described without new result of importance. In regard to the spermatheca, the author notes that in the cold season, blood-corpuscles enter the reservoirs, as in *Aulastomum*, and devour the spermatozoa. In discussing the copulation, it is noted that the spermatophores never contain sperms belonging to either of the copulators, but belonging to a third worm which has formerly united with one of them.

The testes, seminal vesicles, seminal funnels, and vasa deferentia are next described, but again the results are almost wholly corroboratory. The author believes that the expulsion of the spermatozoa is in part due to the ciliary action of the vas deferens. A careful account, with beautiful figures, is given of the various parts of the segmental organs. Some new histological details are communicated in regard to the ciliated funnels.

Three new Species of Earthworms.†—Mr. F. E. Beddard describes three new species of earthworms, and takes the opportunity of discussing certain points in the morphology of the Oligochæta.

Acanthodrilus annectens is a new species from New Zealand, which combines to a certain degree the characters of *A. multiporus* and *A. novæ-zealandiæ;* its vasa deferentia are remarkable for running deep within the longitudinal muscular layer, and unite just before their external orifice; the atria open separately upon the seventeenth and nineteenth segments.

Deinodrilus Benhami g. et sp. n., also from New Zealand, is remarkable for having, in each segment, six pairs of setæ; this arrangement is intermediate between that seen in *Lumbricus*, where there are four pairs, and the continuous row of numerous setæ found in *Perichæta*. It is interesting that there are other characters in which *Deinodrilus* is intermediate between *Acanthodrilus* and *Perichæta*. The atria have two pairs of apertures as in the former, and the clitellum is, as in *Perichæta*, found on segments 14–16.

The dorsal vessel is a completely double tube; there are six pairs of lateral hearts. The nephridial system is like that of *Acanthodrilus multiporus*. A special cœlomic sac incloses the dorsal blood-vessel.

The third new species, *Typhœus Gammii*, is from Darjeeling; as in *T. orientalis* there is no prostomium, and the mouth is, therefore,

* Zool. Beitr. (Schneider), ii. (1888) pp. 133–67 (2 pls.).
† Quart. Journ. Micr. Sci., xxix. (1888) pp. 101–31 (2 pls.).

terminal; the penial setæ differ from those of *T. orientalis* by having wavy ridges round the distal portion, and there are only two genital papillæ.

The author discusses the structure and homologies of the so-called prostate glands in the Oligochæta, and comes to the conclusion that the so-called prostates of *Perichæta* are equivalent to the atria of *Acanthodrilus*, *Pontodrilus*, and others; in *Monoligaster Barwelli* the atrium consists of a thick glandular covering of peritoneum, of a layer of muscular fibres, and of a single layer of columnar epithelium.

Reproductive Organs of Eudrilus.*—Mr. F. E. Beddard has a further communication on this subject. He finds that a pair of problematic bodies in the thirteenth segment have their duct communicating with the duct of the spermatheca. These bodies were regarded as being probably ovaries, and this view is supported by Rosa's description of a pair of similar structures which are placed in an identical situation in *Teleudrilus*, and contain nearly mature ova, and by the author's discovery of numerous mature ova in these bodies in *Eudrilus*. But, while the tube by which the ovary in the thirteenth segment in *Eudrilus* communicates with the exterior is a real duct, lined by a single layer of columnar cells, the tube which leads from the ovary to the receptaculum in *Teleudrilus* is simply a cœlomic sac. *Eudrilus* appears to have another pair of ovaries in the fourteenth segment, and its oviduct, on either side, opens opposite to that of the thirteenth into the spermathecal duct. Each ovary is enveloped in a muscular sheath which is continuous with the oviduct, and this investing sheath is probably equivalent to the receptaculum ovorum of other earthworms.

β. Nemathelminthes.

Nematode in Blood of Dog.†—Dr. P. Sonsino has made a study of the life-history of *Filaria hæmatica* (Gruby and Delafond) or *F. immitis* (Leidy), which is found in the blood of the dog. It occurs in the heart, pulmonary artery, subcutaneous tissue, intermuscular connective, &c. The young stages are passed in one of the epizoic parasites, whence the adolescent form returns to the dog. In this the history of *Tænia cucumerina* is paralleled. It is hardly just to regard *Spiroptera* or *Filaria sanguinolenta* as a true hæmatozoic parasite. Besides *F. immitis* there may be in the dog other hæmatozoic nematodes, which like it propagate their embryos in the blood and have similar external intermediate hosts. The parasites may be acquired, according to Galeb and Pourquier, during fœtal life from the mother. From the young dog thus infected from the first, the nematode embryos may pass secondarily to the epizoic parasites.

The author then describes the rare nematode *Rictularia plagiostoma*, obtained from a new host, the fox. Like its previously known hosts, the bat and hedgehog, the fox was probably infected by eating insects. Both sexes are described. Embryos were seen within the eggs contained in the oviduct—the worm is "ovoviviparous." The peculiar chitinous appendages are carefully described, those of the male are more uniform than those of the female. Other species of *Rictularia* are discussed.

* Zool. Anzeig., xi. (1888) pp. 643–6. † Arch. Ital. Biol., x. (1888) pp. 199–6.

δ. Incertæ Sedis.

"Notes on some Rotifera from the neighbourhood of Geneva."*—M. E. F. Weber describes four new species of Rotifers, viz. *Limnias granulosus*, *Œcistes socialis*, *Rotifer trisecatus*, and *Rotifer elongatus*; and discusses, also, several points in the structure of such well-known animals as *Floscularia campanulata*, *Hydatina senta*, &c., &c., which he thinks have been incorrectly described. There is also a full account, accompanied by several drawings, of *Microcodon clavus*. Both the description and the figures of this rare Rotiferon will well repay study, though the latter (pl. xxxix. figs. 5 and 6) greatly exaggerate the slight curvature which the trochal disc has in the living animal, and the former is disfigured by faults that pervade the whole memoir; for these "Notes" are written throughout with an assumption of authority which is by no means warranted by M. Weber's observations, figures, or descriptions.

Let us take, for example, M. Weber's new species *Œcistes socialis*. The head of this Rotiferon is said to consist of a large open funnel, bearing on its upper rim one circular ring of cilia, and having the animal's buccal orifice deep down at the bottom of the funnel. We have here, then, a Rotiferon whose corona is not only utterly unlike that of any known *Œcistes*, but is such as is not to be found in any genus of the Melicertidæ. For every Melicertan has its ciliary wreath fringing a solid, imperforate, and nearly flat fleshy disc—not a perforate funnel. It has, too, a double ciliary wreath—not a single one; and its buccal orifice is asymmetrically situated, on the ventral surface, at the back of a flat trochal disc—not symmetrically situated at the bottom of a funnel-shaped one.

But this is not all; the trophi are said to consist of two rami with three teeth crossing each—that is to say, that *Œ. socialis* has the mastax of a Philodine; and, moreover, there is said to be only one ventral antenna, instead of the usual pair. From all this it is clear either that this new animal is not a Melicertan at all, or that it has been very imperfectly observed and described by M. Weber.

Another new species, *Limnias granulosus*, presents us with almost as many perplexing characters. First, the side view of the head (pl. xxvii. fig. 1) is ludicrously incomprehensible, and must be seen to be appreciated. Next, fig. 2 in the same plate professes to be a dorsal view, but shows the two ventral antennæ on the same side as the solitary dorsal one; and the text distinctly states that the three antennæ are all on the dorsal surface. But such an arrangement is not to be found in any other Melicertan: throughout the family the paired antennæ lie on the ventral surface, one on either side of the buccal orifice; and the solitary antenna lies on the dorsal surface. Still, such is the endless variety of Nature, that we should have hesitated to have challenged a positive statement, like the above, were it not that in fig. 4 in the same plate the same three antennæ are all placed side by side on a surface, which the drawing of the trochal disc shows to be the ventral one. A glance at figs. 2 and 4 will satisfy any one, familiar with *Limnias*, of the correctness of our statement.

Again, in the figures (pl. xxx. figs. 1, 2) of the new species *Rotifer trisecatus*, we meet with a similar anomaly. In fig. 1 the spurs are

* Arch. de Biol., viii. (1888) pp. 647–722 (11 pls.).

rightly placed on the dorsal surface of the foot, but in fig. 2 they are palpably attached to the ventral surface.

A similar confusion is to be seen in the drawing of the last new species, *Rotifer elongatus;* for in pl. xxxi. fig. 2 the dorsal antenna and the proboscis ("trompe") are actually drawn on opposing surfaces; the proboscis being placed on the ventral surface, beneath the buccal orifice.

Space would fail us to point out the numerous errors contained in M. Weber's off-hand corrections of the observations of others; but two of these deserve notice. First, M. Weber states that the male Rotifera have no contractile vesicle ("cette vessie n'existe pas chez le mâle";) and that the lateral canals open directly outwards on each side of the penis. Now, nothing can excuse so gross an error. If M. Weber had ever examined a male *Asplanchna* (a common animal enough), he would have seen in it a contractile vesicle that no beginner could miss. He would have seen it contract, and he might have counted, even, the muscular threads to which the contraction is due. The very memoirs he quotes from, and of which he gives a list, ought to have preserved him from such a blunder; were it not that M. Weber appears to have no doubt that, when an observer differs from him, the person in error cannot be himself.

The following is an amusing instance of this curious belief in his own infallibility. M. Weber fails to find the contractile vesicle in the male of *Hydatina senta*, so he dismisses all the observers who *have* seen it by saying, "Cohn, Leydig, Daday, and Hudson have seen it with the eye of faith!"

Again, when describing the trophi of *Brachionus urceolaris*, he challenges the accuracy of Gosse's beautiful figure in his famous memoir "On the manducatory organs," and offers one of his own as more correct. It is well worth while to place these figures side by side; and at the same time to look at M. Weber's figure of the trophi of *Hydatina senta*. The comparison will give a very fair measure both of M. Weber's capacity and of his own opinion of it.

We have only space to notice one more extraordinary statement. M. Weber, when describing the rotatory organ of the Rotifera, says that it consists generally of two ciliary wreaths: one (for locomotion) which is always in movement; and the other (for bringing nourishment to the mouth), which moves or not, according to the animal's pleasure. He further says that in the Rhizota this latter wreath "is usually very reduced, and forms a semicircle round the mouth." Can M. Weber ever have seen *Melicerta ringens?* and if he has, can he have failed to see that the secondary wreath, which brings food to the buccal orifice, is not a mere semicircle round the mouth; but that it runs almost entirely round the trochal disc, parallel to the greater wreath, and of length quite equal to it? Of course, these remarks apply equally well to a *Limnias*, *Œcistes*, *Conochilus*, *Lacinularia* or *Megalotrocha;* yet M. Weber studies a new species both of *Œcistes* and *Limnias*, and misses altogether the real structure of their Rhizotic coronæ.

Parasitic Rotifer—Discopus Synaptæ.*—Dr. C. Zelinka gives a detailed account of this parasitic rotifer, to the preliminary notice on which we have already called attention.† The following notes may be

* Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 333–458 (5 pls.).
† This Journal, 1888, p. 52.

added :—It lives on Synaptæ in the English Channel and in the Adriatic. The animal, when extended, is from 0·25 to 0·15 mm. long. The ciliated oral funnel has a circular fold ; the formula for the jaws is $\frac{2}{2}$, and the teeth diverge. The wall of the mid-gut is thick and of an intense yellow colour, and the lumen of the gut makes therein a complicated loop ; the mid-gut is attached to the dorsal wall by two bands. At the anterior end there are two dorsal and one ventral gland (pancreas). The hind-gut is formed of a pyriform vesicular portion, and a rectum. Ciliated infundibula have been noticed in the neighbourhood of the pharynx and brain. The gonads are germ-yolk-glands, which lie close to the enteron ; a straight process passes backwards and downwards from their investing membrane. The foot is three-jointed, and the penultimate joint forms a sucker. A firm capsule is developed around the isolated glandular ducts. The author believes that *Echinoderes* stands nearer to the Rotatoria than to the Archiannelides.

Echinodermata.

Development of Calcareous Plates of Asterias.* — Mr. J. W. Fewkes has investigated the development of the skeleton of some American species of *Asterias.* He finds that the first plates to appear are the terminals ; these are simple, and form a protecting cap which shields the ambulacrals, interambulacrals and, possibly, marginals. The genital plates arise after the terminals ; the one which lies nearest to the madreporic opening does not always antedate in time or exceed in size the other genitals ; the madreporite is not formed till after the rudiments of the stone-canal. After the terminals and genitals there appears the dorso-ventral, which arises before any plates are developed on the actinal hemisome. The first set of body-plates are arranged in a circle, and radially, inside the genitals ; the second is also radial and lies inside the first or somatic radials. A third and inner circle appears before the interradial somatic plate. The first plate in the circle outside that of the genitals is the first dorsal of the arms ; this plate is the radial of Sladen ; when the arm of the young star-fish is broken from the body it always remains on the arm. The dorsals, or median row of plates on the dorsal surface of the arm, originate peripherally to the first dorsal, and are at first relatively very large. As the oldest dorso-laterals may not be the nearest to the body, it is clear that they do not appear in the same sequence as the dorsals. Marginal plates appear after the ambulacrals (adambulacrals).

The first plates to be developed on the actinal hemisome are the oral ambulacrals ; at their first appearance there are already on the abactinal hemisome five terminals, five genitals, one dorso-central, and thirty spines on the terminals. The oral ambulacrals are at first set parallel to the radial culs-de-sac of the water-system, but subsequently become placed at right angles ; they are at first ten in number. The interbrachial ends of the oral ambulacrals of adjacent radii (arms) grow towards each other, forming two parallel ends in each interradius, each of which bears two spines. The median end of each oral ambulacral bifurcates into a dorsal and a ventral part. All the other ambulacrals arise with their axes at right angles to the line of the radii ; they are

* Bull. Mus. Comp. Zool., Cambridge, U.S.A., xvii. (1888) pp. 1–56 (5 pls.).

formed near the middle line of the under side of the ray, and grow towards the peripheral end; the first formed are the adoral, and these bifurcate in the neighbourhood of the median line.

The first interbrachials, which are regarded by Mr. Fewkes as the odontophores, originate as heart-shaped, interradially placed calcifications, five in number; each is placed abactinally to the interbrachial ends of the oral ambulacrals.

No ventral embryonic row of spines was observed in any species of *Asterias* which was studied.

The author regards the genitals of *Asterias* as homologous with the "basals" of *Amphiura;* the first interbrachial is homologous with the orals of *Amphiura;* the madreporic opening is placed on homologically different plates in *Asterias* and *Amphiura.* The interambulacrals of *Asterias* are the homologues of the laterals of *Amphiura.* The oral ambulacrals of the former are represented by the "spoon-shaped" plates of the latter. The first and second adambulacrals have no homologues in the mouth-parts of *Asterias.* The dorsolaterals and the connectives of the arms of *Asterias* were not recognized in *Amphiura.* There is some doubt as to the homologies of the marginals.

Development of Synapta digitata.*—Dr. R. Semon has made a careful examination of the development of this Holothurian. Segmentation is remarkably equal. While in Echinids and Ophiurids the formation of mesenchym precedes the invagination of the archenteron, in the Holothurians it succeeds it; it is not possible to decide which of these two is the more archaic arrangement. The ciliated bands of the *Auricularia*-larva are local thickenings of the ectoderm; the other ectodermal cells simultaneously lose their flagella, and become flattened. The somewhat remarkable fact that the larvæ of Asterids have two, and not, like other classes of Echinoderms, only one ciliated band, is explained by the discovery of an adoral band, from which the second circlet is developed. It may be concluded that all bilateral echinoderm-larvæ have two separate ciliated bands, one adoral and one postoral; and there is no essential difference between the larvæ of Asterids and those of other classes; the characters of the larvæ are discussed at some length.

Flattened mesenchym-cells form a simple and not completely continuous layer beneath the epidermal investment, and form a half-groove-like sheath to the ciliated bands and the stripes of the lateral surfaces, as well as an investment for the stomach and rectum. These cells are very much flattened, and are thereby distinguished from the other mesenchym-cells. The larva has, at an early stage, an extremely thin epidermis, which is formed by the ectodermal cells which were at first ciliated, and a unilaminate cutis which is formed of mesenchym-cells. There is no doubt that the two bands discovered by Metschnikoff are the nervous system of the larva; this is shown, not only by the whole structure of the organ, but by the fact that, later on, the bands pass into the permanent nervous system of *Synapta.*

When the larva enters the *Auricularia*-stage the rudiment of the hydroenterocœl is a simple elongated vesicle, which opens to the exterior by the dorsal pore. At first it lies in about the median plane of the larva, and later on it passes to the left side. It next divides into two

* Jenaisch. Zeitschr., f. Naturwiss., xxii. (1888) pp. 175–309 (7 pls.).

vesicles; the superior of these is the hydrocœl, the inferior the enterocœl. The latter becomes a band-like body, which gives rise to the two sacs of the cœlom. The fine canal which puts the interior of the hydrocœl-vesicle into connection with the outer world by means of the dorsal pore is the primary stone-canal of Holothurians; this canal lies interradially to the five primary tentacles; while these primary tentacles are, in all Echinoderms, radial in position, the secondary outgrowths of Holothurians are interradial.

The elements of the mesenchym do not only form a subcuticular layer, but they give rise to unilaminate investments for the enteron, ciliated bands, and nerve-bands, to stellate cells in the gelatinous substance, to the muscular elements, and, lastly, are the seat of origin of the calcareous deposits. Physiologically the calcareous concretions appear to be of importance for the larva, as they make the lower part of the body heavier than the upper, so that the animal always moves in water with the lower end more or less directed downwards. The rudiments of the calcareous ring appear while the rosette-like rudiment of the water-vascular system lies freely in the gelatinous substance to the left of the fore-gut. These are, at first, merely fine delicate rods, which occupy an interradial position.

In the passage of the *Auricularia* to the tun-shaped form the most remarkable phenomenon is the hitherto unnoticed diminution in the length of the various axes; while a fully developed *Auricularia* has a long diameter of 1·4–to 1·7 mm., the larva in the pupal stage and the quite young *Synapta* (*Pentactula*) is only from 0·4 to 0·5 mm. long. With this diminution in size there is a loss of transparency, owing to the closer approximation of the mesenchym-cells.

The tun-shaped larva with ciliated bands, its conversion into the young *Synapta*, the young and adult *Synapta*, are described at a length greater than that which we can follow.

In the second half of his memoir Dr. Semon deals with the phylogeny of the Echinodermata. He commences by raising the question of the position of the Synaptidæ among the Holothurioidea; as to this, he concludes that there are no facts of structure and development which justify us in supposing that the simple organization of the Synaptidæ is due to reduction from the more complicated organization of the pedate Holothurians. Secondly, as to the relation of the Holothurians to other classes of the Echinodermata. The former are all distinguished by the fundamental peculiarity that their body water-vessels lie adradially and not radially, for these vessels arise from the secondary interradial evaginations of the water-tube. In all other Echinoderms the madreporic plate lies interradially to the rays of the primary tentacles; it is perradial in Holothurians, on the supposition that the secondary evaginations are the homologues of the primary tentacles of other Echinoderms. But this is a view we can hardly accept, and we must rather suppose that the primary tentacles of Holothurians are comparable to the primary tentacles of other Echinoderms, and that the secondary evaginations are special formations. Goette alone has perceived that the body ambulacra of Holothurians correspond to the interradii of the star-fish. If this view of homologous parts be true, it follows that it is quite impossible to suppose that the Holothurians were developed from echinoid-like forms, and we must rather suppose that the two groups separated before a water-vascular system was developed, or, in other words, at a time when the hydrocœl consisted only of a circular canal and five primary tentacles. All difficulties are evaded if we suppose that divergence arose from an earlier and simpler stage of development, and one which is retained in the young *Echinus* and, with slight modifications, in the young *Synapta;* this will be again found in the ontogeny of other classes of Echinoderms. The primitive form may be called the *Pentactula.*

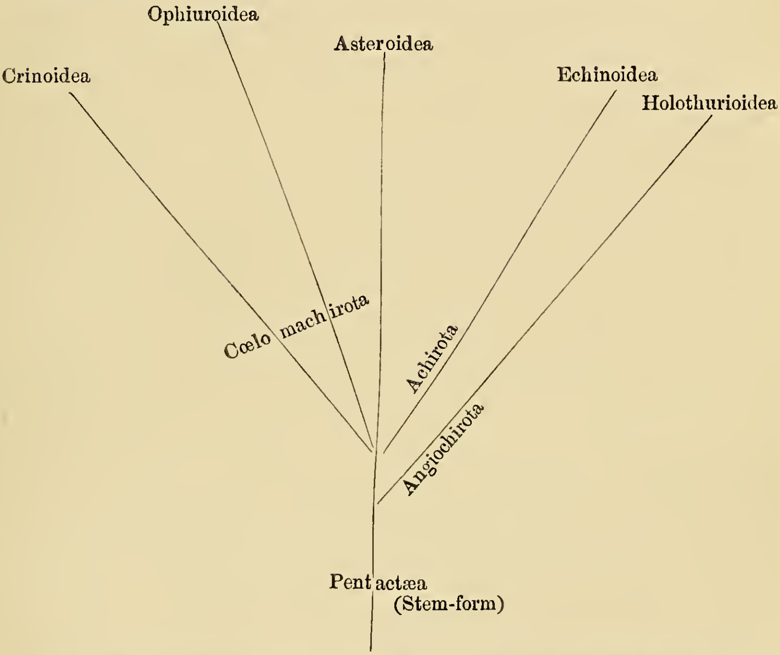
This phase of development is characterized by the fact that the dipleural larva has begun to confuse bilateral with radial symmetry by the development of the five primary tentacles. At first the radial symmetry affects only one system of organs — the water-vascular —but the nervous system is soon likewise affected; the bilaterally symmetrical larva may be called the *Dipleurula.* It may be said that all Echinoderms, save where their development has been cenogenetically shortened, pass through two larval stages, one bilaterally symmetrical and one bilateral and radial. It is especially during the latter that the internal and external resemblance between the larvæ of different classes is considerable.

The *Pentactula* may be regarded as a creature whose anterior pole is marked by the mouth-opening. Around the mouth are five tentacles, formed as outgrowths of the water-vascular ring which surrounds the pharynx. Over these outgrowths the outer skin forms a thickened sensory epithelium. From the ring a canal leads to the surface of the body, and this canal, the primary stone-canal, opens by the dorsal pore freely to the exterior; as this pore is always found on the dorsal side in the bilateral early stages of Echinoderm-larvæ, it is called the dorsal pore. In front of the water-vascular ring there is a nervous ring which surrounds the pharynx; it gives off five nerves to the primary tentacles, on the inner side of which the nerves lie. The nerves as well as the nerve-ring, whose derivates they are, lie superficially in the ectoderm, from which they are derived. The enteric canal consists of œsophagus, mid-gut, and hind-gut; the anus lies on the ventral side, and may approximate to or remove itself away from the mouth, so that, in extreme cases, it comes to lie within the circlet of primary tentacles or at the hinder end of the body. Between the gut and the body-wall there is a wide body-cavity, formed from symmetrical enteric sacs; there is a dorsal mesentery which gives a distinct sign of the bilaterally symmetrical origin of the cœlom. The primary stone-canal arises from the circular canal between the points of insertion of two primary tentacles; this character gives a plane of symmetry for the *Pentactula,* and passes through the dorsal mesentery, dividing the gut in the median line and that tentacle which may be called the ventral tentacle.

This larval form exhibits no characters which can be regarded as cenogenetic, and if we suppose that the stem-form of the Echinodermata was a creature which, in external form and internal organization, had great resemblance to it, we may derive all the classes of the Echinodermata from a form which may be called *Pentactæa.* Dr. Semon thinks that a derivation of this kind agrees with the facts of comparative Anatomy, and offers the key to some unsolved problems.

When we come to consider the divergencies which obtain among the various classes, we see that one group—the Holothurians—have retained essentially the relation of the body to the primary tentacles which we saw in the stem-form; as this tentacular system has remained as essentially an outgrowth of the water-vascular ring with a tegumentary investment, the group may be called that of the Angiochirota. In the second group—that of the Echinoids—the region distinguished by the possession of the primary tentacles has disappeared altogether, and it may, therefore, be called that of the Achirota. In the third type, which is represented by Asteroids, Ophiuroids, and Crinoids, we see important systems of organs drawn into the tentacular region, which thereby gradually acquires greater significance and independence; this group it is proposed to call that of the Cœlomachirota.

The relations of these forms may be indicated by the following diagram:—



The true homologies of the organs of different classes can only be established by reference to the organization of the stem-form. Many of what have been hitherto regarded as homologies are clearly analogies, due to the fact that most of the structures compared are arranged in fives, and to the inheritance from the stem-form of certain peculiarities, such as the structure of the skeletal elements, and the tendency of the mesenchym to form clefts.

It cannot be doubted that the Echinoderms are derived from bilateral creatures with an enterocœl; it cannot be yet decided whether the hydrocœl is a derivate of a primitive excretory system of the bilateral ancestors. There are good reasons for supposing that the conversion of the bilateral into the radial structure was due to a fixed habit of life. With regard to the corm-theory of the organization of certain Asterids, it is urged that such colonies could not have arisen by budding, but by certain organs (tentacles) acquiring greater independence. This independence, which is to be regarded as a consequence of continued decentralization, leads in the most extreme cases to an obliteration of the sharp limits between organ and person.

As to the relations of the Echinodermata to other divisions of the Animal Kingdom, it is certain that in some points they have distinct relations to other Enterocœlia, and especially to *Balanoglossus* and the Chordata, but as to these so little is yet certainly known that it is better to refrain from any further speculation.

Ophiopteron elegans.* — Prof. H. Ludwig gives an account of a remarkable new genus of Ophiurids, the type of which appears to be natatory. A single example was found at Amboina by Dr. Brock. It is most remarkable for having on each arm-joint a pair of large fins.

The disc has a transverse diameter of 6 mm., and each arm is about 36 mm. long; the latter with the fins are at their base 5·5 mm. broad, and without the fins hardly 1·5 mm. The lateral shields form a high ridge or plate on either side of the arm. The arm-spines are transparent, and form hooks, thorned spines, or supports for the fins; in the composition of these last two spines enter. They are articulated by a thickened base, and suddenly taper to a thin rod, which gradually becomes thinner; they do not, as a rule, end in a simple tip, but fork in such a way that the two branches of the fork lie close to one another. The fins are formed by a thin transparent membrane, in which we may distinguish an inner margin attached to the ridge of the lateral shield, a free anterior edge directed towards the tip of the arm, a free outer edge, and a free hinder edge directed towards the base of the arm. The direction taken by the line of insertion of the fin is such that the anterior edge arises on the ventral and the hinder edge on the dorsal side of the arm. The successive fins lie over one another like the tiles of a roof; the anterior and posterior margins are not directly supported by the rod, but by a delicate fringe of the fin-membrane which extends along the spines.

No less remarkable than the fins are the peculiar structures formed by the dorsal spines of the disc. These give rise to a number of fine and ordinarily six-sided funnels; each of these consists of a short, thick spine, which, at its outer edge, is continuous with six fine spines, so connected with one another as to form a funnel, the delicate membranous wall of which is supported by the six fine spines. The funnels are wanting on the soft, thin, transparent ventral membrane of the disc. The peristome has the general characteristics of *Ophiothrix* and *Ophiogymna*, and with the former of these the new genus seems to be most closely allied. The structure of the fins may remind us of the membrane which connects the adambulacral spines in the Pterasteridæ.

Ophiurid Fauna of Indian Archipelago.†—Herr J. Brock collected sixty species of Ophiurids during a year's voyage in the Indian Archipelago, a number of which, in addition to the *Ophiopteron* described by Prof. Ludwig, are new. The new genera are *Ophioæthiops* and *Ophiosphæra*, and a new genus *Lütkenia* is instituted for a species from Cape York, and *Ophiothela Holdsworthi* E. A. Smith forms the type of *Gymnolophus*: all these are regarded as allied to *Ophiothrix*, and the distinguishing characters are pointed out. A table is given showing the points of all the Ophiothrix-like genera.

* Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 459-64 (1 pl.).
† T. c., pp. 465-539.

It is pointed out that the Indo-Pacific littoral fauna is essentially a fauna of coral reefs, and that the southern extremity of Africa does not belong to it. A list is given of the species of Ophiurids known to inhabit this region, which contains 132 names, or about 40 per cent. of the known littoral fauna of Ophiurids.

Holothurians of Indian Archipelago.*—Prof. H. Ludwig has a report on the forty-one species of Holothurians collected by Dr. Brock in the Indian Archipelago; of these five, *Holothuria sluiteri*, *H. pyxoides*, *H. olivacea*, *Phyllophorus brocki*, *Chirodota amboinensis*, are new.

New Echinoconid.†—Prof. S. Lovén gives a full account of the form which, some years ago, he called *Pygaster relictus*. The single dried specimen is very small, being only 3·5 mm. long and 3·41 mm. broad; the calycinal system is, unfortunately, lost. It agrees with *Pygaster*, *Pileus*, and *Holectypus* in having the auricles of each ambulacrum directed longitudinally in relation to the ambulacrum, and separate. There is, as the author shows, a somewhat different arrangement in *Discoidea* and *Galerites*. Prof. Lovén does not think that the specimen, though small, is young, for the test is rather thick, and the tubercles, the epistromal protuberances, and the depressed ambulacra are adult rather than young characters. It may be called *Pygastrides relictus*, and be defined thus: the periproct is dorsal and posterior, the ambulacral plates are all simple, the first wide with single pores, the auricles longitudinal and separate; the zones of pores are simple and straight. Sphæridia single. Interradial plates of peristome single, wide. The tubercles perforated, crenulate, the primary rather large. Epistrome luxuriant. It was taken near the Virgin Islands, at a depth of from 200 to 300 fathoms.

Cœlenterata.

Cœlenterata of the Southern Seas.‡—In his seventh communication under this title, Dr. R. von Lendenfeld deals with the Rhizostomata. He regards these jelly-fish as representing a suborder of the Scyphomedusæ, distinguished by the absence of tentacles, and the peculiar development of the mouth-arms; he attaches less importance than do most authors to the absence of an oral orifice, for not only have young Rhizostomata a mouth, but in his genus *Pseudorhiza* the mouth is retained throughout life. To the eight families recognized by Claus he adds a ninth, that of the Chaunostomidæ, and he somewhat modifies the characters of the Lychnorhizidæ with which he places *Phyllorhiza*. The distribution of the twelve species found in Australian wat rs is, curiously enough, very restricted. The cause of the separation of the species is to be found in the currents, of which an account is given. Of the seventy-one known species of the suborder, forty-two are found in the southern hemisphere.

Pseudorhiza aurosa, which is found in Port Phillip, is 500 mm. in height, and the disc is 350 mm. in transverse diameter. The arms are S-shaped, and have attached to their sides pinnate cylindrical branches about 50 mm. long. The whole arm has the appearance of a much branched groove open below, with a serriform contour to its edges. On

* Zool. Jahrb., iii. (1888) pp. 805–20 (1 pl.).
† Bihang. Kongl. Svensk. Vet. Akad. Handl., xiii. (1888) No. 10, 16 pp. (2 pls.).
‡ Zeitschr. f. Wiss. Zool., xlii. (1888) pp. 200–324 (10 pls.).

the thin margin of the disc there are eight marginal bodies; the surface of the disc has a network of rather deep grooves. The arm grooves unite by pairs into four short perradial grooves which lead to the four-sided mouth, which is 12 mm. broad. Thence a short œsophagus extends through the arm disc, and divides into four branches which enter the four divisions of the arm, where they are very small and oval in transverse section. They open into a large central gastric cavity, which is only from 3–5 mm. high. Sixteen vessels arise from the central stomach, and all open into the circular canal which is distant 135 mm. from the central point of the Medusa. From this canal blind canals pass towards the centre. The zone outside the circular canal is occupied by a close vascular plexus, which is traversed by continuations of the perradial and interradial canals.

The subumbrella is provided with circular folds which act as brood-spaces and are generally filled with embryos.

The mesoglœa is colourless; on the outer surface of the disc there are numerous round papillæ, separated from one another by deep grooves which are invested by violet epithelium. These grooves form a network which extends over the surface of the disc, and gives it its violet colour.

The author is inclined to think that Haacke's *Monorhiza* is synonymous with his genus; he forms for it the new family Chaunostomidæ which he places between the Cassiopeidæ and the Cepheidæ.

A full account is given of *Phyllorhiza punctata* from Port Jackson; it appears to be most nearly allied to *Toxoclytus* and *Lychnorhiza*, but it differs in the possession of a continuous subgenital space, a character to which Dr. von Lendenfeld attaches less systematic importance then does Haeckel. Some additions are made to our knowledge of *Crambessa mosaica*, corrections of several of Haeckel's characters being made. This species is remarkable for having two varieties, one blue, one brown; the former is found in Port Phillip, and the latter in Port Jackson. Numerous as individuals are in both these localities, the author never found a brown example at Port Phillip, or a blue one in Port Jackson.

In an account of the structure of the three just mentioned species, and of the Rhizostomata in general, the disc and locomotor apparatus was first considered. The disc differs in structure from that of other Medusæ only by always wanting tentacles, and generally having no mouth on the under surface. All the species have large discs, and these are often brightly coloured. In the epithelium of the exumbrella we find several layers of high cells; in the region of the marginal bodies, and especially in the dorsal sensory pits, there is a specially differentiated sensory epithelium. The epithelium consists of an outer layer, composed of supporting cells, goblet, sensory, and stinging cells, and of a subepithelium, which is best developed in the projecting parts, and consists of young cnidoblasts, ganglion-cells, indifferent (?) cells, and, in *Cassiopea polypoides*, of muscle-cells. These are all separately described; the sensory cells are delicate spindle-shaped elements from the upper free end of which a rather long conical tactile seta projects; at the base is a multiramified stalk. Osmic acid gives rise to the appearance of granules similar to those seen by Jickeli in the sensory cells of Hydroids. The subepithelium of the exumbrella contains fibrils which have a tangential course, and which may possibly be nerves.

The mesoglœa is solid, and consists of a structureless ground-mass in which fibres and cells of various kinds are found. There can be no doubt that the gelatinous material of the medusa-disc consists of a network of organized substance, in the meshes of which sea-water is retained by adhesion; the fibres which traverse it are either smooth or granular. Of the cells, the most common are rounded bodies which, with Hamann, the author calls colloblasts, as they appear to form the mesoglœa which they excrete in concentric layers on their surface. As Claus and Hertwig have shown, these cells arise from the endoderm of the upper surface of the stomach, whence they wander into the mesoglœa; they increase by division, and appear to take in nourishment which is diffused through the substance of the jelly. Of other cells there are bi-, tri-, or multipolar bodies which are distributed more irregularly than the colloblasts, and they all appear to be in connection with one another. There are also amœboid wandering cells, and quite irregular cells, which the author is inclined to regard as being poison-glands; the latter have only been observed in *Phyllorhiza punctata*.

In the marginal sensory organs we may distinguish the marginal body itself; the ephyral lobe on either side of this body; the covering plate; the pads on the surface of the lobes which is turned towards the marginal body; the projecting end of the radial canal below the marginal body; the sensory pit behind and above the body, and the gelatinous wall which separates the sensory pit from the pouch of the marginal body. All these are dealt with by the author in considerable detail.

The subumbrella carries the reproductive organs; the female, and generally also the male organs are found in the mouth-arms; the greater part of the subumbrella is occupied by the muscle of the disc, which, by its rhythmical contractions, effects the locomotion of the Medusa. Smooth and transversely striped muscle-cells may be distinguished, the latter being best and most numerously developed. The marginal bodies and their surroundings form a complex of sensory organs, which perceive the waves of sound and light, and such changes as take place in the chemical quality of the water. The stimuli are conveyed to the ganglion-cells, which lie behind the marginal body and in front of the sensory pit. From this central organ locomotor stimuli start, which pass to the nerves which lie in the subepithelium. These extend centripetally along the radial canals, and from the radial nerve numerous circular nerves are given off which follow the margins of the primary folds of the muscle-plate, and innervate the ganglionic cells which lie above the true muscle-plate. Thence other fine nerves pass off which spread out in the muscle-plate and are directly connected with the muscle-corpuscles. The nerves anastomose frequently, and so form a plexus which invests the whole of the lower side of the disc. The muscle has a flexor function, while the hard and very elastic supports of the muscles have an antagonizing action, and serve as extensors.

The gastro-vascular system and the mouth-arms are next described. There can be no doubt that, in the Rhizostomata, digestion is principally effected in the distal parts of the whole gastro-vascular apparatus; thence the prepared food passes by the arm-canals into the central stomach, whence it makes its way by the vessels of the disc into the important organs on the edge of the disc and in the subumbrella. The author considers that the vascular system of the disc is chiefly an apparatus for transport and assimilation, which is, perhaps, comparable to the blood-vascular system of the Cœlomata, from a physiological point of view. There are, apparently, no special renal cells, and the excretion of nitrogenous excreta seems to be effected by certain cells of the vascular plexus.

In conclusion, the genital organs are described; in all the three forms examined by the author, their structure was the same. In each interradius there is a very large broad zone, concave outwards, in which the subumbrellar gastric wall is particularly thin. These thin parts grow so rapidly that they give rise to a large number of folds. On this folded membrane there is a broad band in which the egg-cells are formed and matured; this band consists of three layers—a rather high endodermal cylinder-epithelium, mesoglœa, and a low endodermal pavement-epithelium. The young cells have neither membrane nor follicle, though both appear later on. The male organs of *Crambessa mosaica* and *Phyllorhiza punctata* only differ from the female in that sperm-sacs are developed in the place of eggs.

Two new Types of Actiniaria.*—Dr. G. Herbert Fowler describes two new Actiniarians found by the 'Challenger' at Papeete. One, which is called *Thaumactis medusoides*, is flattened and almost medusiform in shape, and is, perhaps, a free-swimming form; as it is biconvex it has no true body-wall, but the animal is divisible into oral and aboral surfaces; the former is beset by what the author calls pseudotentacles, since they cannot be regarded as homologous with true tentacles in number, position, or structure. In an expanded specimen fourteen true tentacles surround the stomodæum. The pseudotentacles each arise as a simple hollow outgrowth from the cœlenteron; the bud extends laterally over the surface into three or four "roots," and is continued upwards as a free, finger-like process; the ectoderm on the apices of the roots is generally well supplied with nematocysts, but no nematocysts are found on the finger-like process; these false tentacles have no relation to the mesenterial chambers, either in number or position. No siphonoglyph could be recognized in the stomodæum. The musculature of the general wall of the body is slightly developed, and consists of an endodermal circular and an ectodermal longitudinal layer. Of the twenty-one pairs of mesenteries found in the largest polyp, only one pair are directive; six are primary, and six secondary; for the most part the free edge bears the normal form of filament.

The non-fixation and persistent biconvex shape of the polyp appears to indicate a condition more or less ancestral, while, in the opinion of Prof. R. Hertwig, the longitudinal muscle leads to a belief in a close relation with the Hydrozoa. Its peculiarities may justify us in regarding it as the type of a new tribe, the Thaumactinæ.

The other new form, which is called *Phialactis neglecta*, is chiefly interesting from the fact that it affords another example of the retrogression of the tentacles; from the four genera already described by Hertwig it differs in that the tentacles are not replaced by stomidia—slight elevations of the oral disc, surrounding a large opening which is homologous with the pore at the tip of some normal Actiniarian tentacles—but by what Dr. Fowler terms sphæridia,† i.e. ampullate diverticula of the inter- or intramesenterial chambers, devoid of an opening to the exterior, and homologous, therefore, with the imperforate tentacles of many genera.

* Quart. Journ. Micr. Sci., xxix. (1888) pp. 143–52 (1 pl.).

† It may be noted that Prof. Lovén has used the term "sphæridia" in a very different sense.

The animal is goblet-shaped, and the sphæridia are borne on the inside of the cup only, where they are especially numerous round the oral cone. The general structure agrees with that of an ordinary Actinian, the abnormal shape being produced merely by a considerable upward growth at the point where the body-wall passes into the oral disc. The mesoglœa is thick. No arrangement into cycles could be detected in the sphæridia. The stomodæum is marked internally by a series of tongue-like ridges produced by the inward growth of the mesoglœa and ectoderm; the most perfect specimen had twenty-three pairs of mesenteries, of which twelve were complete. As in some other genera, new mesenteries take their origin just under the oral disc, and not in the angle between the body-wall and pedal disc. The muscle of the body-wall is endodermal and circular, and is not differentiated into a sphincter at any point.

The systematic position of this genus is very doubtful; Dr. Fowler is inclined to regard it as the type of a new family, the Phialactidæ, to be placed beside the Liponemidæ; Prof. R. Hertwig thinks it should be associated with the Corallimorphidæ.

Lesueria vitrea.*—Prof. W. C. M'Intosh puts on record the appearance of this Ctenophore in British seas. It was found in May 1888 in St. Andrews Bay, where it was present in large numbers till the succeeding September. There is but little to add to the definition given by Milne-Edwards of specimens found at Nice. The contractile filaments are, however, much more distinct than he figures them, while the concretions in the ctenocyst are perfectly colourless, and not reddish as in the Mediterranean specimens. In July and August some examples showed a much larger development of the principal lobes at the sides of the mouth than had been observed earlier in the season. As they projected like two large flaps at the sides of the aperture they resembled the *Euramphæa* of Gegenbaur. Like the American species described by A. Agassiz, the St. Andrews form was beautifully phosphorescent, the light being intense and almost white. It is readily produced by merely blowing on the water, and glances brightly along the ctenophores.

New or rare Australian Hydroida.†—Mr. W. M. Bale has notes on the new or rare species of Hydroida in the Australian Museum.

He finds it necessary to form a new family for *Ceratella fusca* Gray; the Ceratellidæ may be defined as having the hydranths naked, sessile on processes of a chitinous reticulated polypary, tentacles all capitate, scattered irregularly over the body; gonosome unknown; it is allied to the Corynidæ by the structure of the hydranth, and to the Hydractinidæ, with which *Ceratella* was placed by Carter, by the sessile condition of the hydranth and the character of the polypary.

Among the new forms are *Obelia angulosa*, *Campanularia* (?) *spinulosa*, *Lafoea scandens*, which overruns *Sertularella divaricata*, *Halecium gracile*, which is slender and monosiphonic, *H. parvulum; Sertularella longitheca* is remarkable for the proportionate length of the hydrothecæ; *S. variabilis* comprises a series of forms allied to and partly intermediate between *S. indivisa* and *S. solidula*. *Azygoplon* is a new genus for *Plumularia producta*, which is mainly characterized by the absence of supracalycine

* Ann. and Mag. Nat. Hist., ii. (1888) pp. 464–6.
† Proc. Linn. Soc. N. S. Wales, iii. (1888) pp. 745–99 (10 pls.).

sarcothecæ; *Plumularia turgida*, *P. caliculata*, *P. alata* and *P. aurita* are also new.

Aglaophenia sinuosa has remarkable hydrothecæ, in that they have both the anterior and posterior intrathecal ridges fully developed and forming two partitions which project in opposite directions; *A. macrocarpa*, *A. phyllocarpa*, and *A.* (?) *whiteleggei* are new.

Additional notes and corrections are made to the descriptions of Australian Hydroids which have been published by Dr. v. Lendenfeld.

Protozoa.

Protozoa on Mosses of Plants.*—Prof. L. Maggi has studied the Protozoa which occur on the mosses growing on plants. He found no less than twenty-one forms:—*Amœba brachiata*, *A. diffluens*, *A. radiosa*, *A. polypodia*, *A. anthyllion* n. sp., *A. velifera*, *A.* sp. (?), *Corycia dujardinii*, *Amphizonella violacea*, *Hyalodiscus hyalinus* n. sp., *Arcella vulgaris*, *A. aureola* n. sp., *Difflugia* sp. (?), *Euglypha tuberculata*, *E. alveolata*, *E. zonata* n. sp., *Cryptomonas* (*lagenella*) *inflata*, *Cyclidium glaucoma*, *Amphileptus* sp. (?), *Chilodon cucullulus*, *Oxytricha* sp. (?).

The same forms are very widely distributed. Protective encystation was very frequently observed. The author speaks of some cases of apparent "mimetism," e. g. the "mimetisme homochrome" of the green endoplasm of *Amœba velifera*. It is probable that some forms, as Buck reports of *Lecythium hyalinum*, are parasitic on infusorians, or rotifers, or other organisms sheltering in the moss. Diatoms, bacteria, monads, pollen, spores, &c., may form part of the food-supply. What looked like internal gemmation in *Arcella aureola* is described. The author claims no priority in thus calling attention to the moss fauna, but only aims at extending the observations of Dujardin and others.

Multiplication of Ciliated Infusoria.†—M. E. Maupas has published a detailed account of his observations on the multiplication of Ciliated Infusoria, a brief description of which appeared some time since.‡

They present great differences in the faculty of reproduction; if we look at the matter in a comparative way and represent *Glaucoma scintillans*, which is the most fertile of the forms examined, as 1 to 1, *Paramæcium aurelia* has the formula 1 to 5, *P. bursaria* 1 to 8, and *Spirostomum teres* 1 to 10. The three causes previously assigned—quality and quantity of food, temperature, and alimentary adaptation—do not appear to be sufficient. We must recognize further the special temperament of each species; their differences depend on minute differences of molecular constitution which are at present beyond our means of investigation. Light appears to have no influence on the growth and multiplication of these infusorians.

The belief that the fissiparous faculty of these organisms is modified by conjugation, and that this act strengthens and accelerates it, does not seem to M. Maupas to be justified by the facts observed. He has made daily observations on five species, and has not been able to discover the least differences in the successive generations of divided forms; individuals behave in just the same way, whether or no there has recently been a conjugation.

* Arch. Ital. Biol., x. (1888) pp. 184–9.
† Arch. Zool. Expér. et Gén., vi. (1888) pp. 165–277 (4 pls.).
‡ See this Journal, 1887, p. 414.

The phenomena of senile degeneration are very interesting; the first external sign is a reduction in size; *Stylonychia pustulata*, for example, being in the normal state 160 μ, gradually descends to 45 and even 40 μ. In addition to this diminution in size there is, later on, a loss of various organs, until, at last, we get formless abortions incapable of living and reproducing themselves.

The degradation of the nuclear apparatus has a somewhat different history, according to the species; in *Stylonychia pustulata* and *Onychodromus grandis* it is manifested early by the partial and then complete atrophy of the micronucleus; later on, the nucleus itself becomes affected, the chromatin gradually disappearing altogether. While these are the morphological phenomena, the physiological are no less important, for the organism gradually becomes weaker, and there is a "surexcitation sexuelle." Owing to the loss of the micronuclei conjugation is fatally sterile, and the conjugated forms die. From these observations it may be concluded that the micronucleus is the essential organ of sexuality in the Microzoa, and that it plays no active part in phenomena which are purely vegetative.

The forms undergoing senile degeneration may be said to have an inevitable death before them; they still live an individual life, but they are dead to the life of the species. Notwithstanding this the sexual element is not yet completely destroyed, but, in place of contributing to the regeneration and preservation of the species, it accelerates the destruction and disappearance of these atrophied generations. With this sexual atrophy there is also degeneration of other parts. The nucleus, the regulator of the vegetative functions, becomes little by little disorganized, nutrient changes get gradually feebler, the general energy of the organism diminishes, and the size becomes reduced. This senile decay ends in death.

It is clear that these considerations are by no means in accord with the views of Weismann, which the author next proceeds to consider, remarking by the way that the theory of the potential immortality of Protozoa was first broached by Ehrenberg. M. Maupas regards Weismann's theory as resting on the two axioms, that the Monoplastids know nothing of physiological waste, and that their development by fissiparous division is, consequently, the absolute equivalent of all the generations which have arisen from a single progenitor. The first is regarded as being completely false, the second as partly false and partly true. Weismann does not appear to have sufficiently distinguished between the superficial lesions from which all living beings may suffer, and the more deeply seated retrogressive changes which are caused by senescence. Like multicellular animals, the unicellular do suffer loss, and that loss becomes intensified with successive generations. The whole theory of Weismann is an *à priori* one, and has no base in fact, while M. Maupas thinks that the facts which he has observed contradict it.

M. Minot appears to be right in discriminating between the various kinds of individuality, and if the German naturalist had reflected on them he would have immediately comprehended "toute l'inanité de sa théorie de l'immortalité des Protozoaires," or, at least, he would have seen its difficulties and would have hesitated to publish it.

Believing that all organisms are fated to suffer senile decay, M. Maupas refuses to accept Weismann's further hypothesis that death is peculiar to the Metazoa, and has been brought about by some selective action.

Reserve Substances in the Protoplasm of Infusoria.*—Dr. Fabre-Domergue in discussing the nature of the reserve spherules found in Infusoria remarks that one of the most prominent facts is the way in which they become diffluent after the action of ammonia, or from compression. He seems disposed to regard these bodies as composed of paraplasm charged with a coloured liquid material which is capable of being absorbed by the paraplasm itself. This view he says is supported by the manner in which the spherules behave at the moment of their disappearance by absorption. The granules do not disappear little by little as they decrease in size, but they gradually grow pale, their outlines become less clear, while their volume remains the same, and little by little the infusorian recovers its normal homogeneity.

If when the infusorian has lost its spherules it be killed with osmic acid, examination shows that its constitution is quite different. The paraplasm does not consist of isolated spherules surrounded by thin layers of paraplasm, but seems as if it were contained in the hyaloplasmic reticulum; from which the author is inclined to believe that when the paraplasm charged with colouring matter is separating from the hyaloplasm, it forms within its substance spherules, after the manner of the food-boluses, which are always present in the Ciliata.

Aegyria oliva.†—Dr. L. Plate calls attention to the unusual structure of the nucleus of this Infusorian. It is composed of two halves which behave differently with staining materials, in the same way as is known to be the case with *Spirochona gemmipara*, *Leptodiscus medusoides*, and some Rhizopoda. After the animal has been killed with osmic acid one half of the nucleus has a darkly granular appearance, while the other looks nearly homogeneous and clear, having a very slight granulation at its foremost pole. The two divisions lie close together, but are separated by a distinct line. On the application of carmine solution the clear half of the nucleus becomes intensely, and the dark one very faintly coloured. The nucleus of *Aegyria oliva* behaves, therefore, with staining materials, in a way just opposite to that of *S. gemmipara*, in which the darkly granular part is the chromatic and the clear part the achromatic portion. Dr. Plate considers that it would be interesting to ascertain whether in the one form the nuclear division is of as complicated a nature as in the other; if it be so we should be justified in regarding the separate arrangement of the chromatic and achromatic nuclear elements as the cause of such a mitosis.

New Vorticelline.‡—Dr. L. Plate describes, under the name of *Heliochona sessilis*, a new Vorticelline which he found on the branchial plates of a *Gammarus* from the North Sea. As in *Stylochona* the anterior end of the body is widened into the form of a funnel, and beset internally with numerous cilia which whirl in the food. The head-funnel is characterized by a sun-like border of thin rigid bacilli, which issue from its margin.

Two narrow and two broad sides can be distinguished in the flask-shaped body; the animal attaches itself to the branchial plate of its host

* Ann. de Micrographie, i. (1888) pp. 24–30.

† Zool. Jahrb., iii. (1888) p. 173, translated in Ann. and Mag. Nat. Hist., ii. (1888) p. 431.

‡ Zool. Jahrb., iii. (1888) p. 172. translated in Ann. and Mag. Nat. Hist., ii. (1888) pp. 431–2.

by the lower, transversely truncated, pole of the body. One of the broad sides of the funnel is produced into two symmetrically placed lobes which are bent over inwards and partially cover up the cavity of the funnel. The bacilli form a lattice-work, through which only the smaller food-particles can pass to reach the short œsophagus which is situated at the bottom of the funnel. The nucleus is rounded and finely granular, but no paranucleus could be detected. As in *Spirochona gemmipara*, reproduction is effected by buds which are constricted off at a spot on the ventral surface at the base of the neck.

Nyctotherus in Blood of Apus cancriformis.*—Prof. G. Entz has found a large number of examples of a parasitic ciliated infusorian in the blood of the gills of *Apus cancriformis;* they gave the appearance of the gills having been injected by a hardened mass. The species may be called *Nyctotherus hæmatobius;* the body is of a compressed oviform shape, sometimes sharper at the anterior or both ends; the left lateral margin is strongly, and the right slightly convex; the body-bands on the dorsal surface run parallel to the left lateral margin; the peristome appears to correspond exactly to that of other species of the same genus; the anus is placed a little to the left of the hinder pole of the body, and the characteristic anal tube is directed forwards and to the right. The resemblance to *N. cordiformis*, from the intestine of the frog, is so close that were it not for the differences in the form and position of the nucleus it would be impossible to separate them; that of the new species is somewhat compressed and circular, with a laterally placed paranucleus in the middle or, as more often happens, in the hinder half of the body.

The bodies of different specimens vary considerably in size, from 0·03 mm. to 0·12 mm. in length. Though various stages of division were observed, cysts were never seen.

Influence of Light on Noctiluca.†—M. F. Henneguy gives an account of experiments on the influence of light on the phosphorescence of *Noctiluca.* He finds that it is not luminous during the day, and that it only becomes so after being half an hour in a darkened room. After an hour's darkness the phosphorescence acquires the intensity observable during night. In the evening phosphorescence is not complete till two hours after sunset.

Psorospermium Lucernariæ.‡—Mr. R. Vallentin describes a sporozoon which he first observed in the tissues of *Lucernaria auricula;* in the rare *L. cyathiformis* as many as thirty distinct psorosperm masses were observed in a single individual, and they appear to affect the well-being of the host, for when a stimulus—in the shape of a needle-point—was applied to the margin of the umbrella the "latent period" was decidedly longer than in a specimen of *L. auricula.* No definite membrane separates the spores from the "structureless layer" of its host; in their youngest stage they consist of a spherical mass of protoplasm which forms the wall; larger cells, irregularly scattered, are found interiorly; they are inclosed by a hyaline envelope of varying size and possess one or two nuclei. The centre is occupied by several, and at times by numerous chitin-like capsules—the débris of those which

* Zool. Anzeig., xi. (1888) pp. 618–20.
† Comptes Rendus Soc. Biol., v. (1888) pp. 707–8.
‡ Zool. Anzeig., xi. (1888) pp. 622–3.

have lost their protoplasmic contents. A fully matured psorosperm has a fine hyaline envelope, with one or two nuclei, inclosing a thick chitinous capsule, within which is a spherical mass of protoplasm. The best preparations obtained were those which were treated with osmic acid or stained with picrocarmine.

Coccidium infesting Perichæta.*—Mr. F. E. Beddard gives the first account of a Coccidium living in an earthworm. The forms in which they have been found are *Perichæta novæ-zealandiæ* and *P. armata;* the perivisceral cavity was the part infested; some individuals were, in form, hardly distinguishable from *C. oviforme*, but the "micropyle" is very different. This so-called micropyle does not seem to be a perforation of the cyst at all, but merely a bulging-in of the cuticle, due possibly to a separation of part of the internal cuticular lamella caused by reagents. Sometimes two of these structures are present. The outer cyst-membrane does not, as in *C. oviforme*, disappear, but increases greatly in importance, until it finally comes to project beyond the two poles of the cyst for a very considerable distance; it still, however, remains very transparent.

The contained protoplasm breaks up into a large number of sporoblasts, just as happens in the Gregarinidæ, and this fact, added to others, shows that there is a closer affinity than is generally supposed between the Coccidiidæ and the Monocystidæ. *C. perichætæ* also resembles certain of the latter, e. g. *Gamocystis*, in the great development of the outer cyst-membrane.

Sarcosporidia in Muscles of Palæmon.†—M. L. F. Henneguy describes from the muscles of *Palæmon rectirostris* a parasite which seems unquestionably allied to the Sarcosporidia hitherto only known in mammals. The muscles were white and opaque instead of being transparent; the fibres were full of clusters of granule-like bodies. Each granule usually contained eight small corpuscles, presumably spores. The parasite was only distinguishable from the Sarcosporidia of mammals in the envelope which surrounded the several clusters of granules. All the specimens of *Palæmon* examined had the parasite in the same stage; infection was tried but failed. The life-history remains, therefore, in *Palæmon*, as elsewhere, obscure. The disease appeared to limit the muscular power. The diseased forms were usually in sheltered and warm water. Other species were observed to be similarly affected —*P. squilla*, *P. serratus*, and *Palæmonetes varians*. M. Henneguy distinguishes the Sarcosporidia from *Psorospermium haeckelii*, from parasites of some Daphnids, and from some strikingly similar granules found in *Gobius*. The present form seems to come in between *Microsporidia* and *Myxosporidia*, but the author refrains from a verdict till the life-history of this and similar forms has been made out.

Cercomonas intestinalis.‡—Prof. E. Perroncito finds that guinea-pigs are infested by numerous varieties of *Cercomonas* of which there are three principal species, (1) *C. ovalis*, (2) *C. pisiformis*, (3) *C. globosus*. The last two kinds are so numerous in a certain disease of these rodents as to become the cause of a great mortality among these animals.

* Ann. and Mag. Nat. Hist., ii. (1888) pp. 433–9.
† Mém. Centenaire Soc. Philom., 1888, pp. 163–71 (1 fig.).
‡ Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 220–1.

The Indian variety being very liable to this disorder is specially suitable for studying the evolution forms of *Cercomonas*. Numerous observations showed that the flagellated *Cercomonas* changes to a body which repeats the form of the parasitic protozoon. The protoplasm is transparent, but shows a peripheral darkening indicating the presence of a protecting membrane. In this stage, which may be called the encysted or resting stage, no flagella are observable, and it would appear that these are lost during encapsulation. Although all involution forms do not present well marked investing membranes, their protoplasm is always transparent, and the transformation of the protozoon is easily observable.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.*

(1) Cell-structure and Protoplasm.

Movement of Rotation of Vegetable Protoplasm.†—M. J. B. Schnetzler has recently studied the rotation of the protoplasm in an elongated protonemal cell of *Chara fragilis*. The grains of chlorophyll develope first in the upper part of the cell, while the lower part is filled with colourless protoplasm. On the interior of the cell-wall a thin motionless layer of protoplasm is differentiated; the chlorophyll-grains being fixed on the inner face of this layer. In the interior of this inert protoplasm will be found a comparatively thick layer of protoplasm which executes the movement of rotation.

Protoplasmic Movements.‡—Dr. J. Clark has investigated the influence of the lowered oxygen pressure on protoplasmic movements. A great number of vegetable organisms with streaming protoplasmic movements were experimented with. The removal of oxygen brings the movement to a standstill; the return of the natural conditions immediately brings back the circulating phenomena. A pressure of 1·2 mm. of oxygen restored the movement in *Triania bogotensis*; a pressure of 2·8 mm. was required for the hairs of *Urtica americana*; the other cases lie between these two extremes. The experiments with ciliary action have been already referred to.§

Optical Properties of the Cuticle and of Suberized Membranes.‖—Herr H. Ambronn shows that while suberized membranes, as observed by Dippel, exhibited a change in their optical axes on treatment with potash, they can be made optically neutral by simply warming in water or in dilute glycerin. From this fact he infers the presence in the cell-walls of a substance which melts at the temperature of boiling water and again crystallizes on cooling. This must obviously be either a waxy or a fatty substance.

(2) Other Cell-contents (including Secretions).

Structure of Chlorophyll-grains.¶—Herr A. Meyer replies to Schwarz's criticisms ** on his views as to the structure and development of chlorophyll-grains. After repeating his observations with the greatest care, he asserts that Schwarz's account of the structure of chloroplasts, that they consist of green "fibrillæ" lying side by side, united together by an intermediate substance "metaxin," is founded on error. By continuous and careful observation of the action of water on a single chloroplast, he was never able to detect anything approaching to fibrillar structure.

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents (including Secretions); (3) Structure of Tissues; and (4) Structure of Organs.

† Bull. Soc. Vaud. Sci. Nat., xxiv. (1888) pp. 83–8.

‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 273–80.

§ See this Journal, 1888, p. 971.

‖ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 226–30. Cf. this Journal, 1888, p. 602.

¶ Bot. Ztg., xlvi. (1888) pp. 636–40.

** See this Journal, 1887, p. 979.

Photolysis in Lemna trisulca.*—Mr. S. Le M. Moore refers to the figures published by Stahl to illustrate the variations in position undergone by the chlorophyll of *Lemna trisulca* in consequence of the alternation of day and night (photolysis), but is unable to acquiesce in them as representing the facts according to his impression of them. Stahl's figure shows the chlorophyll of the thin part of the frond ranged upon the side walls during the night, while in the cells of the thick part the inner wall is also studded with chlorophyll, the superficial wall being bare. According to Schimper, however, while all the grains upon the wall abutting upon the epiderm are apostrophized during the night, a few of those ranged during the day upon the inner wall still remain in epistrophe. After giving the details of a number of experiments, the author's conclusions are that, in marginal cells, the effect of night is to transfer to the side walls only 22 out of the 34 grains in a cell, leaving 12 of them still in epistrophe; and that in cells from the thick part rather more than 50 per cent. move during the night on to the side-walls, the remainder being fairly equally distributed upon both upper and lower walls.

Chemistry of Chlorophyll.†—Mr. E. Schunck has continued his contributions to the chemistry of chlorophyll. As one of the products obtained by the action of alkalies on phyllocyanin, the author obtained a substance which he proposes to call *phyllotaonin*. On spontaneous evaporation of an ethereal solution of phyllotaonin it is obtained in regular flattened crystals or crystalline scales, which by reflected light appear of a fine peacock or steel-blue colour; the crystals are mostly opaque, but when very thin they are transparent, and then appear brown by transmitted light. The author concludes by describing the various properties of phyllotaonin, and also the compounds it is capable of forming.

Chromoleucites.‡—M. L. Courchet gives details of a great number of observations on the structure and origin of chromoleucites, chiefly in a variety of coloured fruits.

Among the more important of the general results arrived at, he states that chromoleucites are always formed at the expense of chloroleucites or leucoleucites. The leucites may also give birth to crystals of colouring matters or to crystalloid substances which originate at the periphery of the stroma or generating layer. The primitive leucites are mostly formed out of starch, but this is usually resorbed before the leucite is mature. The development of the pigment in the leucite may take place in various ways. Blue, violet, red, and rose tints are usually due to coloured fluids, though the blue pigment is sometimes in the form of crystals or granules. Orange and brick-red tints may be caused either by coloured fluids, or by chromoleucites with either amorphous or crystalline pigment, or by true crystalline or crystalloid formations. The same is true also of yellow tints.

Chromoleucites are always formed in a proteinaceous substratum or stroma with which are united one or more pigments. Both may be either in an amorphous or in a crystalline condition. The crystals and crystalline formations always consist of pure pigment. Although

* Journ. of Bot., xxvi. (1888) pp. 353–7.
† Proc. Roy. Soc., xliv. (1888) pp. 448–54. Cf. this Journal, 1887, p. 606.
‡ Ann. Sci. Nat. (Bot.), vii. (1888) pp. 263–374 (6 pls.).

hitherto recognized only in the fruit of the tomato and the root of the carrot, they occur in a large number of fruits, seeds, and even flowers. All the coloured substances arise in the peripheral zone of chloroleucites or of uncoloured leucites.

Yellow pigments are always amorphous, and incapable of artificial crystallization; they are but slightly soluble in chloroform, ether, or benzin, much more so in alcohol, insoluble in water. The residue left on evaporating an alcoholic solution, when treated with concentrated sulphuric acid, is coloured, like the solution itself, at first green, afterwards blue. It may be called *xanthin*. Orange-red and orange-yellow pigments are insoluble in water, soluble in alcohol, but more so in ether, chloroform, and benzin. They are either amorphous or crystalline, or intermediate between the two conditions. Treated with concentrated sulphuric acid, they are all coloured violet or violet-red, afterwards indigo-blue. The gooseberry-red pigment is peculiar to the flowers of the aloe. All these pigments are distinguished essentially from those of chromoleucites by the fact that they do not turn blue with concentrated sulphuric acid.

M. Courchet's observations confirm as a whole those of Schimper * as to the structure and development of chromoleucites, though differing in some minor points. The crystals, whether natural or artificial, furnished by orange pigments are all derived from the oblique rhomboidal prismatic form. Their orange-yellow, orange-red, or carmine-red colour, and the corresponding tints which they communicate to the organs, depend on the greater or less thickness of these formations or on the molecular state of the pigment. This is shown by the facts that solutions of these colouring substances in absolutely neutral solvents have a constant orange-yellow colour, and that the variable tints presented by crystalline formations, whether natural or artificial, depend on their thickness.

Colouring-matter of Leaves and Flowers.†—Under this title Mr. P. Sewell gives a summary of the state of knowledge in regard to vegetable pigments, and communicates some suggestions as to their physiological import. The first part of the paper discusses the physical and chemical properties of the pigments. The second part deals with colour-changes, which are grouped as follows:—(1) those induced artificially by reagents, or naturally by the presence of substances of a like nature; (2) those associated with particular environments; (3) those characteristic of definite conditions of growth. Of each of these interesting illustrations are given. The third part of the paper reviews the various hypotheses suggested to explain colours and colour-changes. The observations of Buchan, Darwin, Grant Allen, J. E. Taylor, and others, are discussed. What Spencer pointed out as to the co-existence of colour and of flowers is emphasized and elaborated. The author agrees with Vines that colouring matters are physiologically waste products, and maintains that in contrast to the green of chlorophyll, "colour" is to be regarded "essentially as a product of a destructive metabolism (katabolism) in the cells in which it occurs." The autumn tints, the colour of the young shoots of spring, the pigments of the reproductive organs or flowers are expressions of relative katabolic

* See this Journal, 1886, p. 640.

† Trans. Bot. Soc. Edin., xvii. (1887–8) pp. 276–308.

preponderance. Parts furthest from nutrition, the sunny sides where metabolism is quickened, parts growing at the expense of stores, plants growing under disadvantageous conditions, dying organs, &c., are adduced in support of the author's thesis. Mr. Sewell recognizes the "immense power of selection" in relation to the colours of plants, but also the ætiological limits of this explanation. His general conclusion, though somewhat guarded, is that colours other than the green of chlorophyll are associated with katabolic preponderance. A copious bibliography is appended.

Sphærites.*—By this term Herr H. Leitgeb designates the various spheroidal deposits in tissues, whether composed of needle-shaped particles, and hitherto known as spherocrystals, or of fine granules arranged in radial or tangential rows. The former kind are commonly deposited on treatment of sections of the tissue with alcohol; the examples specially treated of here are *Acetabularia mediterranea*, *Galtonia* (*Hyacinthus*) *radicans*, the cactus-like species of Euphorbiaceæ and Asclepiadeæ, and the well-known spherocrystals of inulin in the root-tubers of the dahlia. They consist uniformly of organic substance and calcium phosphate. These were further compared with sphærites produced artificially.

The sphærites of inulin consist of alternate porous and compact layers, the porous layers alone possessing a crystalline structure, while the compact layers are altogether amorphous. In other cases the crystalline portion forms an external layer, or it may occupy the central portion and be surrounded by an amorphous envelope. Pigments are sometimes abundantly taken up, both by the crystalline and by the amorphous portion. They are sometimes formed, already of their full size, by the solidifying of drops; when they do grow, it is always by apposition.

Aleurone-grains.†—Herr F. Werminski agrees in general with the conclusions of Wakker.‡ From the examination of preparations in citron-oil of the endosperm of *Ricinus*, and of the seeds of some Leguminosæ, he concludes that the aleurone-grains are formed in vacuoles containing abundance of protoplasm by the abstraction of water; and that, on germination, they are again transformed into vacuoles by taking up water.

Asparagin and Tyrosin in Tubers of the Dahlia.§—Herr H. Leitgeb finds that organs of plants may contain a very large amount of asparagin and tyrosin, even when alcohol does not precipitate them in a crystalline form in sections, if crystallization is prevented by some mucilaginous substance. Inulin has this effect in the tubers of the dahlia, whence the fact that the very large amount of these substances which they contain has been so long overlooked. Asparagin was found by Leitgeb to be a constant constituent of dahlia-tubers, although the quantity is less than in many seedlings. Tyrosin was found only in very small quantities in the individual cells, the test employed being Millon's reagent.

As the aërial stem of the dahlia developes, the author found a very rapid decrease, in the tubers, of both asparagin and tyrosin, but at the same time he was entirely unable to determine their presence in the green aërial organs of the plant.

* MT. Bot. Inst. Graz, i. (1888) pp. 255–360 (2 pls.).
† Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 199–204 (1 pl.).
‡ See this Journal, 1888, p. 443.
§ MT. Bot. Inst. Graz, i. (1888) pp. 213–36 (1 pl.).

(3) **Structure of Tissues.**

Litoral Plants.*—Herr C. Brick finds the general characteristics of litoral halophilous plants to be a succulent tissue in the form of a strongly developed cortical parenchyma; the invariable presence of a vascular bundle-sheath, which serves as a starch-sheath; and the rarity of starch in the chlorophyll-grains. The strong turgidity of the cells may be due to the formation of salts of an organic acid with the soda with which they are so abundantly supplied.

Herr Brick proposes the following types of halophilous plants:—(1) The cortical parenchyma is composed of round cells, between which are small triangular or polygonal intercellular spaces; the chlorophyll is either distributed through the parenchyma, or is limited to a special outer zone of the cortex (*Honckenya peploides*, *Cakile maritima*). (2) The cortical parenchyma consists of round cells, between which are large nearly regular air-passages (*Aster Tripolium*, *Glaux maritima*). (3) The cortical parenchyma has a structure similar to that of a leaf; the chlorophyll is usually confined to the palisade-cells (*Salsola Kali*, *Salicornia herbacea*).

Comparative Anatomy of Desert Plants.†—M. P. Maury has examined the structure of a large number of species of flowering plants from the Algerian Sahara, and finds them characterized in common by the following features:—But slight thickening of the epidermal walls; the epidermis similar on the two faces of the leaf; the hypoderm consisting of a single layer of cells; the cortical parenchyma partly of a palisade nature, or simply assimilating; the pericycle with sclerotized elements; the vessels of the root with a larger diameter than those of the stem; a palisade-parenchyma on both faces of the leaf; the median parenchyma uncoloured, with gummy cells; ramifications of the vessels in the horizontal plane of the leaf not provided with sclerotized strengthening elements. In no case do these features conceal the special characters of the genus or family, but serve to adapt the species to its peculiar conditions of life.

Palisade-parenchyme.‡—From observations made on both water and land plants, Herr O. Eberdt concludes that the chief factor in determining the formation of palisade-parenchyme in leaves is not light, but strong transpiration and the rapid transport of formative substances. Diminished transpiration, even when there is strong assimilation, causes directly a disruption of the palisade-parenchyme; its cells become much less closely fitted together, intercellular spaces appearing between them.

Stem of Ephedra.§—Mr. W. H. Evans points out that, according to Bentham and Hooker, *Ephedra* occupies an intermediate position between *Welwitschia* and *Gnetum* in the order Gnetaceæ. Holding thus a low rank among Gymnosperms, we would expect interesting anatomical structure. In all there are about thirty species, most of which are

* Schrift. Naturf. Gesell. Danzig, vii. (1888) pp. 108–15. See Naturforscher, xxi. (1888) p. 214.

† Assoc. Franç. pour l'avance. d. sci., Congrès de Toulouse, 1887. See Morot's Journ. de Bot., ii. (1888) Rev. Bibl., p. 101.

‡ 'Beitr. zu d. Unters. üb. d. Entstehungsweise des Pallisaden-parenchyms,' Freiburg-i.-B., 1887, 52 pp. See Bot. Centralbl., xxxv. (1888) p. 362.

§ Bot. Gazette, xiii. (1888) pp. 265–8.

tropical. The author has made a special study of *E. nevadensis*, comparing it with several of the other species.

The stem bears no leaves, but at the nodes of the young shoots are two or three scale-like bracts one to six lines long. These scales are in all probability rudimentary leaves, yet they do no leaf work, having no fibrovascular connection with the stem. The epiderm of the stem is rather tough, and is composed of irregularly shaped cells. The cortex is for the most part made up of palisade-parenchyme, containing chlorophyll. Scattered singly or in groups of from two to ten within the cortex, and also in the pith, are found very long sclerenchymatous fibres. They are thick-walled and shining. Next within the cortex is found the bundle-sheath of very thin-walled cells, and within this the phloëm. The xylem-area resembles that of *Pinus*, having rectangular-shaped cells with heavy lignified walls. The medullary rays are not very prominent, and the pith consists of large irregular cells.

Anatomy of the Wood of Laurineæ.* —Herr E. Knoblauch has examined the wood of a large number of species of Laurineæ, in order to determine whether characters can be obtained from it for the determination of the genus or the order. As far as generic characters are concerned, the results were negative, and for the order no single character can be relied on, but only the concurrence of a number of characters, each of which may belong also to other natural orders. These are as follows:—Vessels in the annual rings of about uniform width (only in *Sassafras* are they very broad in the spring, very narrow in the autumn wood); in some species they are broader in the autumn-wood, quite visible to the naked eye, usually solitary, and in regular radial rows, less often in irregular groups. The transverse walls usually perforated by roundish or elliptical orifices, sometimes also scalariform, rarely the latter only. In the walls which separate them from one another the vessels have close roundish clearly bordered pits, and in those which separate them from the wood-parenchyme and the medullary rays numerous large pits of variable form, usually round or elliptical and slightly or evidently bordered, often passing into one another. The wood-parenchyme-cells are always present, but vary in number and arrangement and in the thickness of their walls. The medullary rays are of one kind only, the cells usually in from one to five rows; those in the centre and at the angles high and short. The rays are very close together, so that in the breadth of the medullary rays there are usually from 1 to 20 wood-parenchyme-cells and from 1 to 3 vessels. In many species a larger or smaller number of the wood-parenchyme-cells and those of the medullary rays are transformed into large thin-walled oil-cells without pits.

Radial Connection of the Vessels and Wood-parenchyme.†—Herr F. Gnentzsch states that radial connections are much more common than is usually supposed between the vessels and the wood-parenchyme of successive annual rings in dicotyledonous trees. The observations were made on a large number of trees and shrubs belonging to many different natural orders. The annual rings are not by any means always completely isolated; the xylem-vessels at the boundary line of two successive rings are, in fact, usually in connection with one another, either directly, or by tracheides, which must then be considered as equivalent

* Flora, lxxi. (1888) pp. 339–400 (1 pl.).

† Ibid., pp. 309–35 (1 pl.).

to vessels. Through this connection there is an active interchange of formative material between the annual rings, which plays the greatest part when, as in spring, the medullary rays cannot serve this purpose in consequence of the accumulation of reserve-material. With regard to the cells of the wood-parenchyme, it must be assumed that they serve, as a rule, only for conduction in the tangential, and only exceptionally in the radial direction.

Order of Appearance of the first Vessels in the Leaves of Humulus Lupulus and H. japonicus.*—M. A. Trécul states that the leaves of *Humulus Lupulus* and *H. japonicus* are palmatisect, with a stipule on either side. In *H. japonicus* the stipules arise before the lower leaves, and in some cases even before the upper ones; and in the case of the hop the leaves appear in the form of a little eminence only when the stipular lamellæ are already bilobed. The first vessel appears in the median vein of the stipules before that in the median vein of the corresponding leaf. The author then describes in detail the appearance of the vessels first in the stipules and then in the leaves.

Primary Liber-fibres in the Root of Malvaceæ.†—M. P. Van Tieghem finds fibres in the primary vascular bundles in the root of many genera of Malvaceæ, also in some of Sterculiaceæ and Tiliaceæ. They have at present been met with almost solely in Leguminosæ among Dicotyledons, and are unknown in Monocotyledons or Vascular Cryptogams.

Development of Cork-wings on certain Trees.‡—Miss E. L. Gregory applies the term cork-wing to ridges of corky substance extending lengthwise along the young stems of certain trees and shrubs. The species examined may be considered as represented by three types: viz. *Quercus macrocarpa*, *Liquidambar styraciflua*, and *Euonymus alata*. The last genus is extremely interesting from a systematic standpoint. No two species agree in the manner of cork development, while a variety differs from its typical form only by a slight and unimportant variation. The author describes in detail the anatomy of the superficial periderm of *Quercus microcarpa*.

Two kinds of *Acer* were further examined, one, *A. campestre*, conspicuously winged till the stem is three or four years old; the other, *A. monspessulanum*, much less so. The development differs in both cases from that of *Quercus*. Instead of five, as in *Quercus*, there are six longitudinal bands growing faster than the remaining six; this continues till a furrow is formed along the top of each wing, making a shell-shaped appearance on cross section. In *Liquidambar styraciflua* the cork-wings have one striking peculiarity which renders them an exception to all other cases examined—this is their eccentric or one-sided origin and growth. In this respect this species seems to stand quite alone. The wings of the lateral branches appear always on the upper side, and generally stand at such an angle as to form troughs along the entire length of the branches.

Mode of Union of the Stem and the Root in Angiosperms.§—M. P. A. Dangeard gives the following as his conclusions on this subject:

* Comptes Rendus, cvii. (1888) pp. 577–83.
† Ann. Sci. Nat. (Bot.), vii. (1888) p. 176.
‡ Bot. Gazette, xiii. (1888) pp. 249–58, 281–7.
§ Comptes Rendus, cvii. (1888) pp. 635–7.

—(1) The median vertical plane of the cotyledons always corresponds with a vascular bundle in the root. (2) The bundles of the root never pass the cotyledons. (3) The insertion of the cotyledonary bundles on the bundles of the root follows a general principle. (4) There is no absolute limit between the stem and the root. (5) The number of bundles in the root corresponds in a certain measure with those of the cotyledons.

(4) Structure of Organs.

Dimorphism of the Flowers of the Horse-chestnut.* — Sig. U. Martelli has observed two kinds of dimorphism in the flowers of *Æsculus Hippocastanum*. One kind relates to the arrangement of the patches of colour at the base of the petals, and appears to be related to the visits of insects. In addition to this, the greater number of the flowers in a spike are abortive, only a few being perfect. These fertile flowers are found only in the lower part of the inflorescence, and appear there to be arranged in regular order. Similar observations were made on some other species of the genus.

Cleistogamous Flowers of Tephrosia heterantha.†—Herr G. Hieronymus describes the structure and mode of fertilization of this plant from the Argentine Republic. The cleistogamous flowers contain only five stamens and two or three instead of the fifteen ovules in the open flowers. The pollen-grains are few in number, and their pollen-tubes pierce the wall of the anther in order to reach the stigma.

Hermaphroditism of Lychnis dioica when attacked by Ustilago.‡—M. A. Magnin points out that the flowers of *Lychnis dioica* L. (*L. vespertina* Sibthrp.) are ordinarily unisexual; Linnæus, however, determined the possibility of hermaphroditism, and M. Crié has called attention to the floral polymorphism of this plant. The author states that *Lychnis dioica* is often attacked by *Ustilago antherarum*, and that the effects produced are different according to the sex that is attacked. In the male it only causes a slight malformation of the anthers, and the replacement of the pollen by the spores of the *Ustilago*, while in the female it causes the appearance of stamens; the female organs undergo partial atrophy, while the plant retains otherwise altogether the characters of the female plant in habit, mode of branching, &c.

Zygomorphy and its Causes.§ — Mr. C. Robertson discusses the causes of zygomorphy in flowers, especially in relation to the mode of pollination by insects, whether the flower is nototribal, sternotribal, or pleurotribal, in Delpino's use of these terms, i. e. whether the pollen from the open anthers is deposited on the back, the abdomen and legs, or the side of the visiting insect. Mr. Robertson holds that the first change towards zygomorphy is for the stamens and styles to turn down at the bases and up at the tips, so as to strike the under side of the insect more effectually; the lower nectaries, being thus rendered less accessible, will tend to abort. Irregular polypetalous flowers are, as a rule, sternotribal; some, however, are nototribal, as most orchids,

* Nuov. Giorn. Bot. Ital., xx. (1888) pp. 401–4.

† JB. Schles. Gesell. Vaterl. Cultur, 1887, pp. 235–8. See Bot. Centralbl., xxxvi. (1888) p. 170.

‡ Comptes Rendus, cvii. (1888) pp. 663–5, 876–8.

§ Bot. Gazette, xiii. (1888) pp. 146–51, 203–8, 224–30 (2 figs.). Cf. this Journal, 1887, p. 779.

Viola, and *Impatiens*. Orchids must have developed as sternotribal, and become nototribal by the twisting of the ovary. The following is a summary of the general conclusions at which Mr. Robertson has arrived.

When shallow flowers become horizontal, insects light on the stamens and styles, and prefer the upper nectary. The stamens and styles bend to the lower side, and the lower nectaries abort. Zygomorphic flowers of shallow origin are sternotribal, and have a single nectary, or a central nectary more strongly developed or more accessible on the upper side. Nototribal flowers of shallow origin are inverted. When regular tubular flowers with included stamens and styles become horizontal, insects land on the lower border and prefer the lower nectary. The stamens and styles bend to the upper side, and the upper nectaries abort. Zygomorphic flowers of deep gamopetalous origin are nototribal, and have a single nectary, or a central nectary more strongly developed or only accessible on the lower side. Sternotribal flowers of deep gamopetalous origin have originally exserted stamens and styles, or have become shallow. Irregular flowers were modified with reference to a landing-place, and were modified through the influence of insects lighting upon them. Irregular flowers adapted to insects which do not light have changed visitors. Small closely-crowded flowers do not tend to become zygomorphic. Small closely-crowded irregular flowers are liable to lose their zygomorphic characters, unless the stamens and styles are protected by galeæ, carinæ, &c.

Opening of the Anthers of Cycadeæ.*—Of the different modes in which, according to Herr J. Schrodt, anthers and sporanges open in order to allow of the escape of the pollen and spores respectively, the anthers of Cycadeæ belong to the class in which there is no "fibrous layer" in the wall, the mechanism of the rupture being due to other causes. From the examination of a number of species of *Zamia*, *Ceratozamia*, *Stangeria*, *Cycas*, *Encephalartus*, &c., Herr Schrodt arrives at the conclusion that the epidermal cells of the anther-wall contain, in their membrane, a substance which varies according to the species, and which, when in contact with water, swells up more strongly than the cell-wall which incloses it, so that the latter is placed in a state of tension. Of the three layers of cells of which the anther-wall of Cycadeæ is composed, it is only the epiderm which takes any part in the opening and closing of the valves. The epiderm consists of cells elongated in a direction parallel to the longitudinal axis, which contain within their walls masses of cellulose capable of great expansion and contraction, and whose thick lignified inner membrane offers greater resistance to the contraction which results from desiccation than the thinner cuticularized outer membrane.

Protection of Buds in the Tropics.†—Herr M. Treub describes the contrivances by which, in many cases, leaf-buds and flower-buds are protected against excessive insolation in the Tropics. Among the most interesting is that of *Spathodea campanulata* (Bignoniaceæ), a tree of Tropical Africa, in which the inflorescence is umbrella-shaped, and the flowers completely exposed to the rays of the sun. The buds have the

* Flora, lxxi. (1888) pp. 440–50 (1 pl.). Cf. this Journal, 1886, p. 828.

† Handel. Nederl. Nat. en Geneesk. Congres, Sept. 30, 1887, p. 130. See Bot. Centralbl., xxxv. (1888) p. 328.

appearance of elastic pear-shaped bladders ending in a sickle-shaped point. This is the calyx, within which the corolla is formed at a much later period enveloped in a watery fluid. When mature the calyx splits open, and the petals are exposed, copiously moistened by the fluid.

Extrafloral Nectaries in Compositæ.*—Dr. R. v. Wettstein points out the existence of nectariferous scales in the following species of Compositæ:—*Jurinæa mollis*, *Serratula lycopifolia*, *S. centauroides*, and *Centaurea alpina*. The nectary is in all cases of very simple structure; the excretion of the saccharine fluid takes place through orifices which are usually distributed uniformly over the surface of the scales, but in *Serratula* are collected together below the apex. The nectar attracts ants, which appear to keep off noxious insects.

Structure and Development of Seeds with ruminated Endosperm.†—In continuation of previous observations on the seeds of the nutmeg, Herr A. Voigt now extends his investigations to other seeds with ruminated endosperm, belonging chiefly to Javanese Palmæ and Anonaceæ. In the palms he distinguishes two types.

The first type is illustrated by species of *Calamus* and by *Actinorhytis Calapparia*. The appendages to the integuments which project inwards, and which have no connection with the vascular bundles of the testa, form nearly cylindrical cones at nearly equal distances from one another, varying in number and length in different species. After fertilization the embryo-sac elongates considerably at the expense of the nucellar tissue, and, when the ovary has attained about one-third of its ultimate size, the appendages to the testa make their first appearance. While the nucellar tissues gradually disappear, these project further into the embryo-sac, especially on the side opposite to the raphe. They consist of comparatively large thin-walled cells containing tannin, and are covered by a small-celled epiderm. In the ripe seed the nucellus has entirely disappeared; the space inclosed by the integument is completely filled up by the embryo and the endosperm.

In the second type among palms the appendages to the testa have quite a different form, and their arrangement is closely connected with the vascular bundles of the testa. They consist of plates, cushions, and ridges, the lines of insertion of which correspond to the vascular bundles; they vary greatly in breadth. To this type belong *Actinophlœus ambiguus*, *Ptychococcus paradoxus*, *Chamærops humilis*, *Ptychosperma elegans*, *Caryota furfuracea*, *Nenga Wendlandiana*, *Archontophœnix Alexandræ*, *Arecha Catechu*, and *Pinanga Kuhlii*. In the last-named species the appendages also gradually consume the nucellus, and the endosperm is not formed until the ridges are fully developed. In both types the rumination probably begins a little before impregnation. In all the species of palm examined the seed has only a single integument.

In the seed of *Myristica fragrans* the structure of the endosperm is very different. The ovule has two integuments, but the inner one covers only the upper half of the nucellus. Almost the entire tissue of the inner integument and of the upper portion of the nucellus passes over, soon after the opening of the flower, into permanent tissue. The inner portion

* SB. K. Akad. Wiss. Wien, July 12, 1888. See Bot. Centralbl., xxxv. (1888) p. 398.

† Ann. Jard. Bot. Buitenzorg, vii. (1888) pp. 151–90 (3 pls.). See Bot. Centralbl., xxxvi. (1888) p. 134.

of this tissue serves for the nutrition of the embryo-sac, and is ultimately resorbed; the outer portion takes part in the formation of the testa. In the permanent tissue there is developed a much-branched system of vascular bundles, and as these develope the rumination of the endosperm makes its appearance. The testa of the ripe seed has a very complicated structure.

In other Anonaceæ with ruminated endosperm the ovule has two integuments, and the appendages spring from the inner of these; they have a very regular arrangement. The primary nucellus is ultimately resorbed entirely. The first endosperm-cells are formed in the embryo-sac, not by free-cell-formation, but by ordinary cell-division.

Integument of the Seed of Geraniaceæ.*—Dr. G. B. de Toni describes the peculiarities of the Italian species of *Geranium* as respects the seminal integument. He finds that they can be classed under three heads, viz.:—(1) Seeds with areoles not exceeding 12 μ in diameter; (2) seeds with areoles from 20 to 35 μ in diameter, nearly or quite regular, having therefore a finely reticulated appearance; and (3) seeds with large areoles, at least 40 μ in one direction, hence reticulated, or with minute pits. The genus belongs to the class characterized by having hard seeds, with one or two protective strata of cells, and nearly or quite destitute of endosperm.

Hygroscopic Movements in the Cone-scales of Abietineæ.† — Mr. A. N. Prentiss calls attention to the fact that in most of the Abietineæ, soon after the ripening of the cones, the persistent scales fold backward or outward from the axis to permit the ripe seeds to escape. The scales are very sensitive to moisture, and in many species exhibit very rapid movements when wet. This is strikingly the case with *Tsuga canadensis*. This property is very efficient, first, in loosening the winged seeds from the scale which bears them, and, secondly, in securing their wide dispersion in different directions by the wind.

Relationship of the Twisting Action of the Vascular Bundles to Phyllotaxis.‡—Dr. P. Teitz confirms Schwendener's view § as to the mechanical origin of the special mode of phyllotaxis in any particular species. It is the result of the action, during the formation of the leaves, of the concurrence of definite forces of pressure and traction, resulting in a regular law as to the arrangement of the leaves.

Development of Floating-Leaves.‖—Herr G. Karsten has investigated the cause of the phenomenon that when aquatic or amphibious plants whose leaves ordinarily float on the surface of the water grow entirely in the air, their petioles elongate greatly. The observations were mostly made on *Hydrocharis morsus-ranæ*, *Ranunculus sceleratus*, and *Marsilea quadrifolia*. The conclusion arrived at was that it is the oxygen of the atmosphere which causes the arrest of growth of the petiole of floating-leaves as soon as the lamina reaches the surface. The same is the case also with the water-lilies; while, on the other hand, in *Trapa natans* and the batrachian *Ranunculi*, belonging to the section *R. aquatilis*, the elevation of the floating-leaves to the surface

* 'Ricerche sul istologia del tegumento seminale dei Geranii Italiani,' Venezia, 1888, 43 pp. (5 pls.).

† Bot. Gazette, xiii. (1888) pp. 236–7.

‡ Flora, lxxi. (1888) pp. 419–39 (1 pl.).

§ See this Journal, 1887, p. 475.

‖ Bot. Ztg., xlvi. (1888) pp. 565–78, 581–9.

depends not so much on the growth of their petiole as on the greater or less development of the upper internodes of the floating stem.

Glands on the Rhizome of Lathræa.*—Herr A. Schertfel has carefully examined the glands in the hollows of the scales on the rhizome of *Lathræa squamaria*, and has come to a conclusion adverse to the function, ascribed to them by some, of assisting in the capture of animals. The rod-like bodies found generally, but not invariably, attached to the summit of these glands, are not, as some have supposed, protoplasmic outgrowths from the gland; the author believes, on the other hand, that he has determined them to be bacteria, the exact nature of which requires, however, further investigation.

In the corresponding glands in *Bartsia alpina*, the author was quite unable to find any similar structures; still less, therefore, than in the case of *Lathræa* can insectivorous habits be assigned to this plant.

Adaptation of Anatomical Structure to Climatal Conditions.†—Herr E. Giltay classifies under the following heads the contrivances for preventing excessive transpiration, viz.:—(1) Reduction of the surface of the leaf (*Statice elongata*, *Aster Tripolium*, *Convolvulus Soldanella*, *Plantago maritima*, *Schoberia maritima*, *Halianthus peploides*, *Salicornia herbacea*); (2) Number, size, structure, and position of the stomates; they are depressed in *Eryngium maritimum*, *Euphorbia Paralias*, and in many maritime grasses; (3) Reduction of the intercellular passages (*Festuca rubra*, *Triticum acutum*); (4) Cuticularizing of the epiderm and its extension into the stomates and intercellular passages (*Eryngium maritimum*, *Halianthus peploides*, *Plantago maritima*); (5) Halophytic plants, with large quantities of salts in the cell-sap (*Salsola Kali*).

β. Physiology.‡

(1) Reproduction and Germination.

Fertilization of Euphrasia.§—Dr. M. Kronfeld refers to Kerner's observations on the mode of fertilization of the various species of *Euphrasia*, and points out that, although they are all distinctly proterogynous, yet, by secondary growth of various parts of the flower, the anthers are eventually brought into immediate contact with the stigma, which may lead to autogamy.

Case of Germination of Ranunculus aquatilis.‖—M. J. B. Schnetzler has determined the presence of leucine, which is formed in considerable quantity during the germination of the seeds of *Ranunculus aquatilis*. This amide had not before been noticed in the higher plants.

(2) Nutrition and Growth (including Movements of Fluids).

Resistance of plants to causes which alter the normal state of life.¶—According to M. J. B. Schnetzler, the substratum of life, the proto-

* MT. Bot. Inst. Graz, i. (1888) pp. 105–212 (1 pl.). Cf. this Journal, 1887, p. 111.

† Niederl. Kruidk. Archief, iv. (1887) pp. 413–40 (1 pl.). See Bot. Centralbl., xxxvi. (1888) p. 42.

‡ This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

§ Biol. Centralbl., viii. (1888) pp. 518–9.

‖ Bull. Soc. Vaud. Sci. Nat., xxiv. (1888) pp. 28–9. ¶ T. c., pp. 23–7.

plasm, in which the resultant of the chemical and physical forces produces a state which we call life, offers a remarkable resistance to all the actions which would interfere with the harmony of these forces. The degree of this resistance varies with the individual, but the end is always the maintenance of the integrity of the organism. This result is more easily obtained when the organism is of simple constitution; and the equilibrium which exists between the forces is more stable than when the organism is more highly constituted and the equilibrium is more easily disturbed.

Action of Oxygen under high pressure on growth.*— From the result of experiments on various flowering plants and on *Phycomyces nitens*, Herr S. Jentys finds that an increase of the partial pressure of oxygen up to one atmosphere does not, in most cases, exercise any perceptible influence on the rapidity of growth. Only in a few cases is there a distinct acceleration. Beyond one atmosphere an increase in the pressure of oxygen retards growth in proportion to the increase. The result is the same if the increased pressure is due to nitrogen. The author believes compressed oxygen to have a directly injurious effect upon the growth of the plant.

Influence of the Substratum on the Growth of Plants.†—Herr S. Dietz finds that the influence said to be exerted by the substratum on the direction of the growth of the hypocotyledonary portion of plants is due entirely to heliotropism, since it is not exercised in the dark. Heliotropism and haptotropism both exercise an influence on the sporangiophores of *Phycomyces nitens;* the contact of fine wires and tinfoil affects the direction of growth even at an early stage before the complete formation of the sporanges.

Conduction of Fluids through the Alburnum.‡—From observations made mainly on the birch, Herr R. Hartig confirms his previous conclusions that the younger or outer alburnum of a trunk is the part through which the conduction of water chiefly takes place, the inner alburnum and duramen taking but a subordinate part in it. He takes the opportunity also of expressing his general concurrence with the conclusions of Wieler.§

(3) Irritability.

Forces which determine the Movements in the Lower Organisms.‖—Dr. R. Aderhold has attempted to ascertain the causes which determine the movements of swarm-spores and of some of the lower algæ. In the first place with regard to rheotropism and aerotropism, he is of opinion that the former does not exist, while *Euglena* is certainly positively aerotropic. The geotropic sensitiveness of *Euglena* can be demonstrated when the aerotropic movement is prevented. Similar phenomena to those of *Euglena* are presented also by the mega- and microzoospores of *Chlamydomonas pulvisculus*, by *Hæmatococcus lacustris*, and by the swarm-

* Unters. Bot. Inst. Tübingen, ii. (1888) pp. 419–64. See Bot. Centralbl., xxxvi. (1888) p. 105.

† Unters. Bot. Inst. Tübingen, ii. (1888) pp. 478–88. See Bot. Centralbl., xxxvi. (1888) p. 106.

‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 222–5.

§ See this Journal, 1888, p. 768.

‖ Jenaisch. Zeitsch. f. Naturw., xxii. (1888) pp. 310–42. See Bot. Ztg., xlvi. (1888) p. 621.

spores of *Ulothrix tenuis*, the latter with a slight difference. Swarm-spores of *Polyphagus Euglenæ* and a *Bodo* (?) appeared to be quite indifferent to gravitation; and diatoms and Oscillariaceæ appear to be neither geotropic nor aerotropic.

The most complete series of experiments made were those with regard to the heliotropic movements of desmids. He found, in all the species examined, that when subjected to diffused light on all sides, the longer axis placed itself in such a direction that one end of the cell rested on the substratum, while the other placed itself in such a position that the angle of elevation was between 30° and 50°. The free end of the cell moves about with a motion which the author believes to depend on nutation; but in diffused daylight there is no definite direction of the axis nor of the movement. In *Pleurotænium nodulosum* and *carinatum* he found a nutating movement of the free end of the cell, the direction of the axis changing with the direction of the incident rays of light. *Cosmarium Meneghinii* and *Closterium striolatum* exhibit also a definite direction of the axis with very weak light; but this was not the case with the other species examined. The direction of the movement in *Pleurotænium* is towards the light. Desmids are, therefore, positively heliotropic.

When swarm-spores move forwards with the portion which bears the cilia in front, this, the author believes, is another illustration of the same law. When light is allowed to fall on them on one side, the swarm-spores place themselves with their longer axis in the direction of the incident light, and with the cilia turned either towards or away from the source of light, and then either positive or negative heliotropic movement takes place; the author finds in these phenomena an exact analogue of the heliotropic or geotropic curvatures of the higher organisms.

The angle which the alga makes with the substratum varies with the species; and this he terms the "special angle" (Eigenwinkel) of the species, and asserts that it is not affected by the nature of the substratum. He is able to reconcile with the above theory the statement of Stahl that, when moving away from the light, the axis of the alga is nearly or quite at rightangles to that of the rays of light, and he confirms Stahl's statement that when the illumination is strong, *Pleurotænium* exhibits striking negative heliotropism.

The author has at present been unable to determine whether desmids are also geotropic.

Photo-position of Leaves.*—Herr H. Vöchting calls attention to some old observations of Batchinsky that, in *Malva rotundifolia* and in some allied species, at night the leaf-stalk makes a more acute angle with the leaf than in the day; and that in the daytime the leaves follow the course of the sun in such a way that the surface of the lamina is always at right angles to the incident rays of light, whether the radiation be more or less intense. Soon after sunset they take up their nocturnal position. These changes in position Vöchting states to be determined entirely by light, causing the morphological upper side only to be illuminated; the geotropism of the lamina and its weight have no influence on these movements. While the lamina of the leaf shows neither epinasty nor hyponasty, the lower

* Bot. Ztg., xlvi. (1888) pp. 505-14, 517-27, 533-41, 549-60 (1 pl.).

portion of the petiole is, on the other hand, epinastic. The actual movements of the leaf-stalk by which the different positions of the lamina are brought about, consist either of curvature or of torsion, or of a combination of the two, the movement being always in the direction of least resistance.

Phenomena of Curvature.*—Herr J. Wortmann replies to the objections of Elfving to the explanation of the phenomena of geotropic curvature advanced by him,† and reaffirms his previous conclusions. The vertical elevation from a horizontal organ must be due, as de Vries's plasmolytic experiments have shown, to unequal growth of the upper and under side of the organ, and this must be the consequence of one of two forces, or of a combination of the two—viz. unequal turgidity of the two sides, and the unequal stretching of the membrane on the two sides. De Vries supports the former theory, viz. that the geotropic curvature is due to an accumulation of osmotic substances in the under side of the organ. From experiments both on multicellular and on unicellular organs like the sporangiophore of *Phycomyces*, Wortmann has come to the opposite conclusion, that there is no evidence of any change in turgidity, and therefore in osmotic force; and that the geotropic curvatures both of unicellular and of multicellular growing organs are caused by changes in the extensibility of the membranes, that of the under side becoming greater when the geotropism is negative. This is, however, not necessarily a mechanical stretching, but may be due to accumulations of cellulose on the under side, and this again can be the result only of movements in the protoplasm which cannot take place except in living cells.

(4) Chemical Changes (including Respiration and Fermentation).

Chemical process in Assimilation.‡—Dr. T. Bokorny has made a fresh series of experiments, the results of which he considers further confirm the probability of Baeyer's hypothesis that the first product of assimilation in plants is formic aldehyde. They were made in the light, chiefly on cells of *Spirogyra*. He finds that, when carbon dioxide is excluded, but mineral food-material supplied, green cells are able to form starch out of methyl-alcohol and out of glycol, as well as out of glycerin.

Decomposition of Albumen in the absence of free oxygen.§—From a series of experiments made chiefly on *Triticum vulgare* and *Vicia Faba*, Herr W. Palladin draws the following conclusions:—(1) If green plants containing non-nitrogenous substances are placed in an atmosphere destitute of oxygen for not longer than 20 hours, no loss of albumen takes place. (2) If, however, the plants have been previously deprived of their non-nitrogenous substance, they will, in these circumstances, lose a portion of their albumen in the first 20 hours. (3) The decomposition of albumen can maintain the life of a plant for a time in an atmosphere containing no oxygen; (4) this decomposition is independent of the atmospheric oxygen; (5) the decomposition of albumen which takes place in a non-oxygenous atmosphere during the fourth and fifth days is

* Bot. Ztg., xlvi. (1888) pp. 469–78, 485–92. † See this Journal, 1888, p. 259.
‡ 'Stud. u. Exper. üb. d. Chem. Vorgang d. Assimilation,' Erlangen, 1888, 36 pp.
§ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 205–12.

a phenomenon which continues after the death of the plant; (6) active decomposition of albumen takes place in the ordinary atmosphere in the dark, beginning even during the first 24 hours.

γ. General.

Parasites on Trees.*—Freiherr C. v. Tubeuf describes the diseases produced in a number of trees by parasites, both phanerogamic and cryptogamic. These include *Botrytis Douglasii* on *Pseudotsuga Douglasii; Arceuthobium Douglasii* and *americanum* on *Pseudotsuga Douglasii* and *Pinus Murrayana;* the Japanese Loranthaceæ; a new parasitic fungus *Trichosphæria parasitica* on several conifers; the witch-broom of *Alnus incana* caused by *Taphrina borealis; Pestalozzia conorum Piceæ* n. sp.; and the mycorhiza of *Pinus Cembra.*

Protection of Plants against Snails.†—Herr E. Stahl goes in great detail into the means of protection exhibited by many plants against the attacks of snails, whether land or fresh-water species. These may be classed under two categories—substances contained within the cells, and external morphological protection.

Among the former may be named tannin, an acid cell-sap, especially if due to calcium binoxalate, volatile oils, bitter substances, as in *Gentiana*, *Polygala*, &c., and the oil-receptacles of some Hepaticæ, &c.

Among external protections are stiff hairs, impregnation of the epiderm with lime or silica, and the formation of mucilage or jelly (this applies especially to water-plants). Raphides also protect plants, both by their poisonous properties, and by the injury inflicted by the sharp crystals on the internal organs of animals; some animals, however, such as the caterpillars of *Deilephila*, consume greedily plants which contain raphides.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Chlorophyll-bodies of Selaginella.‡—Herr G. Haberlandt describes the structure of the chlorophyll-bodies in several species of *Selaginella.*

In the cells which are specially connected with assimilation in many species of *Selaginella*, there is only a single chlorophyll-body, resembling the similar arrangement in *Anthoceros*, and this has frequently somewhat of a cup-form; but in its finer structure it agrees completely with the chloroplasts of the higher plants, showing distinct granulation. In the cells of the base of the leaf there is usually either one irregularly lobed chlorophyll-body, or several of different forms. In the parenchymatous cells of the cortex of the stem are a number of chloroplasts, usually more or less of a spindle-form. They are united together by delicate colourless strings of protoplasm forming a continuous branched or unbranched chain in each cell. The substance of these chains does not belong to the cytoplasm, but to the chlorophyll-bodies. Some of the chloroplasts in these chains are usually transformed into leucoplasts. The starch in them occurs in the form of either minute grains or rods.

As regards their history of development, Haberlandt finds even in

* 'Beitr. z. Kenntniss d. Baumkrankheiten,' Berlin, 1888, 58 pp. See Bot. Ztg., xlvi. (1888) p. 659.

† Jenaische Zeitschr. f. Naturw., xxii. (1888) 126 pp. See Bot. Centralbl., xxxvi. (1888) p. 164.

‡ Flora, lxxi. (1888) pp. 221–308 (1 pl.).

the meristem of the growing-point small pale chloroplasts; the chlorophyll-chains in the young cortical cells being formed from them by successive bipartitions; a minute portion of the colourless protoplasm remains over in the form of the connecting strings. From the mode of formation and position of the starch-grains, the author believes that the nucleus plays an important part in their production.

Prothallium of Lycopodium.*—Dr. M. Treub describes the prothallium of a new species of *Lycopodium*, *L. Salakense*, found by him in one spot only in Java, and allied to *L. cernuum*. Of the three types of *Lycopodium*-prothallium, it belongs to that of *L. cernuum*, being intermediate between that species and *L. inundatum*.

Some days after the spores were sown in the laboratory they developed a number of small tubers or primary tubercles, and growth then ceased for a time. After a lengthened period of rest, apparently independent of external circumstances, a further development of the prothallium took place into at first a single, and afterwards several filaments consisting of several rows of cells lying side by side. The prothallium of *L. Salakense* does not bear the small outgrowths found on that of *L. inundatum* which perform the function of leaves, but in their place small elevations. On the cylindrical portion near the apex are produced first the antherids and later the archegones; but the development of these organs presents no special features. Rhizoids are almost or entirely wanting; but the prothallium is green, and not saprophytic.

The prothallia of *L. carinatum*, *L. nummularifolium*, and *L. Hippuris* belong to the type of *L. Phlegmaria*, and the last contains also the same endophyte. The prothallium of *L. nummularifolium* consists of filaments which are not more than three cells in thickness.

Influence of Light on the Origin of Organs in the Fern-embryo.†—Herr E. Heinricher confirms Leitgeb's statement that the origin of organs in the embryo of the Polypodiaceæ is influenced only by its position in the prothallium, and is quite independent of gravity; and his observations lead also to the additional conclusion that it is quite independent of light. The experiments were made on the prothallium of *Ceratopteris thalictroides*, but the author has no doubt the results apply equally to the whole of the Polypodiaceæ. The first root originates in all cases from the octant in the embryo which faces the neck of the archegone. This first root exhibits extraordinarily vigorous negative heliotropism; when the light falls on the embryo from below, the root rises vertically erect from the nutrient fluid, unaffected by gravity. Temperature has also a very powerful influence on the development of the embryo. The position of the archegones on the underside of the prothallium, which is determined by light, insures that the root shall be formed on the shaded, the first shoot on the illuminated side.

Muscineæ.

Acutifolium-Section of Sphagnum.‡—Herr C. Warnstorf gives a critical review of this group of European bog-mosses, which he further

* Ann. Jard. Bot. Buitenzorg, vii. (1888) pp. 141–50. See Bot. Centralbl., xxxvi. (1888) p. 101. Cf. this Journal, 1888, p. 262.

† MT. Bot. Inst. Graz, i. (1888) pp. 237–53 (3 figs.).

‡ Verhandl. Bot. Ver. Prov. Brandenburg, 1888, pp. 79–127 (2 pls.). See Bot. Centralbl., xxxvi. (1888) p. 69.

classifies as follows:—A. Stem-leaves with completely resorbed cell-membranes in their upper portion (*S. fimbriatum* Wils., *Girgensohnii* Russ.); B. Stem-leaves never with completely resorbed cell-membranes, usually toothed at the apex (*S. Russowii* Warnst., *fuscum* Klinggr., *tenellum* Klinggr., *Warnstorfii* Russ., *quinquefarium* Warnst., *acutifolium* Ehrh. *ex p.*, *subnitens* R. & W., *molle* Sulliv.).

Rabenhorst's Cryptogamic Flora of Germany (Musci).—The two most recently issued parts of this work (Nos. 9 and 10) are almost entirely occupied by the family Pottiaceæ, which is divided into the two sub-families Pottieæ and Trichostomeæ, distinguished by the structure of the mid-rib. The former comprises the genera *Pterygoneurum*, *Aloina*, *Crossidium*, *Pottia*, *Desmatodon*, *Tortula*, *Dialytrichia*, and *Syntrichia*, the latter *Timmiella*, *Hydrogonium*, *Leptodontium*, *Trichostomum*, *Oxystegus*, *Leptobarbula*, *Pleurochæte*, *Tortella*, *Didymodon*, and *Barbula*. Each genus is illustrated by at least one beautifully executed woodcut.

Algæ.

Chromatophores of Phæosporeæ.*—Herr J. Reinke has examined the form and appearance of the chromatophores in a number of Phæosporeæ, for the purpose of determining whether any character can be derived from them that will be of use in classification. He finds that, while in some instances a special form of chromatophore is characteristic of all the members of a group, in other cases nearly related species will differ widely in this respect. Thus both the genera of Scytosiphoneæ, *Phyllitis*, and *Scytosiphon*, are characterized by the presence of a single large oval or sometimes nearly rectangular chromatophore in the parietal protoplasmic layer of each cell. In the Sphacelariaceæ and Laminariaceæ there are also general characters to be derived from the chromatophores. In the Ectocarpaceæ, on the other hand, the form and arrangement of the chromatophores are constant within the species only, varying greatly in nearly related species; and the same is the case in *Ralfsia* and *Myrionema*.

Mode of Distribution of Algæ.†—Herr W. Migula gives a list of Algæ and Schizophyceæ found attached to water-beetles, especially *Gyrinus natator*, in a tarn at a height of 1050 metres. He believes that these insects play an important part in their distribution.

Genetic Connection of Draparnaldia glomerata and Palmella uvæformis.‡—Herr O. F. Andersson has found a mass of *Draparnaldia glomerata* in the spring, partly in the ordinary vegetative condition, partly with resting-spores. These last consisted of round cells inclosed in a membrane, identical in size, form, colour, and nature of the cell-walls, with *Palmella uvæformis* Ktz. Every intermediate state between the two occurred on the same plant, and it was evident that the two were stages in the cycle of development of the same species.

Inferior Algæ.§—In continuation of his previous researches on the lower forms of vegetable life, M. P. A. Dangeard reviews the position

* Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 213–7 (1 pl.).
† Biol. Centralbl., viii. (1888) pp. 514–7.
‡ Naturvet. Studentsällsk. Upsala, Nov. 5, 1887. See Bot. Centralbl., xxxv. (1888) p. 351.
§ Ann. Sci. Nat. (Bot.), vii. (1888) pp. 105–75 (2 pls.). Cf. this Journal, 1888, p. 754.

and structure of the *Chlamydomonadineæ*, which he regards as a subdivision of the Volvocineæ, and to be separated from the Chrysomonadineæ, which belong properly to the animal kingdom. The points of departure of the Volvocineæ from the Chrysomonadineæ is *Polytoma uvella* Ehr., which does not possess the power of absorbing solid aliment into its interior, but which has no chlorophyll.

Very nearly related to *Polytoma* is *Chlorogonium euchlorum* Ehr., under which name two species have hitherto been confounded, and the conjugating form of which has been described by Ehrenberg as *Dyas viridis*. A new genus and species *Cercidium elongatum* is described, differing from *Chlorogonium* in having only two amyliferous corpuscles stained a light blue by iodine, instead of five or six; it is reproduced sexually by gametes formed six in a cell; the germination has not been observed. In the same circle of affinity come also *Phacotus angulosus* Stein (*Cryptoglena angulosa* Cart.) and *Phacotus viridis* Pert.

The author's previous researches on *Chlamydomonas* and *Chlamydococcus** are then given more in detail; and a new genus and species described, *Pithiscus Klebsii*, nearly related to them, found among *Gonium* and *Pandorina*. The body is barrel-shaped, enveloped in a thick membrane; at the base of a small conical anterior papilla are four cilia; the protoplasm is coloured an intense green; there is a nucleolated nucleus, a posterior amyliferous corpuscle, and a pigment-spot; reproduction takes place by two, four, or eight zoospores. To the same family belong also *Tetraselmis cordiformis* Stein, *Coccomonas* Stein, and *Chlorangium* Stein.

In the general review of the characters of the Chlamydomonadineæ it is stated that they are distinguished by the presence of special bodies, charged with the production of starch, the amyliferous corpuscles; these are usually one or two in number, occasionally five or six. There are always two or three contractile vacuoles. Reproduction takes place by zoospores or by conjugation of zoogametes; in the latter case the envelope of the gametes may contribute or not to the formation of the zygote (zygosperm). In some genera the sexual mode of reproduction is replaced by encystment.

The author then proposes the establishment of a new family, the Polyblepharideæ, founded on a single new genus and species, *Polyblepharides singularis*. Its internal structure agrees with that of the Chlamydomonadineæ, but it differs in its mode of multiplication, viz. by longitudinal division of the body into two individuals; cysts are also formed.

Under Volvocineæ proper the author includes the genera *Gonium*, *Pandorina*, *Eudorina*, *Stephanosphæra*, and *Volvox*; the Hydrodictyeæ (*Hydrodictyon*, *Pediastrum*, *Sorastrum*, and *Cœlastrum*) forming quite a distinct group.

The provisional group Tetrasporeæ comprises the genera *Glœocystis*, *Apiocystis*, *Schizochlamys*, and *Tetraspora*, characterized by the property of surrounding themselves by a mass of gelatin. They are reproduced by biciliated zoospores; conjugation of gametes takes place in *Tetraspora*, and the formation of cysts in *Glœocystis*; they are chiefly distinguished from the Chlamydomonadineæ by the immobility of the cell during the vegetative period.

The Pleurococcaceæ, comprising the genera *Pleurococcus*, *Dactylococcus*, *Raphidium*, *Scenedesmus*, and *Nephrocytium*,† are distinguished

* See this Journal, 1888, p. 1004. † Ibid., p. 1013.

from the Tetrasporeæ by the absence of the power to form zoospores; the production of new cells takes place by repeated bipartitions of the protoplasm; each cell is capable of becoming encysted. *Cosmocladium*, sometimes incorrectly included here, belongs to the Desmidieæ. Klebs's family of Endosphæraceæ is made up of the genera *Chlorochytrium*, *Endosphæra*, *Phyllobium*, and *Scotinosphæra;* the cells produce zoospores, which may be sexual or not. The zygote (zygosperm) resulting from the conjugation of the zoogametes gives birth, in *Phyllobium*, to a thallus, which may hibernate in the encysted condition. In the Characieæ, consisting of the genus *Characium* alone, there are mega- and micro-zoospores, both apparently non-sexual.

The author concludes by stating that the Chlamydomonadineæ, detaching themselves from the Flagellata, constitute the base of the great group of Algæ, and that there is a clear distinction between the lower members of the animal and vegetable kingdoms in the mode of nutrition, animal digestion taking place in the interior of the protoplasm, vegetable digestion in contact with the cell-wall; while assimilation is subject to the same laws in both kingdoms.

New Algæ from Porto Rico.*—Dr. M. Möbius describes a new species and genus of epiphytic algæ, *Phyllactidium tropicum*, from Porto Rico. It occurs as small discs resembling *Coleochæte* on the leaves of various orchids, but without appearing to have any organic connection with them. The nearly circular thallus consists of repeatedly bifurcating rows of cells, each containing a nucleus; growth takes place in the same way as in *Mycoidea*, by the division of the peripheral cells. The thallus also puts out ascending filaments from certain cells, which are not hyaline bristles, as in *Coleochæte*, but are divided transversely into a number of cells. It is propagated by swarmspores, between which no conjugation was observed, but which develope directly into a new thallus. They are formed in zoosporanges which are transformations of the ends of ordinary filaments of the thallus; the number formed in a sporange varies between 8 and 32. A *Chroolepus*-form of the alga is also described; and, as in the case of *Mycoidea*, the author believes that it unites in a symbiotic manner with a fungus to form an epiphytic lichen. Dr. Möbius placed *Phyllactidium* near *Mycoidea*, and considers it to belong probably to the Chroolepideæ.

Several other algæ from Porto Rico are also described, and among them the little-known *Compsopogon chalybeus* Ktz., a fresh-water Floridea found growing on leaves of a *Potamogeton.*

Algæ of New Zealand and Australia.†—Prof. O. Nordstedt describes the fresh-water algæ collected by Dr. S. Berggren in New Zealand and Australia in 1874 and 1875. Among them are a number of new species belonging to the genera *Aphanochæte*, *Rhizoclonium*, *Hyalotheca*, *Euastrum*, *Staurastrum*, *Cosmarium*, &c.

Fungi (including Lichenes).

Sporids of Lichens.‡—Rev. W. Johnson claims for lichens a character quite distinct from fungi, as seen in the nature of their tissues, as well as in the circumstances of their growth. Lichens never putrefy

* Hedwigia, xxvii. (1888) pp. 221–49 (3 pls.).
† K. Svensk. Vetens. Akad. Handl., xxii. (1888) 98 pp. (7 pls.).
‡ North of England Micr. Soc., Newcastle-on-Tyne, Dec. 11, 1888.

like fungi, and they endure for ages unaffected by frost or snow, whereas fungi are short-lived and disappear on the first approach of frost. Lichens have many chemical elements in their composition unknown to fungi, such as colouring matters, various acids, and lichenin. The hyphæ and paraphyses of the latter are thin-walled, non-elastic, non-amylaceous, and dissolve in hydrate of potash; while those of lichens are thicker-walled, more flexible, and do not dissolve in hydrate of potash. A difference is also manifested in the spores of lichens; they are smoother, capable of greater endurance, their walls are thicker, more mucose and pellucid than those of fungi.

The development of sporids in the asci is traced and illustrated, but Stahl's theory of the origin of the apothece in a fertilized ascogone was doubted. The apothece may begin in an act of fertilization by the "spermatia" (pollinoids), while much mystery still hangs about the process of lichen-fertilization, yet present knowledge, as far as it goes, favours the idea that such fertilization takes place in the substance out of which the spores are formed rather than by direct contact between the "spermatia" and the spores themselves, and the impregnated mass could only take place at the origin of the apothece, or at some initiatory stage, as the spores and asci are developed within it; but that the apothece springs from a fertilized ascogone is not proved. It seems rather to begin in the fruitful centre, by the hypha becoming denser, and then differentiating into the cellular hypothece or bed, from which arise the whole contents of the hypothece.

Lichen spores originate in the hyaline protoplasmic contents of the ascus or theca, which become more grumous as the parent-cell advances. Through the pellucid walls of the theca denser spots begin to show, casting a slight shadow, as may be seen in the young asci of *Pertusaria fallax*, *Physcia ciliaris*, &c. These denser spots are the spores taking shape, and they gradually show a thin coating and distinct form. The spore is a double-walled cell of varying size and shape, simple or septate.

How the colour of lichen-spores is taken up, or whence it is secreted, is a mystery; but there is the fact, in many lichens, of a hyaline or colourless closed theca or spore-sac, full of blackish-brown or reddish-brown spores. The coloured pigment of the spores is lodged, not in the contents, but in the epispore or outer wall. When spores of *Physcia pulverulenta* are broken up, every separate particle retains the same dark colour as when the spore is entire.

Saccharomyces apiculatus.*—Herr C. Amthor concludes, from the different composition of the same wine fermented by different cells of this ferment, that there must be distinct varieties of the yeast. The total amount of acid formed during fermentation is about three times greater than that found by Pasteur with ordinary yeast. In beer-wort, *S. apiculatus* caused, in 30 days, the formation of only 0·93 per cent. of alcohol. The author believes that this species does not ferment maltose, and that this property furnishes us with a means, not only of detecting small quantities of dextrose in the presence of maltose, but of estimating the quantity present by the amount of alcohol formed.

* Zeitschr. Phys. Chem.. xii. (1888) pp. 558–64. See Journ. Chem. Soc., 1888 (Abstr.), p. 1218.

Kefir.*—Sig. G. Arcangeli has investigated the source of this intoxicating drink prepared in the Caucasus by the fermentation of cows' milk. The ferment is sold in the form of tubercle-like bodies from 1 mm. to 1 cm. in diam., of a yellow colour and horny consistency. These preserve their activity for a long period, and induce fermentation in milk in twenty-four hours at the ordinary temperature. Arcangeli agrees with Kern † that the ferment is a cultural form of *Saccharomyces cerevisiæ*, closely resembling *S. minor*. He was unable to detect with certainty the presence of *Bacillus acidi-lactici*. The organism described by Flügge and others as *Dispora caucasica*, he believes to be a form of *Bacillus subtilis*, which, coming in contact with the grains of kefir, has the power of peptonizing the albuminoids and determining the partial solution of the casein.

New Type of Hymenomycetes.‡—Under the name *Hymenoconidium petasatum*, Herr H. Zukal describes a new fungus found on rotting leaves and fruits of the olive under a glass bell. Resembling somewhat a minute *Marasmius*, it yet differs in some respects from all hitherto known hymenomycetous fungi. The hymenium clothes the upper convex side of the pileus in the form of a smooth layer. The densely packed club-shaped basids (?) bear each a single brownish spore with spinous thickenings. The spore is not formed by budding nor from a sterigma, but by the cutting off of the upper swollen portion of the basid (?) by a septum; the lower portion becoming the sporophore, the upper portion the spore. All attempts to cause the spores to germinate were unsuccessful. The author believes *Hymenoconidium* to present a type of very simply organized Hymenomycetes, in which the conidiophore has not become specialized into basids.

Ustilago Treubii.§—Graf zu Solms-Laubach describes this new species, which forms small wart-like excrescences on *Polygonium chinense* in Java, with a curved stalk and dark violet ustilago-spores. It causes the production of abnormal wood in the cambium. The spores are separated from one another by vertical rows of parenchymatous cells which are connected above and below with the closed tissue. When the spores are ripe they burst through the outermost layer of the tissue, and these columns project in the form of a capillitium-like structure which promotes the dissemination of the spores by protecting them from moisture, and thus preventing their germination before they are scattered. The spores are about 4 μ in diameter, and germinate in the ordinary way, producing a promycele which is usually short and unicellular, on which are borne terminal or lateral sporids which conjugate before the germination of the filament. The pathological structures produced by this parasite bear a strong resemblance to galls.

Saprolegnieæ.‖—A posthumous fragment on this subject by Prof. A. de Bary is published by Graf zu Solms-Laubach. Four new genera are briefly described, viz.:—(1) *Leptolegnia;* resembling *Saprolegnia*,

* Nuov. Giorn. Bot. Ital., xx. (1888) pp. 381–7.
† Cf. this Journal, 1882, p. 383.
‡ Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxviii. (1888). See Biol. Centralbl., viii. (1888) p. 513.
§ Ann. Jard. Bot. Buitenzorg, vi. (1888) pp. 79–92 (1 pl.). See Bot. Centralbl., xxxvi. (1888) p. 67.
‖ Bot. Ztg., xlvi. (1888) pp. 597–610, 613–21, 629–36, 645–53 (2 pls.).

but with only a single oosperm which entirely fills up the oogone. (2) *Pythiopsis;* gonids with two terminal cilia, escaping separately from the mouth of the sporange, and moving about with a swarming motion, then coming to rest and germinating without becoming invested with cellulose or a second period of swarming; zoosporanges terminal on the branches of the primary filaments, in rows, or with a cymose arrangement, never proliferous after emptying; oogones and oosperms as in *Saprolegnia.* (3) *Aplanes*, resembling *Achlya*, but the gonids not swarming. (4) *Leptomitus* (*Apodya* Corn.); thallus divided into compartments by strictures without any actual septum, each containing a single nucleus; zoosporanges terminal, often several, one behind another, not proliferous; zoospores with terminal cilia, germinating directly, without a second period of swarming; sexual organs unknown. The following new species are also described:—*Saprolegnia monilifera*, *Leptolegnia caudata*, *Pythiopsis cymosa*, *Achlya apiculata*, *A. oligacantha.*

Structure of White Rot.*—MM. G. Foex and L. Ravaz state that a transverse section of the portion of a plant attacked by "white rot" reveals the presence of the mycele of *Coniothyrium diplodiella.* The filaments which compose it have a uniform structure. The spores arise on the stigmata, to the summit of which they remain fixed until they have finished growing, when they detach themselves from their support. They are generally ovoid in form; and if they are placed in a drop of water they germinate in a few hours at a temperature of 18° to 20°. As for the remedies to apply for "white rot," it has been found that the salts of copper are the most efficacious.

Cancer of the Cinchona.†—Herr O. Warburg describes two kinds of cancer which attack the cinchona-plantations of Java: one on the root, the other on the stem. The former closely corresponds to the disease produced by *Agaricus melleus*, and appears to be due to a fungus propagated by an underground rhizomorph rather than by spores. The latter is caused by a different fungus, propagated by its spores, and is not unlike the cancer of the larch.

New Fungi of the Vine.‡—Dr. F. Cavara enumerates the following new species of fungus as attacking the vine:—*Physalospora baccæ*, *Glœosporium Physalospora*, *Pestalozzia viticola*, *Napicladium pusillum*, *Alternaria vitis*, and *Tubercularia acinorum.* The author gives the following diagnosis of the new genus *Briosia*:—Stroma verticale, cylindraceum, stipitatum, hyphis fasciculatis compositum, apice capitulum compactum efformans; conidia globosa, tipice catenulata, fusca, acrogena.

Diseases of the Vine.§—MM. P. Viala and L. Ravaz state that the disease known as *mélanose*, which is caused by the parasite *Septoria ampelina* B. & C., originally came from America. Mélanose appears only to attack the leaves of the vine, and has not as yet been observed either on the branches or on the fruit. Small circular brown spots, which are equally apparent on both surfaces of the leaf, are the first indications of this disease; these grow rapidly and change in colour to a deep brown or sometimes even black. The mycele of this fungus, which

* Rev. Mycol., x. (1888) pp. 201–3.
† SB. Gesell. Bot. Hamburg, iii. (1887) pp. 62–72. See Bot. Centralbl., xxxvi. (1888) p. 145.
‡ Rev. Mycol., x. (1888) pp. 207–8.
§ Ibid., pp. 193–9.

grows in the tissue of the leaf, is wavy, thin, and hyaline, and the pycnids are ovoid and nearly entirely buried in the palisade-tissue of the leaf. The cells of the envelope of the pycnid are small, irregular, and with a rather thick membrane; the innermost layer gives rise to the spores.

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—The two last-published parts (29 and 30) of this work are still devoted to the Discomycetes. The first sub-order is completed by the families Pseudophacidieæ (*Pseudophacidium*, *Coccophacidium*, *Pseudographis*, *Clithris*, *Cryptomyces*, and *Dothiora*). The second sub-order, or Stictideæ, is made up of the following families:—Eusticteæ (*Trochila*, *Ocellaria*, *Nævia*, *Xylographa*, *Briardia*, *Stegia*, *Propolis*, *Phragmonævia*, *Cryptodiscus*, *Propolidium*, *Xylogramma*, *Mellitiosporium*, *Næmacyclus*, *Stictis*, and *Schizoxylon*); Ostropeæ (*Laquearia*, *Ostropa*, and *Robergea*). The third sub-order or Tryblidieæ commences with the families Tryblidiaceæ (*Tryblidiopsis* and *Tryblidium*), and Heterosphærieæ (*Heterosphæria*, *Odontotrema*, and *Scleroderris*).

Protophyta.

a. Schizophyceæ.

Dicranochæte a new genus of Protococcaceæ.*—Under the name *Dicranochæte reniformis*, Herr G. Hieronymus describes a new genus and species of Protococcaceæ, growing as an epiphyte on Mosses and Hepaticæ, and on decaying grass-leaves. It is hemispherical or reniform, with the indentation facing the substratum; at the base of this indentation is a fine hyaline dichotomously branched bristle, composed, like the cell-wall, of gelatin. In the summer swarm-spores are formed by continued bipartition of the protoplasmic cell-contents and of its nucleus. They are naked, and have apparently four cilia and a red pigment-spot. They germinate directly without conjugation.

The author claims also to have established that *Chlamydomyxa labyrinthoides* belongs to the same cycle of development as *Protococcus macrococcus*, *P. aureus*, *Urococcus insignis*, and *Peridinium cinctum*.

Structure of Diatom-valves.†—Mr. J. Deby has made a minute examination of the structure of diatom-valves, by imbedding in a mixture of zinc chloride and zinc oxide, or of magnesium chloride with magnesia, and then making excessively fine sections of the dried mass. His conclusion is that the valve consists of several layers, but is not everywhere perforated in the fashion of a sieve, the result differing therefore from that of Van Ermengem, and from Prinz's observations, in which the membranes which close the pores had completely disappeared.

New Species of Navicula.—Mr. F. Kitton describes the following new species:—*Navicula venustissima*. Valve elliptical, apices more or less produced, marginal striæ close, slightly radiant, moniliform, space between the striæ and median line irregularly punctate, puncta sometimes confluent, length 0·008 in. to 0·01 in. In dredgings from Samarang, Java, and Aberdeen Bay, Hong Kong, made by Mr. A. Durrand. The dredgings in which the above species was found also

* JB. Schles. Gesell. Vaterl. Cultur, 1887, pp. 293–7. See Bot. Centralbl., xxxv. (1888) p. 321.
† Journ. Quekett Micr. Club, ii. (1888) pp. 308–16.

contained *N. Durrandii*, not so fine as those occurring in the gathering from the island of Rea; many of the valves are bullate on each side of the median line; the presence or absence of these markings is, however, of no specific value.

Diatoms of Hot Springs.*—Count F. Castracane enumerates the diatoms found among the "muffe" in the hot springs of Valdieri, at a height of 1336 metres, the temperature of the water varying between 28° and 69° C. in different springs. He finds the prevalent forms not to be those usually found at high elevations, from which he draws the conclusion that the distribution of diatoms is dependent rather on temperature than on altitude.

Composition of the Marine Tripolis of the Valley of Metaurus.†—According to Count F. Castracane, the community of types of diatoms in all the marine tripolis of Italy indicates that they are a portion of one and the same deposit. In the tripolis examined by him from the valley of the Metaurus between Fano and Fossombrone, the diatoms are nearly all of familiar species. But the following new genera are described:—*Thalassiotrix.*—Frustulis linearibus radiatis per pulvillum gelineum armilliforme unitis, bino erectiorum punctulorum ordine instructis; post frustulorum deduplicatione armilla disrumpitur, et frustula in seriem alternam per isthmum triangularem coalescunt. *Etmodiscus.*—Frustula solitaria discoidalia; valvis tenuissime et inconspicue striolatis; forma plus minus convexa, quandoque diversimode denticulata; zona connectiva punctulata.

Classification of the Cyanophyceæ.‡—Dr. A. Hansgirg gives a synopsis of all the known genera and subgenera of Cyanophyceæ, or, as he prefers to call them, Myxophyceæ. He arranges them under three orders, viz.:—(1) GLŒOSIPHEÆ (suborders Heterocysteæ and Isocysteæ); genera, *Stigonema*, *Hapalosiphon*, *Mastigocoleus*, *Capsosira*, *Nostochopsis*, *Scytonema*, *Tolypothrix*, *Plectonema*, *Desmonema*, *Hydrocoryne*, *Diplocaulon*, *Isactis*, *Rivularia*, *Glœotrichia*, *Brachytrichia*, *Calothrix*, *Sacconema*, *Leptochæte*, *Amphithrix*, *Microchæte*, *Nostoc*, *Anabæna*, *Nodularia*, *Microcoleus*, *Inactis*, *Symploca*, *Lyngbya*, *Isocystis*, *Aphanizomenon*, arranged under various subfamilies and tribes. (2) CHAMÆSIPHONACEÆ; genera, *Chamæsiphon*, *Clastidium*, *Godlewskia*, *Hyella*, *Cyanocystis*, *Dermocarpa*, *Cyanoderma*, *Pleurocapsa*. (3) CHROOCOCCOIDEÆ; genera, *Allogonium*, *Oncobyrsa*, *Xenococcus*, *Entophysalis*, *Homalococcus*, *Placoma*, *Glœochæte*, *Chroothece*, *Glœothece*, *Aphanothece*, *Synechococcus*, *Dactylococcopsis*, *Glaucocystis*, *Coccochloris*, *Merismopedium*, *Tetrapedia*, *Cœlosphærium*, *Gomphosphæria*, *Clathrocystis*, *Polycystis*, *Glœocapsa*, *Aphanocapsa*, *Chroococcus*, *Cryptoglena*, *Chroomonas*. *Oscillaria* is reduced to a subgenus of *Lyngbya*.

Dactylococcopsis is a new genus, with the following characters:—Cellulæ graciles, solitariæ vel 2–8 in familias fasciculatim consociatæ, fusiformes, subovatæ-lanceolatæ, modice vel falcato-curvatæ, utroque polis angustatis, subacutis vel longe cuspidatis. Cytioplasma pallide ærugineum vel olivaceo subcæruleum, granula oleose nitentia, bina raro pluria vel singula includens. Membrana tenuis, homogenea, lævis. Propagatio fit cellularum divisione ad unam directionem. The only species, *D. rhaphidioides*, was found on wet rocks.

* Notarisia, iii. (1888) pp. 384–6. Cf. this Journal, 1888, p. 633.
† Boll. Soc. Geol. Ital., v. (1886) 7 pp. ‡ Notarisia, iii. (1888) pp. 584–90.

Heterocystous Nostocaceæ.*—MM. E. Bornet and C. Flahault complete their monograph of the Heterocystous Nostocaceæ contained in the principal herbaria of France. The fourth and last tribe, the Nostoceæ, constitute the simplest group, and are divided into the two subtribes Anabæneæ and Aulosireæ.

The Anabæneæ are distinguished by the sheath being inconspicuous or dissolving into jelly, or firmer, thick and gelatinous, and are made up of the six genera, *Nostoc*, *Wollea*, n. gen., *Anabæna*, *Aphanizomenon*, *Nodularia*, and *Cylindrospermum*. Under *Nostoc* are described twenty-nine species, arranged in nine sections; among them is one new species *N. maculiforme*, found on *Enteromorpha intestinalis*. The new genus *Wollea*, belonging to the United States, is founded on *Sphærozyga saccata*, and is thus described:—Thallus tubulosus, cylindricus, mollis; fila suberecta, paralleliter agglutinata vel leniter curvato-implicata, vaginis confluentibus; heterocystæ intercalares; sporæ catenatæ, heterocystis contiguæ vel ab eis remotæ. *Anabæna* includes eleven species, divided among the three sections, *Trichormus*, *Dolichospermum*, and *Sphærozyga*. Two new species, *A. sphærica* and *laxa*, are described. *Aphanizomenon* includes only two species, and *Nodularia* four, one of the latter, *N. sphærocarpa*, being new. Under *Cylindrospermum* are enumerated five species.

The subtribe Aulosireæ is characterized by the filaments having a thin membranaceous sheath, and being free or agglutinated into parallel bundles. It is made up of the genera *Aulosira* with two species, and *Hormothamnion* Grün. also with two, one of them, *H. solutum*, being new.

As an appendix is added the subtribe Isocysteæ of Borzì, made up of the single species *Isocystis Messanensis* Borz. The subtribe differs from the typical Nostoceæ by the absence of heterocysts, and is thus characterized:—Trichomata cellulis perdurantibus (heterocystis) destituta, muco parcissimo involuta, in thallum irregulariter diffusum densissime aggregata, raro subsolitaria.

Relationship of Bacillus muralis and Glaucothrix gracillima.†—Prof. H. Tomaschek adduces further arguments against the view of Hansgirg ‡ that there is a genetic connection between these two organisms, and that of Zukal § that the Schizomycetes are descended from the Schizophyceæ.

He regards *Bacillus muralis* as an endosporous and not an arthrosporous bacterium (in de Bary's sense), and therefore characterized by the production of aplanospores, while in the Phycochromaceæ only akinetes are formed. The objection that *B. muralis* is not a true bacterium, founded on its immotility, is also not conclusive, since the same objection would apply to *B. anthracis*. Equally inconclusive is the objection that *B. muralis* is invested with a gelatinous envelope, since this also holds good of some undoubted bacteria, such as *Bacterium cyanogenum*, and of *Beggiatoa*.

Prof. Tomaschek has found intermixed with *Bacillus muralis* true zooglœa-colonies of *Glaucothrix gracillima* or *Aphanothece caldariorum*,

* Ann. Sci. Nat. (Bot.), vii. (1888) pp. 177–26. Cf. this Journal, 1888, p. 472.
† Bot. Centralbl., xxxvi. (1888) pp. 180 (figs. 2–6). Cf. this Journal, 1888, p. 786.
‡ See this Journal, 1888, p. 787. § Ibid., 1884, p. 601.

and finds very important points of difference between them. In *A. caldariorum* the rods or cocci have a distinct bluish or verdigris colour; the gelatinous envelopes of the separate cells have a circular or oval form; and not more than from two to four rods or cocci are inclosed in the same envelope. In *Bacillus muralis*, on the other hand, the cells are colourless; the number of rods inclosed in the same envelope is considerably greater, up to eight; and of the spore-like micrococci a very large number go to make up the secondary micro-zooglœa, the envelope being usually considerably longer in one direction; and the rods and cocci have a tendency, like those of *Nostoc*, to arrange themselves in rows.

β. Schizomycetes.

Bacterium Balbianii, a chromogenous marine Bacterium.*—M. A. Billet describes a new micro-organism, *Bacterium Balbianii*, which makes its appearance in macerations of marine algæ after a period of several weeks, either on the surface of the liquid or on the sides of the cultivation vessels. In colour it varies between a pale and an orange yellow. In its zooglœa condition it appears as a number of spheroidal bodies inclosed in a thin gelatinous capsule. Within the capsule are thin straight rodlets, 1 to 2 μ long, usually in pairs. The capsule rapidly increases in size, and by agglomeration a mass is formed with a bran-like appearance. Pure cultivations were made in solid and liquid media. The former was 1·5 per cent. agar-agar; the latter an infusion of *Laminaria* made by boiling these algæ in sea-water for an hour, and after filtration sterilizing at 120°. The density of the liquid is 1·029. By growing the bacterium in the foregoing media, the author found that this bacterium passed through certain stages of development, or an evolution cycle, which comprised four distinct states. The stages were the filamentous, i. e. numerous motionless elements joined end to end; when the filaments got matted together a felt-like pad was produced. This constituted the second stage. The third stage, or that of dissociation, was distinguished by the mobility of the elements, which were either isolated or formed chains of not more than two or three individuals. The fourth stage was the zooglœa condition, already described.

Ferment from putrefactive Bacteria.†—Herr E. Salkowski placed fibrin which had been well washed and exposed for a few days to a temperature of 7°–10° C. for many months under chloroform-water (5 ccm. chloroform to a litre of water), by which putrefaction was entirely prevented. The fibrin, however, dissolved slowly; the proteids in solution were at first globulin and albumin, later albumoses, and finally peptones. The cause of these changes must certainly have been an unorganized ferment, since bacteria were excluded during the experiment. The author determined that this ferment must have been derived from the bacteria which contaminated the fibrin after the process of washing. Such a ferment was discovered in the undissolved residue; it was active in an alkaline solution, and was therefore of the nature of a trypsin.

* Comptes Rendus, cvii. (1888) pp. 423–5.

† Zeit. Biol., xxv. (1888) pp. 92–101. See Journ. Chem. Soc., 1888 (Abstr.), p. 1326.

Contributions to Vegetable Pathology.*—M. J. H. Wakker discusses the malady caused by *Bacterium Hyacinthi*. The bacteria which may be regarded as the cause of this disease are more or less cylindrical and colourless, and may be found by myriads in the yellow mucilage of the bulbs that are attacked. The spores of *B. Hyacinthi* are slightly longer than they are broad, and are bluish in colour.

Another disease of hyacinths and allied plants, caused by *Peziza bulborum*, is also described. The spores of this fungus are ovoid and colourless, and are contained in asci; they show two bright bluish spots, each situated at the same distance from the extremities.

Purple Bacteria and their relation to Light.†—Prof. Th. W. Engelmann, who has long interested himself in the behaviour of bacteria towards light, has continued his observations in the same field, taking for his subjects those forms which are well known and have been thoroughly described, such as *Bacterium photometricum*, *roseo-persicinum*, *rubescens*, *sulfuratum*, *Beggiatoa roseo-persicina*, and several others. In these, most of which belong to the sulphur bacteria, a purplish pigment, bacterio-purpurin, is diffused throughout their plasma. The behaviour of these organisms towards light was found by the author to depend not on the sulphur, but on the bacterio-purpurin.

With regard to the direct influence of light, it was found that the rapidity of the movements was increased by illumination, and, *per contra*, ceased in the dark; and that purple bacteria were differently affected by light of different wave-lengths.

With regard to the spectrometric investigation of the colour of purple bacteria and the measurement of the absorption of the dark heat-rays, the original must be consulted.

The author also discusses the excretion of oxygen by these purple bacteria while they are in the light, and the dependence of their growth on light.

With regard to bacterio-purpurin, he comes to the conclusion that it is a true chromophyll, in so far as the absorbed actual energy of light is changed by it into potential chemical energy.

Pathogenic Bacterium found in Tetanus.‡—Drs. Belfanti and Pescarolo describe a bacillus which they have obtained from the discharges of a person who died presumably of tetanus. Injection of this material into mice produced tetanic symptoms in from 10 hours to 10 days. From this material the authors isolated a bacterium which, injected into rabbits, mice, sparrows, &c., caused death preceded by paralytic or convulsive phenomena. Cultivated on the usual media, the development of this bacillus was examined in hanging drops, wherein it appeared as a rodlet, rather longer than broad, and resembling the bacillus of fowl-cholera. The ends are rounded. It is mobile even at a temperature of 23°–25° C., and it multiplies by fission. It was stained well by the usual methods, and was decolorized in 2 minutes when Gram's method was used. The colonies are white or whitish yellow, and do not liquefy gelatin.

* Arch. Néerland., xxiii. (1888) pp. 1–71.
† Bot. Ztg., xlvi. (1888) pp. 661–9, 677–89 (2 figs.), 693–701 (1 fig.), 709–20. Cf. this Journal, 1888, p. 473.
‡ Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 513–9.

Algophaga pyriformis.*—Prof. N. Sorokin describes an organism which he first discovered in 1886 in its monad form. Since then he has observed the various phases of its development. In the free-swimming stage it occurs as small colourless monad-like bodies, which move slowly forward by the aid of cilia. These corpuscles consist of two parts—a head and long processes. The head is oval or pyriform, and is from 2 to 4 μ long. These bodies are termed small swimmers, in contradistinction to larger bodies of similar appearance, which are developed from a combination or melting together of two or more small ones. Both kinds seem, from the illustration, to be very much alike, and to nourish themselves by sucking at unicellular algæ. After sucking at the alga the swimmer loses the pseudopodia, and forms a microcyst, which is apparently a quiescent condition, during which the absorbed chlorophyll is digested.

Another condition in which this organism appears is as a macrocyst. In this state the pseudopodia are withdrawn, and a transparent membrane envelopes the whole body, just as has happened with the microcyst. The only difference appears to be in the size, the macrocysts being four or five times larger than the microcysts. When the membrane has been formed, vacuoles, oil-drops, and nuclei appear within the macrocysts. Next the vacuoles disappear, the oil-globules crowd together, and the bottom of the cell is filled with a green mass. As time goes on—a question of a few hours—further changes occur within the cell-contents, spherules appear, the cell bulges at one end, and then having burst owing to the pressure, gives exit to a number of small free swimmers with pear-shaped heads and long pseudopodia usually three in number.

The author was fortunate enough to observe a resting form of this organism, which was not distinguishable from the zygosperms of fungi. From the text and illustration it would seem that two separate organisms were concerned in this phase.

Sarcinæ of Fermentation†.—Dr. P. Lindner describes eight varieties of Sarcina which he has found in beer, mash, and in the air and water of breweries.

Pediococcus cerevisiæ Baleke is a bacterium which occurs as a mono-, diplo- or tetracoccus. It was first described by Pasteur, and has been found to be one of the principal causes of the clouding of beer. It grows well on the usual media, and its most marked characteristic is that it will not bear being transferred from alkaline to acid media, but does from acid to alkaline. It will not grow in sterilized beer. Cultivated on potato it produces involution forms like *Bacterium aceti* and *B. termo*. It is killed in eight minutes by a temperature of 60° C.

Pediococcus acidi lactici. As its name implies it produces an acidity of the media on which it is cultivated (neutral malt extract solution at 41° C.) The acid solution replies to tests for lactic acid. The sarcina is found to be identical with the organism which plays an important part in fermentation, and which is known by the name of "Kugelbacterium." It developes best at a temperature of 41° C.; is killed in five minutes at 62° C., and in 20 minutes at 56° C. It appears to thrive better in the absence of air.

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 419–27 (1 pl.).
† Inaug. Diss., 1888, 58 pp. (1 pl.). Cf. Bot. Centralbl., xxxvi. (1888) pp. 97–100.

Pediococcus albus was found in a water-spring supplying a brewery, and in white beer. It liquefies gelatin rapidly, and forms a white crust on the surface.

Sarcina candida, found in brewery water as spherical or irregular zoogloeæ about the size of a pin's head. These consist of diplococci, the sarcina form only appearing in hay decoction. Gelatin is rapidly liquefied by this organism. Diameter of the individual cells 1·5 to 1·7 μ.

Sarcina rosea, found in the fermenting room of breweries. On agar it forms little colonies, which consist of small spherical elements, among which very large cells often appear. In liquid media it throws down a red sediment that becomes green on addition of sulphuric acid and reverts to red on neutralizing with caustic soda.

Nitric and hydrochloric acids, caustic soda and ammonia, do not alter the pigment, which is soluble in alcohol but not in chloroform, petroleum-ether, benzol, or bisulphide of carbon.

Sarcina aurantiaca from orange-coloured sarcinæ or hay decoction. It is also found in Berlin white beer.

The pigment is turned a dark blue-green by sulphuric acid, and on addition of caustic soda becomes red.

Sarcina flava was isolated from beer which contained *Pediococcus cerevisiæ*. This sarcina should not be confounded with the yellow *Sarcina lutea* Schröter. The size of the individual cells amounts to 2–25 μ, and the cube-masses often measure along the side 38 μ.

The pigment is changed to a dirty green with sulphuric acid; soda restores the yellow colour.

Sarcina maxima found in mash. It closely resembles *Sarcina ventriculi*, but is distinguished therefrom by the absence of the cellulose reaction. Grown at 40°–45° C. the cells often attain a diameter of 3–4 μ. Mash at other temperatures did not develope this *Sarcina*. In none of these *Sarcinæ* were involution forms observed.

Photomicrographic Atlas of Bacteriology.—Dr. C. Fraenkel and Dr. R. Pfeiffer are bringing out an Atlas of Bacteriology which is to be illustrated by photographs of the various micro-organisms, showing them in their different phases, and as they appear in cultivations, in sections, &c. The illustrations will be accompanied by an explanatory text.

The atlas will be completed in from 12 to 15 parts, each of which will contain about ten photographs.

Protoplasm considered as a Ferment Organism.*—This comprehensive work is a posthumous expansion of a brochure of the author, Prof. A. Wigand. The book has been put through the press by Dr. E. Dennert, who co-operated with the writer during his lifetime. It is essentially a series of essays on Bacteria and their work, putrescence, fermentation, and the production of diastase, and contains also lucubrations on molecular physiology. The volume is divided into three parts, the first of which discusses the fermentative action of Bacteria, the second part treats of the theory of fermentation, while the third in entitled the Anamorphosis of Protoplasm. In the first part the author discusses the relations between putrescence and Bacteria, lactic fermentation, and the ferment-organisms which produce diastase; the second part treats

* Botanische Hefte (Wigand), Heft 3, x. and 294 pp., 8vo, Marburg, 1888.

of Wigand's peculiar theory of fermentation, and the third of the anamorphosis of protoplasm.

Yeast-poisons.*—Herr H. Schulz has experimented on the effects on ferments of very dilute solutions of well-known yeast-poisons, such as corrosive sublimate, iodine, potassium iodide, bromine, arsenious acid, chromic acid, sodium salicylate, and formic acid, and finds that in all cases it promotes the activity of the fermentation. The mode of experiment was as follows. In each of a number of glass cylinders of 200 ccm. capacity were placed 50 ccm. of a 10 per cent. solution of grape-sugar, and to each was added 1 ccm. of fresh baker's yeast and distilled water. The cylinders were closed by a metal lid, which was screwed in, and in this were placed a long divided glass tube and a short one, furnished with a cock for ventilation. The lower end of a long tube dips into a vessel filled with mercury, the upper edge of which projects above the level of the nutrient solution in the cylinder. The carbon dioxide produced during fermentation presses up the mercury in the divided tube, and the course of the process of fermentation was concluded from that of the column of mercury. All the cylinders were placed in a water-bath heated to 21° C., and were submerged, so that any defect in the closing of the cylinder would be shown by the ascent of bubbles of gas.

* Arch. f. d. Gesammt. Physiol. (Pflüger), xlii. (1888). See Bot. Ztg., xlvi. (1888) p. 610.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Fasoldt's "Patent Microscope."—Mr. C. Fasoldt, the well-known ruler of fine lines, has devised the Microscope shown in fig. 1.

The peculiarities of the construction are (1) the combination of the coarse- and fine-adjustments in one mechanism, which is shown in fig. 2, "intended to prevent the breaking of objects and injury of objectives through the accidental moving of the tube"; (2) the vertical illuminator, in which by a pair of plates opening angularly by the rotation of a cam and a single diaphragm plate, pivoting together or separately in front of a fixed quadrangular aperture, the light can be variously regulated. The glass disc reflector is attached to a bar, which can be withdrawn for cleaning or replacing by turning the milled-head cap in front. It can also be inclined as well as moved out of the field of view by pulling the bar through the milled-head cap, when the disc lies in the piece of tubing on which the cap fits; (3) the changing nose-piece applied below the vertical illuminator, by which the objective can be attached or released by the action of a trigger-piece on a sliding tooth, the inner edge of which has the Society screw-thread, and presses the screw of the objective against two similar but fixed teeth opposite; and (4) the fixed stage-ring has a deep groove round the outer edge, in which the upper plate rotates by means of two short pins on the inner edge of an overlapping flange, two diametral slots in the fixed ring enabling the upper plate to be removed.

The combined coarse- and fine-adjustments are shown in fig. 2. At the back of the body-tube slide is fixed a short screw-socket, through which a long coarse-threaded screw passes, the rotation of the screw causing the socket, and with it the body-tube, to move up or down. Near the lower end of the screw is fixed a small pinion with spiral teeth, in which a similar but much larger pinion engages for the coarse-adjustment, raising or lowering the body-tube somewhat slowly, after the manner of worm-wheel and tangent-screw mechanism. The screw has a plain cylindrical fitting at each end, by which the small pinion is kept in close contact with the larger one.

Mr. Fasoldt claims for this system of coarse-adjustment the impossibility of any running down occurring by the accidental concussion of the body-tube, as the mechanism remains locked unless set in motion by the milled heads.

For the fine-adjustment a long bent lever is applied to the lower end of the coarse-adjustment screw, so as to raise it through a space of about 1/8 in. against the downward pressure of a short spiral spring encircling the upper end, the great difference in the size of the pinions permitting this range of motion without disengaging the teeth. The lever is acted upon at the back by a milled-head micrometer-screw.

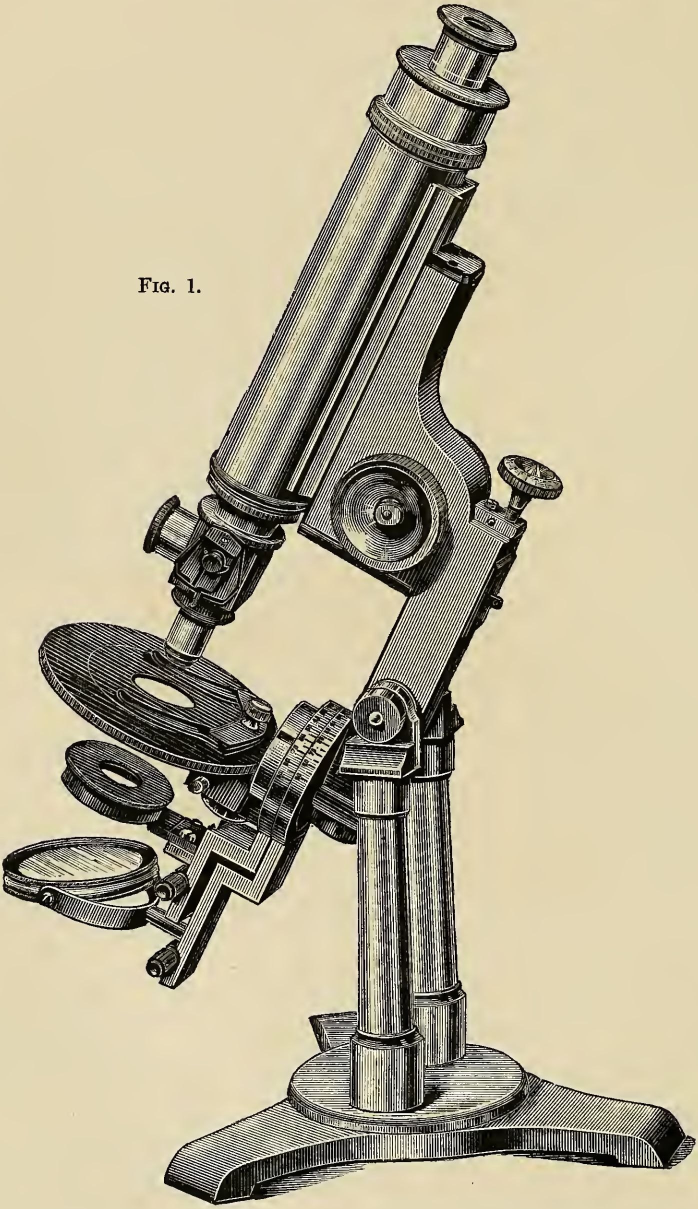
Mr. Fasoldt writes that he uses the illuminator in the following way:—

"When the Microscope is in position and the object on it, first find

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

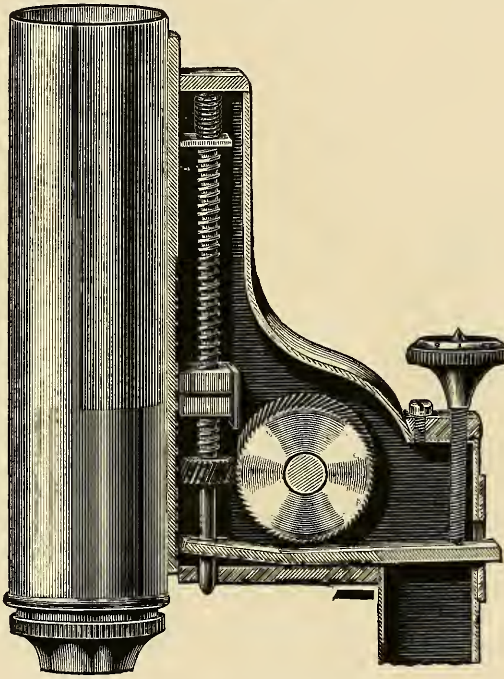
the object with any objective from 2–3/4 in., using either transmitted light or dark field with light through condenser, the latter

Fig. 1.



standing at an angle of about 45° from the stage, and throwing the light directly on the lines, when the latter will give a spectrum. After having them in focus the objective can be changed for a higher homogeneous-immersion lens. Set the lamp about 20 in. distant from illuminator (at which distance I get the best resolution), using the sharp edge of the flame, and in horizontal line with opening of illuminator. I use an achromatic lens 2 in. focus as condenser (1 in. in diameter), and put it further away from illuminator opening than focal distance, the opening being open about the thickness of a penny and the light appears on shutters like a 'cat's-eye.' After having light in place and the pin in front of illuminator, to which the reflecting glass is attached, standing

Fig. 2.



in an angle of about 45°, you will see only a partially illuminated field, with dark spot in centre; when you have it so you are ready for work.

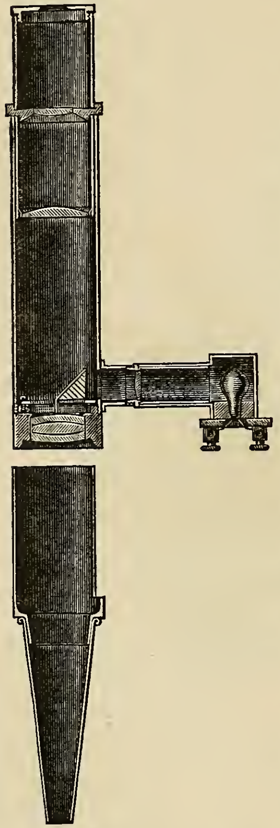
The illuminator can be used only on dry mounts. If you do not want to use the illuminator the reflector can be drawn out by the bar in which the pin is. Then it forms only a single patent nose-piece.

Before putting the light through the illuminator the object should first be brought in focus, using either oblique or central illumination, for lenses of short working distance. The reflector can be set at any angle by turning the milled cap through which the bar passes to which the reflector is fastened. The milled cap is held down by two pins in the cylinder and a groove in the cap into which the pins pass. There are two notches in the cap, which enter into the round groove directly opposite each other. When they are brought in perpendicular position with the illuminator and to where the pins stand, the whole cap can be taken off for the purpose of putting glass in should one be broken.

For dry lenses I place the flame lower than the opening and use no condenser, but open the shutters to their fullest extent. You will obtain different results by using the light at longer and shorter distances. For examining blood-corpuscles, latter should be mounted on cover-glass, and you can get the best results by using less light."

Czapski's Ear- (Tympanum) Microscope.*—At the instigation of Prof. Kessel, the representative of aural surgery in the Jena University, Dr. S. Czapski undertook the construction of a Microscope which, provided with its own means of illumination, should by its handy form permit of observation of the ear under a magnification of about six to eight times. The following arrangement was given to the instrument (fig. 3) which repeated trials proved to be the most suitable.

FIG. 3.



An objective of about 10 mm. opening and 20 mm. focal length is connected by a tube 60 mm. long with an eye-piece magnifying ten times. The objective alone contributes nothing to the magnification; it simply throws the image in approximately unchanged magnitude in front of the eye-piece, so that the whole magnification is about that of the latter. Above the eye-piece is screwed a tube 25 mm. long, which carries a diaphragm for directing the line of sight, here so widely divergent, but this is not absolutely necessary. The length of the whole Microscope is about 100 mm.

Above the objective is a reflecting prism (silvered on the hypothenuse surface) which covers half the objective, and for the avoidance of all external reflections is completely inclosed with a tin cover. The position of the prism is adjustable, so as to direct the light exactly in the middle of the field of view. The light from a small electric incandescent lamp, after passing through a lens, is thrown upon the prism through an opening in the tube opposite the prism. Lamp and illuminating lens are contained in a side tube, the former being independently movable and easily replaceable. Instead of the glow-lamp a gas or petroleum lamp can be used, placed at the side. A socket in which the Microscope slides smoothly is attached by means of a bayonet catch to the ordinary ear-funnel; for the passage of the side tube the socket is slit along three-quarters of its length. The above mode of connection of funnel and tube was preferred to a solid join, partly in order

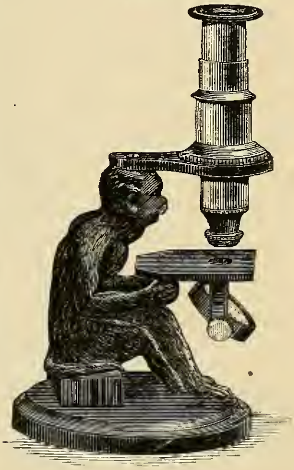
* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 325-7 (1 fig.).

to leave the funnel unchanged for its ordinary use with the reflector, and also to enable it to be easily cleaned.

To use the instrument the funnel, with or without the additional tube, is placed in the ear and its position arranged by means of an ordinary reflector for viewing the interior of the ear. The Microscope is then carefully pushed down into the socket until the image is sharply defined. By moving the instrument to and fro it is possible to obtain a view of every part of the external meatus which can be seen by the naked eye, and its use presents no difficulty even to the novice.

The field of view is not contracted by the prism over the objective, but the light is halved in intensity. The lens-openings are, however, made so large that the brightness of the image is quite sufficient. The illumination is of course most intense over the whole field of view when the lamp is as near as possible to the prism, but regard for the ear and cheek of the patient places a certain limit to the approach of a hot source of light. The lamp and illuminating lens must be so arranged that only the part of the object appearing in the field of view is illuminated, but this as uniformly as possible. The proper arrangement is easily obtained by trial.

Fig. 4.



Moreau's Monkey Microscope.—This Microscope (fig. 4), by M. Moreau of Paris, was exhibited at the December meeting of the Society. In its design Art as well as Science has been drawn on, for instead of an ordinary base and pillar a figure of a monkey is introduced which holds in its hands the stage and mirror, while the cross-arm carrying the body-tube and socket is screwed to the top of its head!

Crouch's Petrological Microscope.—Messrs. Henry Crouch, Limited, have constructed an instrument on the model of that of MM. Nachet, in which the stage and objective rotate together with the upper part of the body-tube, while the eye-piece remains stationary. It is not, therefore, necessary to centre afresh with every change of objective.

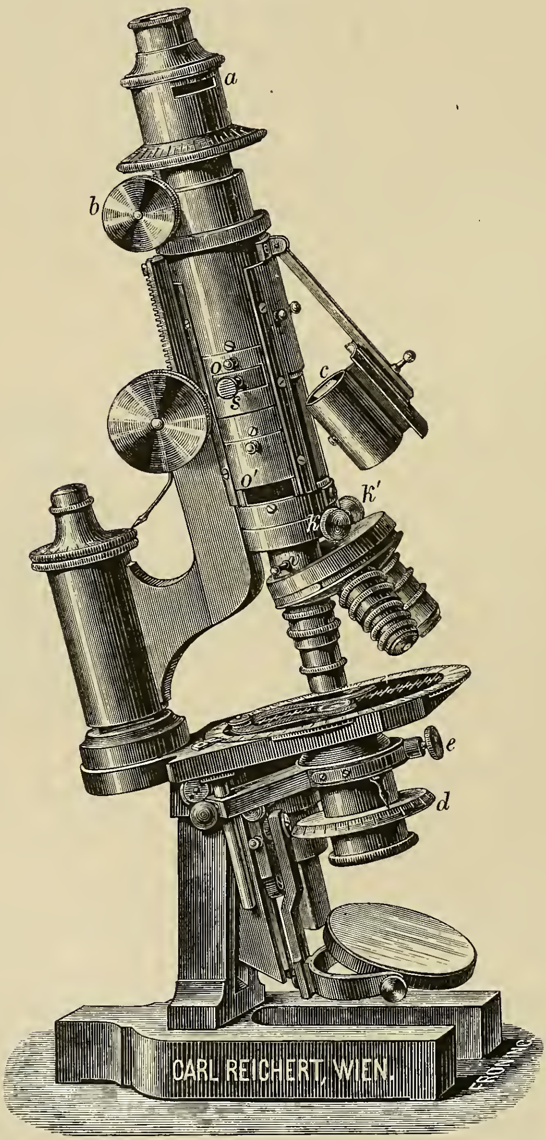
Among other points is the device for the convenient focusing of the substage condenser when convergent polarized light is employed. The lenses are placed in the tube of the polarizer and are then thrown in and out of the line of light at the same time as the polarizer, by merely moving the bar on which both are mounted. A milled ring above the polarizer focuses the condensers by a single rotating movement, similar to that by which the polarizer itself is rotated. Two analysers are provided, one in the eye-piece and the other in a draw-box above the objective.*

Reichert's Petrological Microscope.—Herr C. Reichert's Petrological Microscope (fig. 5), constructed for the Vienna Mineralogical Institute, has two specialities.

* Cf. Mawer's 'Primer of Micro-petrology,' 8vo, London, 1888, pp. 64–6 (1 fig.).

The first is the introduction into the body-tube of a second analyser *c*, which is supported on a hinged arm so that it can be rapidly inserted

Fig. 5.



and removed. This arrangement was adopted by M. Nachet for the Microscope which we described in 1881.*

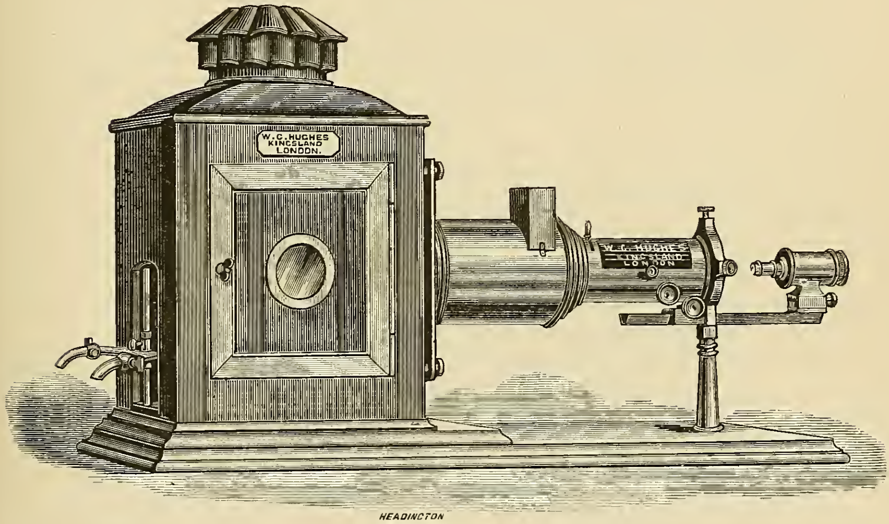
* See this Journal, 1881, p. 934.

The second is thus described (in English) by the designer :—" The tube has three ouvertures *o*, *o'*, and *a* ; *a* serves to place there a quartz wedge ; *o'* to place there a quartz plate, and *o* for the reception of a lens *s*, which magnifies the axial image sketched by the objective, and which conducts the rays of the objective, so that if we will pass from the observation in parallel light to that in convergent light, it is but necessary to place the corresponding objective and the lens *s* without changing the eye-piece, which can be exactly adjusted on the object by the aid of a rackwork of the draw-tube *b*."

The Microscope has the usual rotating stage, centering movements to the body-tube *k* and *k'*, diaphragm holder *e*, polarizer *d*, and eye-piece analyser.

Hughes' Patent Oxyhydrogen Microscope.—This instrument (fig. 6) has been designed and constructed by Mr. W. C. Hughes " with a view to enable scientists, teachers, and lanternists to display on the screen in a clear and well-defined manner the minutiæ of anatomical and geological sections, preparations of insects and vegetable tissues, and general microscopic objects either by ordinary or polarized light.

FIG. 6.



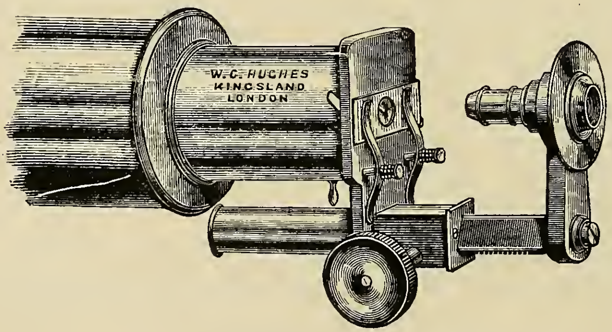
" After a careful and protracted series of experiments, an arrangement has been adopted by which the rays of light converging from a new form of triplet condensers are concentrated into a narrow parallel beam which will pass through the small apertures of the ordinary microscopic objectives, and so be transmitted to the screen, without that loss which is so disappointing in the ordinary lantern Microscope.

" To obtain this maximum of illumination Mr. Hughes has designed a special chamber jet, with which sufficient light can be obtained to magnify transparent subjects to 1900 diameters, which has hitherto been unattainable ; thus a flea, which is about 1/10 in. total length, will be thrown on the screen 16 feet long, and every hair distinctly defined, and nearly as brilliantly as a picture shown by the Pamphengos lantern. The proboscis of the blow-fly can, with various powers, be projected from 8 to 16 feet long, and all the details of an insect's eye in section can be shown most perfectly; the circulation of the blood in the foot of a frog is easily displayed, and the wonders of pond life made manifest without the slightest difficulty or trouble. With the electric light no limit can be put on the magnifying power of the instrument, although, for all ordinary purposes, the lime light is all that is needed to obtain the results above mentioned. Every precaution has been taken to arrest the passage of heat to the objects by means of non-conductors, and the results obtained have met with the approval of all those who have seen its perfect performances.

"This Microscope can be fitted to any good optical lantern, but it is preferable to purchase the instrument in its entirety, as above illustrated. The lantern and Microscope are firmly attached to a solid base-board, rendering any interference with the adjustment unnecessary, an arrangement which will be found invaluable for perfect manipulation. Any ordinary microscopic objective may be used, but it is advisable to adopt those . . . which are specially corrected to insure the largest amount of light, and give a very flat and sharply defined image on the screen."

Hughes' Improved Microscopic Attachment—Cheap Form.—Mr. W. C. Hughes has devised this form of Microscope (fig. 7) for use with the ordinary magic lantern in place of the front lens, and claims that it will

Fig. 7.



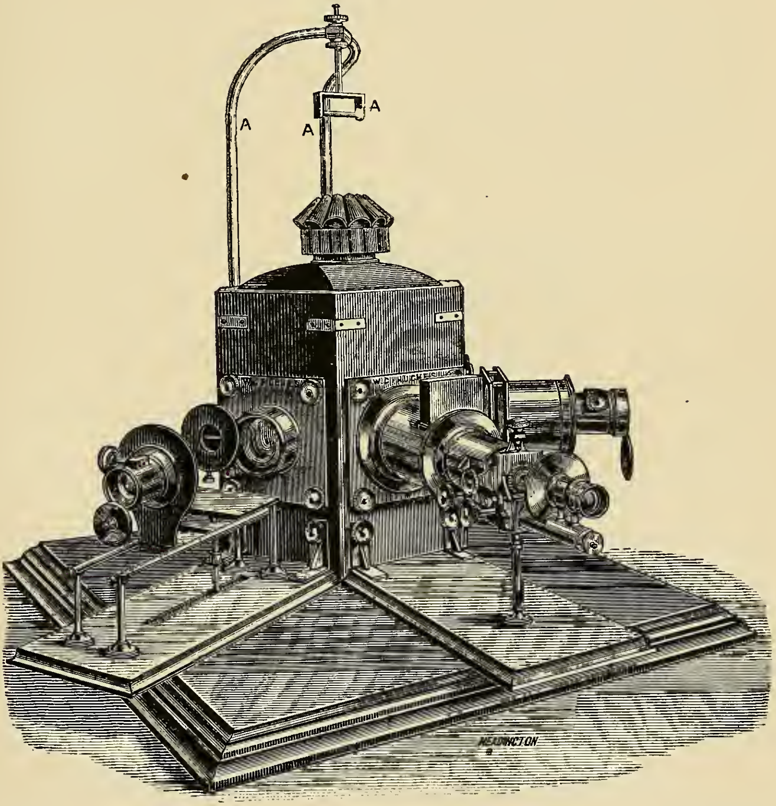
show ordinary microscopical slides on the screen for class or demonstrating purposes far more brilliantly and better defined than the old form of cheap lantern microscopic attachment. It will show chemical, anatomical, and other objects on a disc 8 to 10 feet when limelight is used, and with the "Pamphengos" lantern very excellent results can be obtained. "With a 1/2-in. the spiral formation of a blow-fly's tongue can be shown, the sheep tick, 6 ft. long, exceedingly sharp and well defined, sections of wood, spiders, flies, scorpions, and each hair on a flea or other small insect is brought out with great distinctness. Pond life is easily demonstrated, *Volvox globator*, showing young inside, and *Hydra*, 6 ft. to 7 ft. long. It has a movable substage condenser which enables it to be used with different object-glasses, new form of spring on the stage, by means of which the thinnest objects can be held as firmly as the glass zoophyte troughs. The bar with rack motion is constructed on the best principle by which wear and tear can be compensated for, by simple adjustment of the screws, thus insuring absolute absence of all shake.

"If desired, the image, by a special contrivance superior to the usual right angle reflecting prism, can be thrown direct on the paper for drawing. It has a new form of diaphragm arrangement, by which the aperture can be changed with great facility.

"The Microscope can be adapted, say to the centre lantern of a triple, while the other two can be utilized for showing ordinary photographs and photomicrographs to consecutively illustrate a given object under different phases without leaving the screen blank."

Hughes' Special Combination Scientist Optical Lantern.—Mr. W. C. Hughes has patented the new form of lantern shown in fig. 8, in

FIG 8.



which he "lays claim to having supplied a want long felt by the professional lecturer, both in the class-room and in the theatre, namely, that of rapidly throwing upon the screen (*a*) the general view of an object (*b*) the microscopic portion of the same enlarged, and (*c*) in the matter of chemistry and physics, the experiment in actual operation."

The mahogany body is hexagonal, and each of the three front sides is provided with condensers and projecting arrangements. The back opens to give access to the radiant, which in this case is a Brockie-Pell arc-lamp; but, if necessary, a lime-light can be readily substituted. The lamp is fixed to the base-board, 3 ft. square, and the body can be rotated through 60° on either side of the central position, thus allowing any of the three nozzles to be directed towards the screen. The three sets of condensers are placed so that their axes intersect at a point about which the radiant is placed. The centre nozzle is fitted as a lantern Microscope, with the Microscope-attachment described in the preceding note, with alum cell and various sets of condensing lenses and objectives, and a space in front of the main condensers is provided for polarizing apparatus. The focusing arrangement consists of a skew rack and pinion and a fine screw adjustment; and the whole Microscope can be easily removed and a table-polariscope substituted. The right-hand nozzle is arranged for the projection of ordinary lantern-slides, and the left-hand one is provided with an adjustable slit for spectrum work. A small table sliding on rails serves to carry the prisms, and the same rails support projecting lenses.

Duc de Chaulnes' Microscope.—In the *Museo di Fisica*, Florence, we recently saw the Microscope shown in fig. 9, and by the courtesy

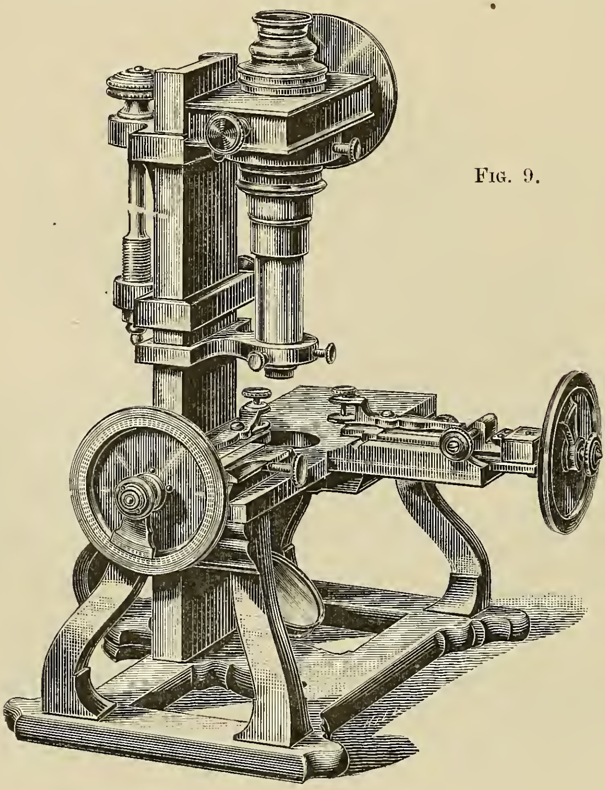


Fig. 9.

of the Curator, Prof. Meucci, we were enabled to secure a photograph of it. Nothing was known as to the origin of the instrument, but from its resemblance to the Microscope figured in plate i. of a folio work entitled 'Description d'un Microscope et de différents micromètres, &c.,' published in Paris, in 1768, by the Duc de Chaulnes, we are able to assign the design to him.

The principal aim in the construction seems to have been to facilitate the verification of micrometric measurements, especially of micrometer-divisions, for the production of which the Duc de Chaulnes devised an elaborate dividing engine in which he claimed to have embodied some original methods of obtaining accuracy in dividing scales.

The design of the Microscope proper, and of the eye-piece micrometer, seems to have been copied to a considerable extent from instruments made in England by John Cuff. The novelties were (1) in the application of a stage of an unusually substantial character, supported by four shaped legs on a framed base, the stage being arranged specially to carry screw-micrometers acting on the object in rectangular directions; (2) the body-tube is supported both at the nose-piece and near the eye-piece in centering sockets, by which the optic axis can be exactly collimated. In the original figure the body-tube is not mounted with these centering arrangements, and levelling screws are shown at each corner of the base, while a rack-work is applied for the coarse-adjustment. The Florence instrument is constructed more solidly than the one shown in the Duc de Chaulnes's figure, the extreme importance of solidity being probably discovered more and more during the progress of the construction.

DIPPEL, L.—**Aus dem optischen Institute von Carl Reichert in Wien.** (From the Optical Institute of Carl Reichert in Vienna.)
[I. The new large stand, No. 1A. II. The apochromatics and compensation eye-pieces.] *Zeitschr. f. Wiss. Mikr.*, v. (1888) pp. 145–50 (1 fig.).

(2) Eye-pieces and Objectives.

Monobromide of Naphthaline as an Immersion Medium.—Mr. H. Jackson, of the Chemical Laboratory, King's College, recommends this substance, not only as a solvent for balsam in mounting, but more particularly as a medium for immersion objectives. The refractive index is too high to use it alone, but diluted with castor-oil it gives excellent results. The relation of its dispersive power to the refractive index shows it to be both theoretically and practically superior to cedar-oil. The smell of it after remaining on the fingers for a little time is unpleasant.

CZAPSKI, S.—**Compensationsocular 6 mit 1/1 Mikron-Theilung zum Gebrauch mit den apochromatischen Objektiven von Carl Zeiss in Jena.** (Compensation-ocular 6 with 1/1 micron graduation for use with Zeiss's apochromatic objectives.)
[Cf. this Journal, 1888, p. 797.] *Zeitschr. f. Wiss. Mikr.*, v. (1888) pp. 150-5.

(3) Illuminating and other Apparatus.

Thoma's Camera Lucida.*—Prof. Dr. R. Thoma considers that the ordinary form of camera lucida is unsatisfactory for low magnifications (1–6). Moreover no account is taken of the refractive condition of the

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 297-304 (4 figs.).

observer's eye, to suit which, changes have to be made in the distance of the paper which give rise to distortions.

His new camera (fig. 10) has two mirrors, one C silvered, and the other *a* of clear glass, and both set at 45°. The observer looks at the object through the unsilvered mirror, and at the same time by reflection from the two mirrors sees the drawing paper *z*. There are two convex lenses, one *b* in a vertical plane between the two mirrors, and the other *d* in a horizontal plane between the object and the unsilvered mirror. The camera and stage slide on a graduated vertical rod (fig. 11), the feet of which rest on the drawing paper, and the positions of the camera and stage are so arranged that the object and the paper are at the foci of the two lenses. Consequently an eye accommodated to infinity sees both

Fig. 10.

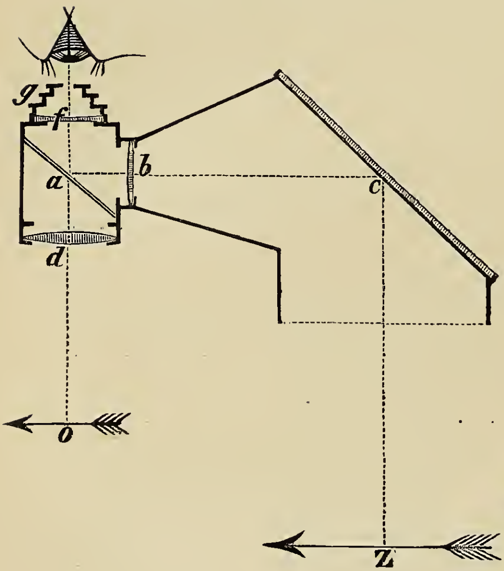
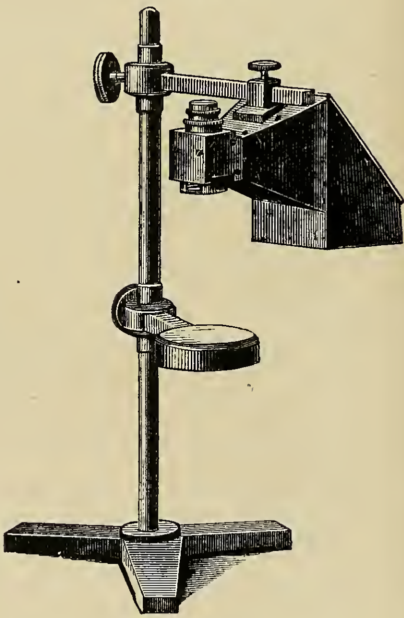


Fig. 11.



object and drawing clearly. To regulate the illumination of the two images, smoked glasses are used. A spectacle glass *f* can, if necessary, be placed in the eye-piece to correct to infinity the eye of the observer. To avoid parallactic displacement of the images a diopter *g* is fitted in the eye-piece above the spectacle glass. The author gives tables of the necessary lenses and distances of object and drawing plane for different magnifications. For diminutions, the positions of object and drawing plane are reversed.

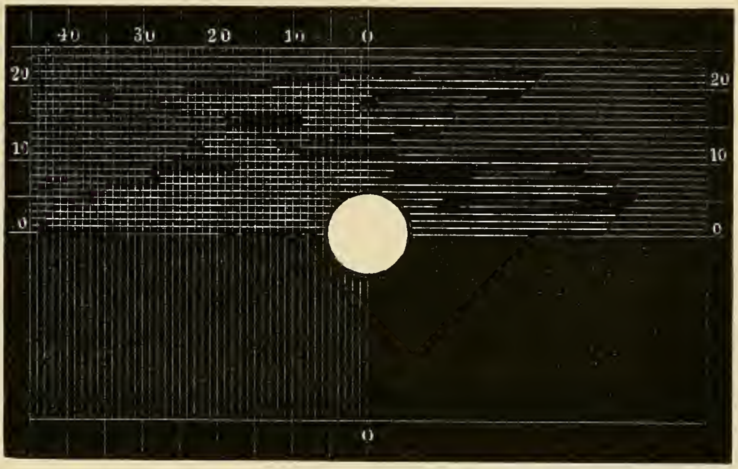
Besides the capability of accommodation to the state of the observer's eye, the apparatus possesses the advantage that for weak magnifications a large field of view is obtained.

Finally the author points out how the use of weaker convex lenses may enable the observer to dispense with the concave glass used for correcting to infinity a myopic eye. The stronger the myopia, the weaker may be the lenses used to produce a considerable magnification. Thus for a myopic eye of − 8 D, to produce a magnification of ten times, the object-lens need only be one of + 13·5 D, and the drawing lens one of − 9 D. To bring any eye then to this state of myopia, a suitable convex lens is placed in the eye-piece. By this means high magnification up to ten times can be obtained without distortion of the images.

Finder.*—Dr. J. Pantocsek describes the finder shown in fig. 12, which he considers to be more serviceable than Maltwood's finder, which he considers "time-wasting" and "minute."

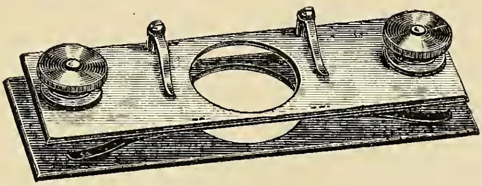
Four lines are drawn on the stage at right angles, intersecting in the optic axis; these are marked 0. Lines a millimetre apart are drawn parallel to those on the upper half and the left half of the finder, thus giving horizontal lines in the right upper quadrant, vertical

FIG. 12.



lines in the left lower quadrant, and squares in the left upper one. Each ten of the lines are marked as shown in the fig. When the object is in the field, note is taken of the two lines on which the left and upper sides of the slide rest, thus: 42/11.

FIG. 13.



Adjustable Safety-stage.—In this form of safety-stage the additional refinement has been introduced of two clamp screws at either end of the

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 39–42 (3 figs.).

plates, by which the upper plate can be brought nearer to or further from the lower plate. The result of this is to make the stage more or less sensitive. If, for instance, the plates are widely apart so that the pair of springs between them are relaxed, the upper plate yields to the slightest touch; when, however, the plates are brought closer together, so that the springs are compressed, the upper plate is much more rigid.

Engelmann's Microspectrometer.*—Prof. T. W. Engelmann points out that both the microscopic anatomist and physiologist are compelled to use peculiar methods of research, and that this is especially the case when it is necessary to examine properties and appearances quantitatively as well as qualitatively. A review of the ordinary methods of microscopical investigation shows that they are almost solely qualitative. As a contribution therefore to quantitative methods of microphysiological research, the author describes a microspectrometer for the analysis of the colour of microscopically small objects.

Originally devised for the quantitative determination of the absorption of different colours through living plant-cells, the apparatus is serviceable for quantitative microspectral analysis generally, and can be used with advantage for most microspectrometrical researches in place of the ordinary larger apparatus. The principle of the instrument is practically that of Vierordt's spectrophotometer. The spectrum of the object is compared with a standard spectrum, and quantitative measurements are obtained by altering the width of the slit until the brightness of corresponding parts of the two spectra is the same. The apparatus, which in use takes the place of the eye-piece in the body-tube, is represented in figs. 14, 15, and 16. The lower part contains the two slits and the arrangement for obtaining a comparison spectrum. The upper part is the spectroscope proper.

The under part consists of a rectangular box A, provided above and below with wide circular openings, into which are screwed the tubes *b* and *c*. The tube *b* fits in the place of the ordinary eye-piece, and is fastened by the screw *b'*, while into the tube *c* fits the eye-piece *oc* during the setting up of the object, replaced later by the cylindrical underpiece *a'* of the spectroscope. The latter rests with the ring *r* in the circular groove *s*, and is here fixed in a constant position with respect to the slits. The insertion and removal of the upper piece can thus take place without any shaking, so that there is much less danger of displacement of the images than in the micro-spectral ocular of Abbe and Zeiss, in which the two pieces are movable one within the other.

In the right of the box A is fixed the small tube *d*, through which, by means of a mirror S or lens, the light from a source at the side is directed upon the totally reflecting prism *pr*. By means of the handle *h* projecting from the box A at *h'*, this prism can be brought at will beneath or out of reach of the right slit which gives the standard spectrum.

The tube *d* carries at its end a frame *n* for the reception of diaphragms and ground or coloured glasses. In order in all cases to obtain a uniform, and, from the position of the observer's eye, as far as possible independent illumination of the standard slit, at the recommendation of Prof. Abbe a lens is fitted into the inner opening of the tube *d*; this throws a

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 289–96 (1 fig. and 1 pl.); and Arch. Néerland., xxiii. (1888) pp. 82–92 (1 fig. and 1 pl.).

virtual image of the outer opening of the tube on the spot where is the opening of the objective.

The most important part of the lower piece is the mechanism of the two slits, which are independent of each other and lie in the same horizontal plane. The symmetrical movement of the edges is effected, as in the author's microspectral objective and in the spectral apparatus of

Fig. 14.

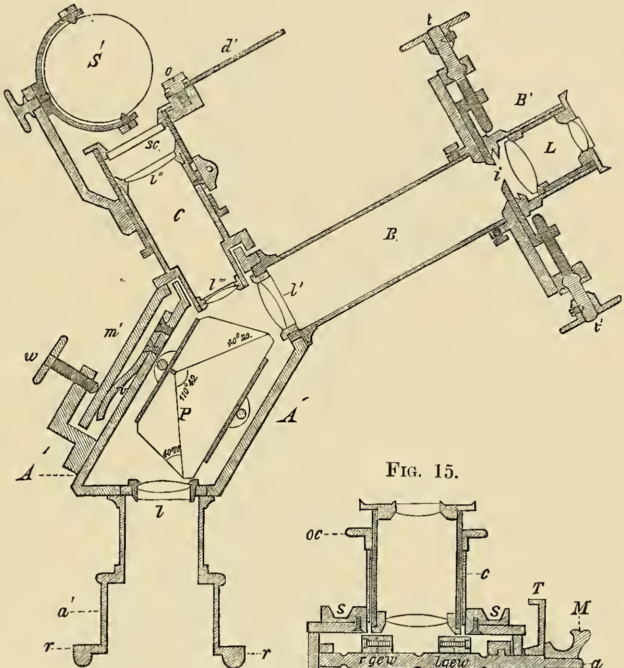
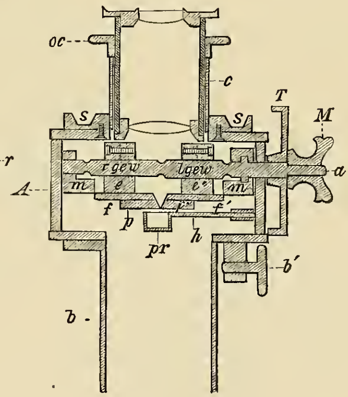


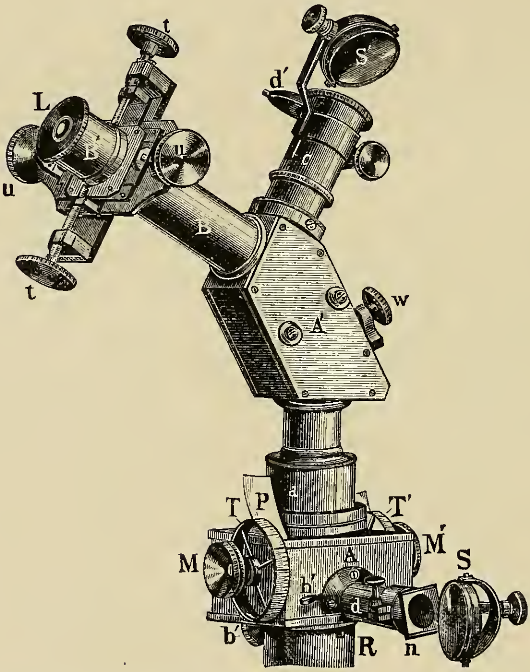
Fig. 15.



Donders, by a single screw which carries two oppositely wound threads. The mechanism of one of the two slits is shown in vertical section in fig. 15. The edges *p* and *p'* are screwed on the blocks *e* and *e'*, which carry companion screws for the screw-threads on the common axis *a*. The screw on *e* is right-handed, that on *e'* left-handed. To avoid back-lash *e* and *e'* are kept apart by a spring not visible in the figure. The axis *a* is firmly fixed on the strong metal frame *m*, so as not to be movable in the direction of its length. Consequently, by rotation of *a*, the edges of the slit separate equally from the unchanged middle of the slit.

The movement of the screw is read off on a divided scale T fixed to the axis, of which 50 divisions, about 1·57 mm. apart, correspond to 100th of a millimetre. The scale readings were controlled by placing the slit apparatus on the stage of the Microscope and measuring the width of the slit with the eye-piece micrometer under a magnification of 500.

Fig. 16.



On loosening the screw M which fixes the scale to the axis, the former can be turned about *a* so as to bring the zero point into position.

The piece of white card *p* seen in fig. 16 is used for the better illumination of the scale.

The mechanism of the second slit, of which only the scale T′ and screw-head M′ are seen in the fig., is exactly similar. In order, in case of accidental displacement of the edges, to bring the middle of the one slit exactly in the line of prolongation of the other, and so insure accurate superposition of corresponding parts of the two spectra, the two edges are fastened by means of two adjusting screws on the plates *f* and *f′* carried by the blocks *e* and *e′*.

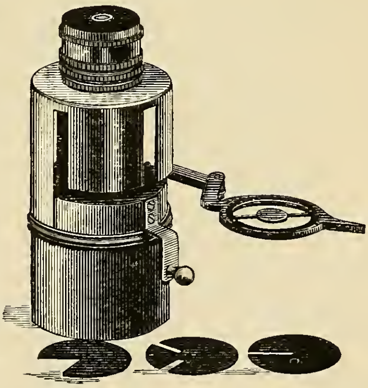
The upper piece, the details of which are shown in vertical section in fig. 14, consists of the box A′ containing the prism system P, which is composed of two prisms of crown glass (refractive index for the yellow rays 1·511, refractive angle 40° 20′) and one of flint (index 1·691, angle 110° 42′). Beneath the box A′ is screwed the collimator-tube *a′*, of which the lens *l* throws the rays coming from the slits parallel upon the prism system. The long axis of the box is at an angle of 30° with both collimator and telescope B. By the objective *l'* of the lattter a real spectrum of the two slits is thrown in the plane *i*, which is observed under a magnification of 20 times by the lens L contained in the tube B'. The apparent magnitude of the spectra thus exceeds by about 4 times that of the spectrum in the microspectral-ocular of Abbe-Zeiss, and by 8 times that of the Sorby-Browning ocular. Projected to a distance of 250 mm., the distance of the Fraunhofer lines *a* and *g* amounts to 185 mm. Except for observations on the extreme red and violet, the intensity when using gaslight is sufficient to allow of the use of the strongest immersion system. With a slit of less than 0·025 mm. the spectrum of the sun's light after passage through two ground glasses showed the D line doubled, with one line clearly broader and darker than the other.

Fitted into a third opening in the prism-box is a second collimator-tube C carrying at *sc* an Angström's scale of wave-lengths (bright lines on a dark ground) which is illuminated by means of a mirror S'. When not in use, a movable screen *d'* is pushed over the opening of C. The light rays from the scale rendered parallel by the lenses *l''* and *l'''* are reflected into the telescope from the end face of the prism system, and an image of the scale is formed by the lens *l'* in the plane *i*.

To obtain the proper position of this image with respect to the spectra, the tube C is movable to a limited extent in the box A', so that the direction of its axis to the end-face of P can be altered. For this purpose, C is fastened to the metallic arm *m'*, which is pressed by means of a spring *v* against the screw *w*. By turning the latter the correct position of C is easily obtained.

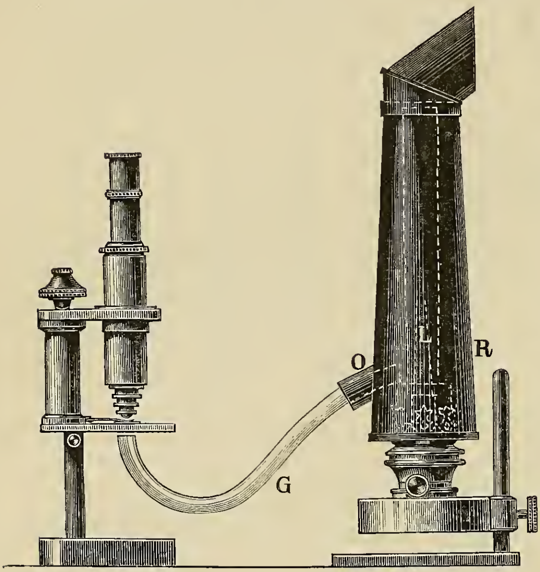
Finally, the tube B is provided with two pairs of diaphragms movable in the plane *i* at right angles to each other. One pair is used in order to limit the spectra to the particular group of wave-lengths under examination. The edges, which run parallel to the Fraunhofer lines, are adjusted by the screws *t* and *t'*. The other pair, movable by the screws *u* and *u'* (seen in fig. 16) serve to make the two spectra of the same breadth, for experience shows that, in order to compare two spectra, they should be of the same form and size.

Fig. 17.



Powell and Lealand's Apochromatic Condenser.—Following upon the extension of the apertures of objectives due to what Prof. Abbe has termed "Stephenson's homogeneous-immersion system," Messrs. Powell and Lealand have brought out the Apochromatic Condenser of 1·4 N.A., shown in fig. 17. This extended aperture involves the employment of a combination of lenses of such large diameter, that it was not found practicable to utilize the usual revolving disc of diaphragms, stops, &c.; hence the application of a pivoting diaphragm-carrier that can be slid up in close contact with the posterior lens of the condenser, the pivoting facilitating the changing of the diaphragms. The carrier is arranged to hold either a series of graduated apertures alone or in combination with a series of central stops, and a few diaphragms are supplied of special forms, such as single or double slots, and single or double circles cut more or less eccentrically, so that a great variety of different kinds of illumination can be obtained.

Fig. 18.



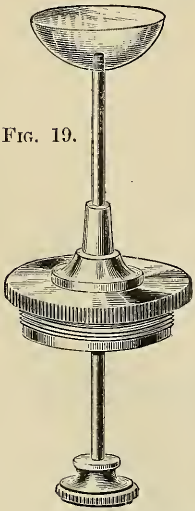
We understand that the sliding arrangement of the tube supporting the diaphragm-carrier, as shown in the figure, was suggested by Dr. Dallinger as being more convenient in use than the system first employed by Messrs. Powell and Lealand, in which the tube was wholly removed for every change in the diaphragms.

Koch and Max Wolz's Lamp.—Fig. 18 shows this lamp in position, when the solid glass rod is used to illuminate a transparent object. The principles of its construction were described at p. 1025 of the last volume of this Journal.

L is the source of light—a mineral oil lamp. Outside the glass chimney is a black one, on the inside of which is a reflector R. At O is an opening fitted with a short tube, in which is fixed the curved glass rod G. The end of this rod is squared off, and lies underneath the stage. The quality of the light may be modified by putting coloured glasses upon the smooth end of the rod.

Although the source of light shown in the illustration is derived from mineral oil, gaslight or other sources can be used.*

Fig. 19.



Adjustable Hemispherical Illuminator.—The Bausch & Lomb Optical Co. now fit this illuminator as shown in fig. 19. The glass hemisphere is attached to an adjustable rod which slides in an adapter screwing on a substage adapter. It is a very convenient accessory in instruments having separate mirror and substage bars, as any number

* Cf. Zeitschr. f. Wiss. Mikr., v. (1888) p. 478 (1 fig.); and this Journal, 1888, p. 1025.

of slides may be used, and any degree of obliquity obtained without disturbing the illuminator.

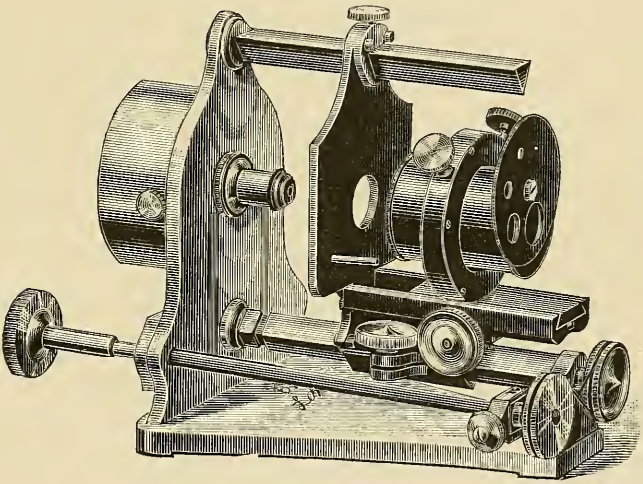
WHELPLEY, H. M.—[Illumination.] *The Microscope*, VIII. (1888) p. 351.

(4) Photomicrography.

Kibbler's Photomicrographic Camera.—This (fig. 20) was devised by Dr. A. Kibbler and carried out in detail by Mr. W. Bailey. It is thus described by the designer.

"The stand consists of a base and an upright, the latter being pierced for the object-glass. At the back of the upright is a shutter for making the exposure and a hood to connect this part of the apparatus with a camera. The connection can be made to any size camera by a simple tube made either of wood or metal and of a length to please the operator. From the lower part of the upright is a rod (firmly supported at the further end by the base) upon which travels the stage with its clamp and screw. The sliding movement of the stage upon the rod serves for a rough adjustment. The fine-adjustment is at the end of the rod and is controlled by a long arm working at the side and connected

FIG. 20.



by a cord. In order that the tension of the cord may be constantly maintained one end of the long arm is made to travel outwards by a tangent screw, the other end working in a ball-and-socket joint to compensate for this lateral movement. At the upper part of the upright is a V-shaped rod upon which the stage also runs. The upper rod tends materially to steady the movements of the stage and is also furnished with a screw which can be used for clamping the position of the stage, after the focusing is accomplished by the fine-adjustment, so that no movement can occur during the process of changing the sensitized plates or exposing. The lower rod which supports the stage and the upper clamping rod are placed as far away from the optical centre as possible in order to prevent any disturbance of the focus from expansion when subjected to a strong heat-producing light.

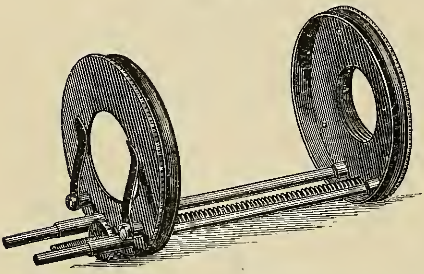
"The substage consists of a tube about 3 inches long with a short-focus condenser at the proximal end and the diaphragm plate at the distal end. It can be moved either backwards or forwards or can be accurately centered by screws which are shown in the woodcut. This particular form of substage possesses, Dr. Kibbler considers, manifold advantages. In the first place the diaphragm plate, being removed to some little distance from the stage and having the short-focus condenser in front of it, is thrown quite out of focus with the object-glass and consequently does not tend in any way to diminish the area of the field, but, on the contrary, produces a general and uniform diminution of light. But what is of still more importance the diaphragm-plate is found in this combination to have developed new functions and acts somewhat similarly to the "stop" used by photographers in the photographic lens. That is, it increases both the area of definition and the depth of focus. Without the condenser the diaphragm-plate, to produce a similar effect, would have to be removed to a distance that would become inconvenient in practice. The condenser obviates this by projecting the diaphragm-plate optically further away by making it still more out of focus and so lessens the distance at which it is necessary to be placed. The condenser also has the effect of converting what otherwise would be a straight pencil of light, into a cone before it reaches the object and transforms it into a more suitable form of illumination for showing the defining powers of an object-glass to the best advantage."

The instrument is made entirely of brass and possesses great stability.

Mawson and Swan's Photomicrographic Apparatus.—This apparatus (fig. 21) is of an extremely simple character and enables an ordinary camera to be used for photomicrography.

It consists of a light metal disc, which can be screwed on the camera front in place of the ordinary lens, the opening in the centre being furnished with the Society screw, so that ordinary microscopic objectives can be readily attached. Upon three horizontal rods projecting from this disc slides another similar disc, also with an opening in the centre, and having a pair of small spring clips for the slide which it is desired to photograph. The third rod is encircled, behind the stage, by a spiral spring, and focusing is effected by turning the screw-nut on the rod, which forces the stage towards the objective, the spring moving it back again when the screw is released.

Fig. 21.



Robinson's Photomicrographic Cameras.—Messrs. J. Robinson & Sons make two forms of cameras which are of an extremely simple character.

The "Student's Micro-Camera" is shown in fig. 22, and is intended for plates $2\frac{1}{8}$ in. × $1\frac{5}{8}$ in. It is made of mahogany, and is fitted to the Microscope by cutting a hole in front and lining it with velvet, the eye-

Fig. 22.

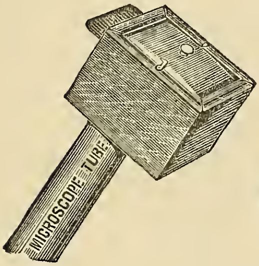
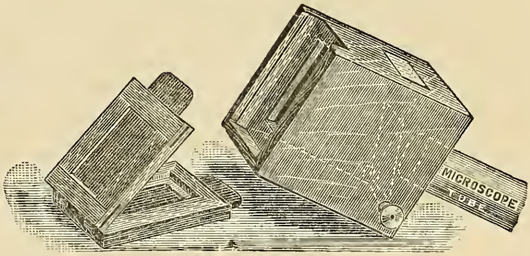


Fig. 23.



piece being removed. After focusing, the camera must be removed from the Microscope to the dark room, where the ground glass is replaced by the plate.

The "Superior Micro-Camera" (fig. 23) has a double dark slide which avoids the necessity of removing the camera from the Microscope during the operation, and the inside shutter (shown by dotted lines in the fig.) enables the exposure to be made more easily without any danger of shaking the apparatus.

Photomicrography with Magnesium Light.*—Dr. E. Roux recommends a magnesium oxyhydrogen light for photomicrography.

Common powered magnesia is mixed up with water to a stiff paste, then stuffed into glass tubes of 4–5 mm. internal diameter. From this it is squeezed out and then cut up into pieces 5 mm. long. These pieces are rolled into balls and stuck on the end of a piece of platinum wire. They are then exposed for three or four hours to a temperature of 100°. They are then first exposed to the hydrogen flame of an oxyhydrogen burner, and afterwards to that of the oxygen. After this treatment they are hard and unalterable in the air.

One of these small pieces of magnesia will last for fifteen hours straight off. The light is uncommonly effectual for photography, and offers the advantage that it illuminates regularly, is not diffusive, and remains fixed to the same point.

Marktanner's Instantaneous Photomicrographic Apparatus.—Dr. G. Marktanner points out that when single individuals out of a great number of moving objects (e. g. fresh blood-corpuscles) are to be photographed, the observer must be in a position, with apparatus ready for the exposure, to wait for the instant when the moving object appears in the field of view. Two conditions are to be noted: that the object during the observation must be only moderately illuminated; and, further, that the observation must be made through a second tube while the body-tube is connected in the usual way with the camera. The latter condition is fulfilled in the Nachet apparatus: it was the consideration of the former which led the author to construct the new

* Photogr. Wochenbl. Berlin, 1888, No. 5. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 497–8.

arrangement, which can be fitted to any photomicrographic apparatus in which Microscope and camera are not rigidly connected.

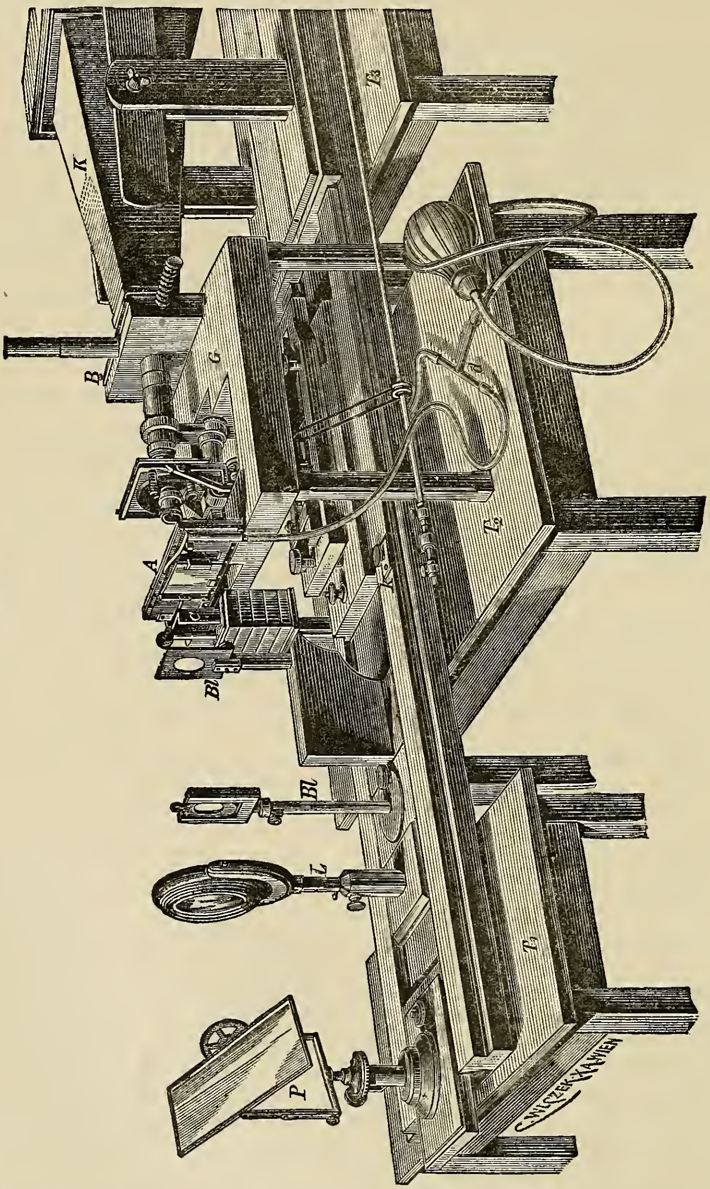


Fig. 24

The apparatus (fig. 24) consists of two instantaneous shutters A and B. The double function of A is to shut out the sunlight during the observation, and during the taking of the picture to allow a momentary entrance of direct sunlight; while that of B is to throw, during the observation, the light from the object by means of a totally reflecting prism into a second tube through which the image can be observed; at the moment of exposure the prism moves to one side, and permits light from the object to enter the camera.

The shutter A, fig. 25, consists of a slide, $5\frac{1}{2}$–6 cm. broad and about 15 cm. long, working between grooves in a wooden or metal frame, and movable by a spiral spring *s*, the tension of which is regulated by the screw *m*. At one side of the slide is a circular or square aperture, over which a smoked or opalescent glass can be placed. Beyond the aperture is an open space of variable breadth of 1–2 cm. Before the slide is released the aperture is in front of a corresponding circular opening of 4–5 cm. diameter in the frame. The release of the slide takes place pneumatically by the knob of the cylinder *c* raising the spring with the catch *r*. This slide is placed behind the diaphragm opening of the Microscope in such a way that the middle-point of the opening in the frame is on the optic axis. The shutter B, fig. 26, provided with brass tubes for connecting it with camera and Microscope, consists of a metal box containing a totally reflecting prism which, during the observation, directs the light from the object into the side tube *t*, and at the same time closes the opening behind leading to the camera. The prism is fixed to a movable slide which is under the tension of the spring *s*, with screw *m*; on releasing it pneumatically, the slide carrying the prism moves to one side and allows light to pass from the tube to the camera.

In order to allow of observation with the eye-piece for different positions of the camera, the author makes the two lenses composing the eye-piece movable, so that the distance between them can be varied within certain limits; the images thus obtained are not quite plane, and have coloured edges, but are otherwise sufficiently well defined.

The two shutters are released together by means of two tubes joined by a three-way piece to a caoutchouc ball. Care must be taken, however, that the shutter B works somewhat quicker or is released sooner than A, so that the light-path to the camera is open during the illumination of the object as the open space *f* in A passes in front of the opening in the frame. This is easily effected for equal tension of the two springs by using a three-way cock instead of merely a three-way piece, and placing the cock in a definite position.

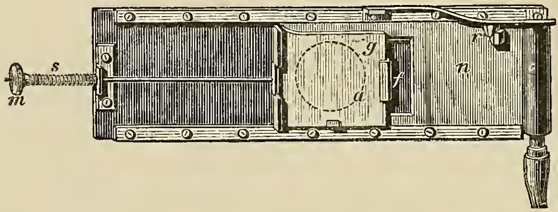
To avoid shaking the whole apparatus, the two shutters are mounted, as seen in fig. 24, on a single separate stand. The shutter B is connected with the camera by Zeiss's method. Somewhat large moving objects (e. g. Daphnida) are placed in cells which just leave room for movement between the two sides.

Sunlight rendered monochromatic by ammonio-copper oxide or Fehling's solution is the light employed for the adjustment. When the objects move too fast for successful adjustment, observation is made of an air-bubble in the cell.

To increase the illumination during the exposure, a condensing lens L of large opening (10 cm.) is inserted in such a position that the object is at its focus, or, if the field of view of the objective is greater than the surface thus illuminated, so that the object is in the converging part of the beam. If, however, the object surface to be illuminated is smaller (by use of a stronger objective), a condenser can be used with the lens, which in this case should not be of too short focal length (at least 30 cm.).

The whole disposition of the instrument is seen from the figure (24), in which *d* is the three-way piece, P the plate mirror, L the condensing lens, B*l* the diaphragms, C the cell, K the front part of the camera, T_1 and T_3 tables on which rests the base-board carrying the camera and

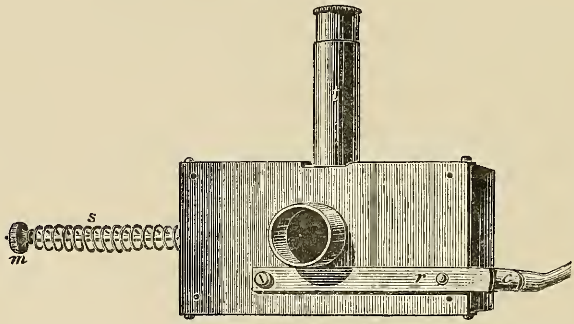
Fig. 25.



optical bank, T_2 the table on which stands the small table G carrying the shutters A and B, and *k* the screw for regulating the tension of the adjustment-cord, which, in this apparatus as in that of Prof. Stricker, works not on the micrometer-screw of the Microscope, but on a second micrometer-screw connected with the stage.

For the adjustment the condensing lens is removed, and the path of the beam of light reflected from the mirror is centered by means of the

Fig. 26.



two diaphragms of equal opening. In the figure is represented the moment when the adjustment is just finished and the lens inserted, but the diaphragm turned towards the mirror not yet replaced by one of wider opening. The latter is chosen of such a size that it cuts off only the zonal edge of the beam, and is situated at such a distance (at least 15 cm.) from the second diaphragm, that the light cone exactly passes through the latter. With a condensing lens of 10 cm. opening and focal length of 33 cm., diaphragm I. (with 70 mm. opening) is distant 62 mm., and diaphragm II. (with 28 mm. opening) 222 mm. from the lens.

As regards the time of exposure, for small crustacea with a magnification of 100 and condensing lens as above of 10 cm. opening, 1/20 of a second is sufficient.

A construction similar to that used in Marey's photographic pistol may be employed to take several successive pictures of moving objects. The same result may, however, be more simply attained by using Janssen's principle, viz. that by quick working of the shutter sharply-defined pictures can be taken on a moving plate, which need not come to rest (as in Marey's apparatus) during each exposure. To this end the photographic plate is pneumatically put in motion (rotation, sliding or free fall) at the same time as the shutters, and the shutter A acts so as to give quick successive illuminations of the object. This is effected by means of a rotating slide, carrying on its periphery 10–12 sector-shaped openings: one opening, viz. that behind the object before the release of the slide is circular, and provided, as above described, with an opalescent glass.

Easy Method for "Photographing" Sections.*—Dr. A. Trambusti says that he has obtained very excellent results from photographing mounted sections in the following simple manner, which is directly derived from De Giaxa's method of reproducing by coarse photography cultivation-plates.†

A small piece of albumenized paper sensitized with silver nitrate is placed on a piece of wood covered with black. To this is clipped on, cover-glass downwards, the slide to be photographed, and this simple apparatus is then exposed to direct or diffuse sunlight until the paper outside the section has become sufficiently black. The paper is then removed to a water-bath in order to remove any excess of silver nitrate and after a little time placed in a bath of chloride of gold. It is next fixed with hyposulphite of soda in the usual way.

Instead of paper sensitized with silver nitrate the author has also tried paper prepared with ferrocyanide. The apparatus arranged as before is exposed until the olive colour is no longer perceived. It is then washed in water. This completes the process. The picture obtained by this method, which is certainly quicker than the other, is of a sky-blue colour.

A score or more of these reproductions may be made in less than an hour.

The author used preparations stained red, and expresses the opinion that the results therefrom are better than with other colours.

Chromo-copper Light-filter.‡—Prof. E. Zettnow says that the copper-chromium filter is very useful for bacteriological purposes, as bacilli stained red, blue, or violet come out quite black on the focusing glass, and therefore a preparation (cover-glass or section) stained with methylen-blue can be photographed with great brilliancy. If sunlight is used and a very concentrated fluid be desired, then the following mixture, diluted afterwards if required, is made:—160 grm. copper nitrate and 14 grm. chromic acid mixed with 250 ccm. of water. For general purposes the following solution in a layer 1–2 ccm. thick is more convenient:—175 grm. copper sulphate and 17 grm. bichromate of potash mixed with 1 litre of water.

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 335–6 (1 pl.).
† See this Journal, 1888, p. 827.
‡ Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 51–2.

Over other yellow or green fluids the copper-chromium filter possesses the advantage of only letting through a very small part of the spectrum; if concentrated, only yellow-green rays from λ 580–λ 560; if diluted, λ 590–λ 545; with great dilution orange rays appear; for these the erythrosin plate possesses very slight sensitiveness.

A filter roughly resembling the foregoing may be made by adding ammonia in excess to a mixture of copper salts and chromate of potash. This, however, only lets through such green rays as the erythrosin plate is but little sensitive to. The maximum and minimum of sensitiveness in the plate lie close together.

It was found that by using the copper-chromium filter combined with mineral-oil light and long exposure the sharpness left nothing to be desired with ordinary objectives up to a magnification of 400. After this difficulties arise which are only overcome by the use of apochromatics, a condenser, and the light-filter.

(5) Microscopical Optics and Manipulation.

Optical Effect of Focusing up or down too much in the Microscope.* —Mr. W. M. Maskell writes that, if when observing *Gonium*, the objective be lowered a very little, so as to throw the alga out of focus, and to see, as it were, beyond its surface, not only do the outlines become blurred and indistinct, but a somewhat curious change of colour is noticeable. The whole plant assumes a green ground colour, the spaces formerly visible between the cells being obliterated, and at the same time an elegant geometrical pattern is produced, with various tints. Four crimson specks appear at about the middles of the four inner cells, and with these as centres four delicate circles of bright yellow interlace each other, the radius of each circle being the distance between two crimson spots. The spots are also connected by narrow bands of lighter red colour. The outer ring of cells appears as composed of pyriform bodies, the points inwards and overlapping, producing thus the semblance of green spokes in the four circles. In each of these cells, on the circumference of the circles, is a crimson spot formed of concentric curves open towards the middle of the plant. By focusing downwards a little more or less the crimson spots or the golden circles may be made more or less conspicuous on the green ground.

If, again, the object-glass be screwed *up*, past the true focus, an entirely different effect is produced. Instead of the whole plant appearing solid, the spaces between the cells are amplified, and the whole colony seems larger and more scattered; and the cells, quite disconnected, are now not green, but yellowish-brown, with a broad darker band encircling each. These effects of colour are noticeable not only with a 1/4 in. objective, but also with the 1/8 in., and they may even be made out with the 1 in., though, of course, not well, as the plant then appears so small.

The author adds, "Of course, I presume that the effects here spoken of are easily explicable: the passage of the light through the semi-transparent green cells, the translucent envelopes, and the empty spaces, producing complementary colours. And in itself the thing is doubtless not of any importance. Yet indirectly it may possess some value, as in a certain kind of way a warning. From the measurements which I have

* Sci.-Gossip, 1888, pp. 248–9 (3 figs.).

been able to make I imagine (my fine-adjustment not being graduated there is no attempt at complete accuracy) that the distance through which the 1/4 in. objective passes from the true focus to the lower position is not more than the 1/150 in.; and from the true focus to the higher position about the same, or rather less. This is accomplished by a very slight turn indeed of the milled head of the fine-adjustment. In the case of *Gonium pectorale* it is usually pretty clear when one has the plant properly in focus, especially as the view of the flagella comes as a guide. But there are many objects as to which it may be supposed that so small a difference as 1/150 in. may not seem to throw them out of focus, whilst in reality they are so to an extent which might cause error. Query: might the striæ of diatoms come under such a category? It is a common thing to hear and read that the appearances of things under the Microscope are not always to be taken as strictly true; and doubtless the microscopists of old days owed some of the queer figures they drew to this cause. The changing colours and form of *Gonium pectorale* as above noticed may perhaps serve a useful purpose, if they warn some young microscopists to be very particular in the observations they make; possibly also some older hands might take a hint."

PENNY, R. G.—**Microscope Objectives—Angular Aperture.**
Engl. Mech., XLVIII. (1888) p. 316.

(6) Miscellaneous.

Death of Dr. Zeiss.—We deeply regret to have to record the death of Dr. Carl Zeiss, the eminent Jena optician, who in conjunction with Prof. Abbe has done so much to advance the practical construction of objectives. His name will for many generations be associated with the most important epoch of Microscopy; the epoch in which the famous diffraction theory of Prof. Abbe was promulgated which revolutionized microscopical optics, to be succeeded by the important suggestion of our late Treasurer, Mr. J. W. Stephenson, which resulted in the homogeneous-immersion objectives first made in 1878, and later followed by the still further advance shown by the construction of apochromatic objectives. In the practical construction of these and the homogeneous-immersion objectives the deceased played a leading part, and whilst it is impossible to exaggerate the services which Prof. Abbe has rendered to microscopy in these matters, he would, we are sure, be the first to admit the invaluable assistance he received from Dr. Zeiss.

The remarks of the President and others on Dr. Zeiss's death will be found at p. 162.

Death of Mr. Zentmayer.—The following is the report of the Committee of the New York Microscopical Society, which was appointed, *more Americano*, to draft resolutions relative to the death of Mr. Joseph Zentmayer:—

"Whereas this Society has received with sorrow the announcement of the death of Mr. Joseph Zentmayer, which occurred at Philadelphia, Pa., on March 28th, 1888, it is hereby

"Resolved:—

"1. That in the death of Mr. Joseph Zentmayer the labourers in the various branches of science employing optical instruments have lost the inspiriting presence and helpful co-operation of an eminently intelligent and successful author, inventor, and mechanician, whose knowledge of optical principles has been attested by his brilliant publications; whose attainments have been recognized by his election to membership in various organizations, and whose mechanical skill and conscientious carefulness are still shown in the large variety of instruments issued from his establishment.

"2. That a record of this action be forwarded to the family of Mr. Zentmayer as a token of our heartfelt sympathy with them in this bereavement."*

American Society of Microscopists.—Meeting of, in 1888.
Amer. Mon. Micr. Journ., IX. (1888) pp. 96–7, 133–4, 153–4, 187–95.
The Microscope, VIII. (1888) pp. 242–3, 275, 377–80.
Queen's Micr. Bulletin, V. (1888) p. 16.
St. Louis Med. and Surg. Journ., LV. (1888) pp. 163–4.

FABRE-DOMERGUE.—**Premiers principes du Microscope et de la Technique microscopique.** (First principles of the Microscope and of microscopical technique.)
viii. and 280 pp., 32 figs., 8vo, Paris, 1889.

Internationalen Ausstellung zu Brüssel, Die wissenschaftlichen Instrumente auf der. (The scientific instruments at the International Exhibition at Brussels.)
[Microscopy only sparingly represented.]
Zeitschr. f. Instrumentenk., VIII. (1888) pp. 394–8.

JAMES, F. L.—**W. J. Lewis, A.M., M.D., F.R.M.S., President American Society of Microscopists.**
[Biographical sketch.] *The Microscope*, IX. (1889) pp. 7–10 (portrait).

[MANTON, W. P., and others.—**Lantern Illustrations of Microscopical Subjects.**]
["We notice that physicians are beginning to avail themselves of the lantern to illustrate their papers on microscopical subjects. At the recent meeting of the American Medical Society, some excellent views of diseased tissues were shown, and we notice that Dr. A. G. Field, of Des Moines, recently entertained the Iowa State Medical Society by a stereopticon exhibition of the microbes mentioned in his paper before that body. This is an excellent method of impressing an audience with the idea that the author of an article knows what he is talking about. We expect to see the lantern commonly used for such purposes in the near future."]
The Microscope, VIII. (1888) p. 207.

Microscope and Adulteration. *Tit-Bits*, XIV. (1888) p. 305.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XLI., XLII., XLIII.
[Attenuated dots and lines. Size of fine threads or of organic particles. Delicate attenuations and anti-diffraction micrometer. Attenuations. Mr. Boys' infinitesimal glass gossamers. The use of a new micrometer gauge (consisting of parallel fibres of spun glass cemented on to a brass plate projecting freely in the field of the eye-piece).]
Engl. Mech., XLVIII. (1888) pp. 325, 389 (1 fig.), 431–2 (7 figs.).

Schott & Gen. in Jena, Neue optische Gläser des glastechnischen Laboratoriums von. (New optical glass from the glass laboratory of Schott & Co., of Jena.)
[Note as to further kinds of glass, principally for photography.]
Zeitschr. f. Instrumentenk., VIII. (1888) pp. 392–3.

STOKES, A. C.—**Microscopical Work for Amateurs.**
[Description of Leeuwenhoek's Microscopes and his work.]
Amer. Mon. Micr. Journ., IX. (1888) pp. 219–23 (5 figs. and 1 pl.).

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* Journ. New York Micr. Soc., iv. (1888) pp. 173–4. Queen's Micr. Bulletin, v. (1888) p. 24 (portrait).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Collecting Diatoms.†—Mr. C. H. Kain, speaking of the bright-brown patches of diatoms frequently seen covering the surface of mud, recommends that they be collected in the following manner.

Half fill a bottle with water. Touch one of the brown patches lightly with the tip of the finger, and the diatoms will adhere; then place the finger over the mouth of the bottle and shake it. The diatoms are, of course, washed off and remain. By repeating this process again and again the water finally becomes quite brown. By the time the collector reaches home the diatoms will have settled to the bottom, and the water may be poured off and the diatoms cleaned. It is worth while to examine under the collecting lens every promising patch of brown mud, for very pure gatherings of quite different species may often be collected within a few feet of each other.

Culture of Unicellular Algæ.‡—Herr V. Jodin has made cultivations of various species of *Protococcus*, *Zygnema*, &c., in artificial media, consisting of solutions of the requisite minerals in distilled water. The most suitable solution is the same as that used by Raulin in his experiments on *Aspergillus niger*. The solution is placed in flasks which are exposed to the light and the carbonic anhydride is renewed in the air of the flasks by an automatic generator. This simply consists of a flask filled with a solution of ferric oxalate, connected with the culture-flask by a bent glass tube passing through the caoutchouc stopper of the latter. The ferric oxalate evolves carbonic anhydride on exposure to light. Under favourable circumstances the crop obtained in several weeks' exposure amounts to 10 grams of fresh algæ or 1 to 2 grams of dried product per litre. These cultivations are well adapted to throw light on the chemical processes taking place in the green cell, since the crops obtained are uniform and homogeneous, and are free from the disturbing influences arising from the differentiation of organs and the migration of proximate principles in the higher plants. The author concludes by stating that the proportion of nitrogen in *Protococcus* varies from 1·43 to 6·67 per cent. of the crop. The conditions of assimilation of this element are still under experiment.

SOYKA, J.—**Ueber Milchreis, einen neuen festen Nährboden.** (On rice-milk, a new solid culture medium.)
Deutsch. Med. Wochenschr., 1888, p. 833.

(2) Preparing Objects.

Reaction of Elastic Fibres with Silver Nitrate.§—Prof. C. Martinotti describes a new method for demonstrating elastic fibres in the various tissues and organs.

Fresh tissue in pieces of 2 to 3 ccm. are placed in a 2 per cent. solution of arsenic acid for 24 hours, but if parts attached to bone are to be

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Bull. Torrey Bot. Club, 1888, pp. 128–31.

‡ Ann. Agronom., xiv. pp. 241–5. See Journ. Chem. Soc., 1888 (Abstr.), p. 1124.

§ Comm. alla R. Accad. di Med. di Torino, 1888, pp. 5–15. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 521–2.

examined (periosteum, tendon, &c.) a 4 per cent. solution warmed to 50° C. is preferable. In this the bones are decalcified. The pieces are next placed for 5–15 minutes in Müller's fluid, and then in the following silver-glycerin solution:—2 grm. of silver nitrate are dissolved in 3 ccm. of distilled water; to this are added 15–20 ccm. pure glycerin. Herein they remain for 24–48 hours. On removal they are quickly washed in distilled water and then transferred to alcohol; therein the excess of silver nitrate is removed. The preparations may be kept in spirit for any length of time. Sections are made under alcohol. In order to prevent any harm from the action of light the sections are immersed for a short time in a 3/4 per cent. solution of salt, and from this at once transferred to absolute alcohol for dehydration. They are cleared up in creosote and mounted in balsam.

Solvent for the Gelatinous Envelope of Amphibian Eggs.*—Dr. C. O. Whitman has found hypochlorite of sodium an excellent solvent for the gelatinous envelope of the amphibian egg. He obtained a 10 per cent. solution, and diluted it with five or six times its volume of water. The eggs are first hardened by heating or by immersion in some preservative fluid, then placed in the Labarraque solution until the gelatinous envelopes are so far dissolved that the eggs may be easily shaken free. They are then washed and preserved in alcohol. This method works perfectly with the eggs of *Necturus*, and has given equally good results with the eggs of the frog. The time required for dissolving the envelope in the case of *Necturus* is about five minutes. Care should of course be taken not to leave the eggs exposed to the solvent longer than is necessary in order to destroy the envelope.

Method of Examining Fragaroides.†—M. C. Maurice gives the following account of the methods adopted in his study of this Ascidian. He found that, owing to the presence of transverse muscles in the gill, the creature contracted too suddenly when treated with picrosulphuric acid, and he used, therefore, the acetic acid method of MM. Van Beneden and Julin. Pure glacial acetic acid (crystallizable) must be used. The colonies were plunged into it entire, and remained there for from 2 to 5 minutes, according to their size. They were then placed in 70 per cent., 90 per cent., or even absolute alcohol at once. By this means the natural appearance was completely preserved. Specimens of which sections were to be made were placed in borax-carmine for from 15 to 18 hours, for it was necessary that the red coloration of the nuclei should be very intense. They were next cleared with hydrochloric acid and washed with 70 per cent. alcohol till the acid had all disappeared. They were then placed in an exceedingly weak solution of Lyons blue made with 70 per cent. alcohol. After remaining in this for from 15 to 20 hours, and being shaken two or three times, they were fixed in paraffin in the ordinary way.

Preparing Fresh-water Bryozoa.‡—Although it is not easy to preserve Bryozoa in the extended condition, Herr M. Vorworn claims to have obtained excellent results with *Cristatella* by means of a 10 per cent. solution of chloral hydrate. The colonies were placed direct in this solution, and though at first they became contracted, they

* Amer. Natural., xxii. (1888) p. 857. † Arch. de Biol., viii. (1888) pp. 220–3.
‡ Zeitschr. f. Wiss. Zool., xlvi. (1887) p. 99 (2 pls. and 9 figs.). Cf. this Journal, 1888, p. 27.

slowly relaxed again, and after a few minutes were so benumbed that they could be placed without harm for 10 minutes in a watery solution of sublimate. The author does not recommend that sublimate should be replaced by alcohol or osmic acid. Borax-carmine was used for staining the animals.

Preparing Tetrastemma melanocephala.*—Mr. A. Bolles Lee used *Tetrastemma melanocephala* for studying spermatogenesis in Nemertines. The best fixative for these preparations was found to be concentrated sublimate solution with the addition of 1 per cent. acetic acid. This reagent showed itself to be superior to osmic acid, chromic acid, and iron chloride, all which kill less quickly, and frequently excite such violent muscular contraction that the contents of the seminal vesicles are greatly altered.

The best staining solution for the sections was an alcoholic hydrochloric acid carmine (100 ccm. of 80 per cent. spirit are boiled with two drops of strong hydrochloric acid and excess of carmine). From this fluid the preparations are transferred to pure spirit, wherein they remain until no more colouring matter is extracted. A good nuclear and double stain is effected by adding a little picric acid to the spirit, the picture thus obtained being sharper than that produced by borax-carmine. As a preliminary to deposition in paraffin, the author recommends cedar oil in place of chloroform. Preparations are best teased out in a 4 per cent. chloral hydrate solution and stained afterwards with Delafield's hæmatoxylin and methyl-green.

Karyokinesis in Euglypha alveolata.†—Dr. Schewiakoff found that the best fixative was Flemming's chrom-osmium-acetic acid, but it must not be allowed to act long, and the animal must be thoroughly washed afterwards. Grenacher's alum-carmine and picrocarmine were the best stains, but picrocarmine must be used with care, as it easily overstains. The animals are then thoroughly washed, and having been passed through spirit of increasing strength and oil of cloves, mounted in balsam or dammar. The foregoing manipulations were carried out in a watch-glass, in which the selected animal was placed. The selection was made by means of a lens magnifying 30 times and a capillary tube.

The nucleus was isolated by Bütschli's method. The animal was fixed to a certain spot by pressure on the cover-glass; this pressure was kept up carefully until the siliceous envelope was broken. A few more taps and a to-and-fro movement of the cover-glass broke up the protoplasm and isolated the nucleus. This procedure was assisted by means of a stream of water added at one side in such quantity that it was at once absorbed by bibulous paper at the other.

Permanent Preparations of Fresh-water Algæ.‡—Dr. L. Klein recommends, for marking the position of any individual example, Schiefferdecker's apparatus.§ This is in appearance and size somewhat like an objective, and can be screwed on to the nose-piece. At its lower end it carries a diamond point, which by aid of a screw can be moved excentrically. When used, the object is first placed in the centre of the field. The nose-piece is then turned round and the tube lowered until the

* Recueil Zool. Suisse, iv. (1888) pp. 409–30 (1 pl.).

† Morphol. Jahrb., xiii. (1887) pp. 193–258 (2 pls. and 4 figs.). Cf. this Journal, 1888, p. 66.

‡ Zeitschr. f. Wiss. Mikr., v. (1888) pp. 456–64.

§ Described in this Journal, 1887, p. 468.

diamond point just touches the cover-glass. By moving the point out eccentrically, a circle may be scratched on the cover-glass with comparative ease. This device can be employed with advantage for algæ mounted in glycerin jelly, but is not to be adopted for wet mounts, because small objects are easily moved out of position.

If several specimens are to be mounted together, the author advises the use of a capillary tube bent at an angle of 120° about 2 cm. from the end of the tube. Then under a magnification of about 100 the desired specimens are sucked up by capillary action, and the process repeated until a sufficient quantity have been obtained.

For collecting Desmidiaceæ the author uses a syringe of the following construction:—A thick glass tube about 2 cm. wide and 30–40 cm. long is closed in front with a cork, through which passes a short fine tube of glass terminating in an opening of 1–2 mm. in diameter. It is advised to have several of these points, and that some should be bent at an angle of 90°, as this angularity is often convenient. The piston is plugged with tow and thread.

Owing to the influence of light on Desmidiaceæ and on Volvociniæ, these objects may be successfully separated if the vessels containing them be exposed to sunlight in such a way that they are protected from the direct rays. In a day or two it will be found that many forms will crawl out of the mud towards the light side, where they may be collected. A pure sample of *Volvox* may be frequently obtained by placing a small quantity of the material in a pipette, and then placing the pipette point end upwards against the window. In a few minutes the Volvociniæ will be found at the top, from whence an almost pure collection can be expelled.

For ringing round preparations mounted in glycerin-gelatin the author advises the employment of amber-lac dissolved in linseed oil. Put on in thin layers it is quite transparent, and allows the use of immersion lenses.

Heydenreich's cement, although it has excellent points, has the disadvantage of requiring to be stained, and the dyes used for this purpose gradually work into the preparation. For completing the fastening down, the author formerly used equal parts of colophonium and yellow wax. To this he now adds to every 10 parts 1–2 parts linseed oil and 1 part of Canada balsam. This is put on warm.

Mounting Fresh-water Algæ.*—Dr. L. Klein mounts fresh-water algæ in glycerin or glycerin-gelatin. The author uses the former for very small objects, and adopts for this purpose the technique proposed by Migula. A drop of 1 per cent. osmic acid is run under the cover-glass, and in ten to twenty minutes afterwards the glycerin. In order not to blacken the oil-drops, &c., the osmic acid is added in as small quantities as possible, and this is best done by blowing it under the cover-glass through a capillary tube. In all other cases the author uses glycerin-gelatin, which, with the proper precautions, is an excellent imbedding material. The object is first hardened by exposing it as a hanging-drop to the fumes of the acid for a few minutes. It is then placed in one or two drops of dilute glycerin, and the surplus having been drained off or the water evaporated, a drop of glycerin-gelatin previously heated in a test-tube is dropped on by means of a fine glass tube. By this device air-bubbles are avoided.

* Hedwigia, 1888, pp. 121–6.

Some objects may be fixed by heating them on the slide up to near boiling-point, instead of using osmic acid.

Preparation of Fungi.*—Dr. G. Istvánffi describes the various modes of preparing fungi for microscopical examination. Preservation in alcohol of 60 per cent. serves for smaller dry fungi, Gasteromycetes (except such as can be preserved dry), most Ascomycetes, the colourless Agaricini and Polyporeæ (but not the *Boleti*), and the Hydnei, Clavariei, Thelephorei, and Tremellini. For the softer Hymenomycetes, alcohol cannot be used. A solution of salt answers better for these; but, with many, only preserves them for a comparatively short time. Pure sodium chloride should be dissolved in freshly boiled water till saturated, then filtered and used at once. The fungus should be completely immersed in it. This answers for many Hymenomycetes and *Pezizæ*. Other preserving fluids are corrosive sublimate of 0·1 per cent., boracic acid of 2 per cent., and a mixture of acetic acid and glycerin. Fungi which are preserved dry should always be washed with a 0·5–1·0 per cent. solution of corrosive sublimate, to destroy bacteria, larvæ, &c.

A convenient mode of making sections is also described, which should be set, in the case of dark-spored species, by an alcoholic solution of mastic or Canada-balsam; in that of white-spored species with gelatin.

Experiments with Chitin Solvents.†—The first experiments of Mr. T. H. Morgan were made upon the eggs of the common cockroach, and the selection turned out to be a most fortunate one. A great many eggs are laid at one time, the whole number being surrounded by a stiff chitinous coat, forming the so-called raft. The solvents used were the hypochlorites of sodium and potassium, recommended by Dr. Looss in 1885.

The most successful experiments on the cockroach's eggs were as follows:—

(1) The rafts were placed, in a fresh condition, in a weak solution of eau de Labarraque (commercial fluid diluted with five or six times its volume of water), and left until the chitinous envelope became soft and transparent. The time varies; if slightly warmed the time is less for the warm solution, perhaps thirty minutes to one hour; but one must go more by the appearance of the chitin than by any definite time. If the embryos are far advanced, they may now be removed from the envelope one by one; if still young, they had better be hardened and cut all together. In both cases the eggs or embryos were next washed for a few minutes in water, and then transferred for an hour to picro-sulphuric acid, then as usual they are passed through the grades of alcohol, 70 per cent., 80 per cent., 95 per cent.

(2) To specimens which have been already hardened and preserved the solvent may also be applied; but in all cases where fresh material is easily obtainable, it should immediately have its chitin softened and then afterwards be preserved. Here the method is somewhat shorter, since the substance has been previously hardened. From alcohol—weak solution—they are put into the Labarraque and softened as above, then passed through water and the alcohols, &c.

* Bot. Centralbl., xxxv. (1888) pp. 343–5, 381–3, 394–5.

† Stud. Biol. Lab. Johns Hopkins Univ., iv. (1888) p. 217, and Dr. C. O. Whitman in Amer. Natural., xxii. (1888) pp. 857–8.

In most cases in which an animal egg or embryo is encased in chitin, the best results have been obtained by straining the sections after they have been cut and fixed to the slide. If the specimen is small, staining *in toto*—after having the chitin softened, or if before this has taken place, after having made an entrance through the chitin with the point of a needle—is equally good. The greatest difficulty, and practically the only one which is met with, is that the Labarraque solution not only attacks the chitin itself, but after a time the soft tissues of the animal—apparently the connective tissue. Where the chitin surrounds the object completely, as is the case with the cockroach's raft, the object can be removed from the solution as soon as the chitin is softened, and before the underlying parts have been attacked. In cases like this the solvent is at its best.

Very often, however, the soft tissues of the animal are exposed in places between the chitin covering. This is well illustrated by the joints of insects' legs, &c., and very frequently these exposed places are attacked before the chitin is completely softened, thus causing the joints, if much handled, to fall apart. By judiciously diluting the solution and taking the parts to be softened from it before the joints are attacked, its application will be found practicable even here.

The greatest difficulty of all is when the chitin is internal, completely surrounded by soft tissue. Better results are obtained here with very dilute solutions—diluted from eight to ten times, or even more. It must be admitted that in this last case the application of the solvent is more doubtful, and of not nearly so much service as in the first and second supposed cases.

Strong solutions, then, had better be used only when the chitin completely surrounds the soft animal parts, and dilute solutions must be used in all cases where these latter substances are exposed. The solution not only softens the chitin, but removes all pigment either in the chitin or in the tissue beneath, and this is at times advantageous.

Bonda's Hardening Method.*—Dr. C. Bonda describes a new hardening process especially adapted to the central nerve-system. It is briefly as follows:—

The material in mass (as for instance the brain of a large dog) is placed for from twenty-four to forty-eight hours in a 10 per cent. aqueous solution of pure nitric acid, whence it is removed without rinsing into a solution of potassium bichromate, made by dissolving one volume of a cold saturated solution of the salt in two volumes of water. The bichromate solution must be replaced in the course of a few hours with a solution consisting of equal volumes of the saturated solution and water. In this the material is left until sufficiently hardened. It is recommended that brain and spinal cord be kept at least eight days in the fluid, and that the temperature be maintained at about that of incubation, or say from 100° to 110° F. The author highly eulogizes the manner in which material thus hardened shows up after staining with hæmatoxylin.

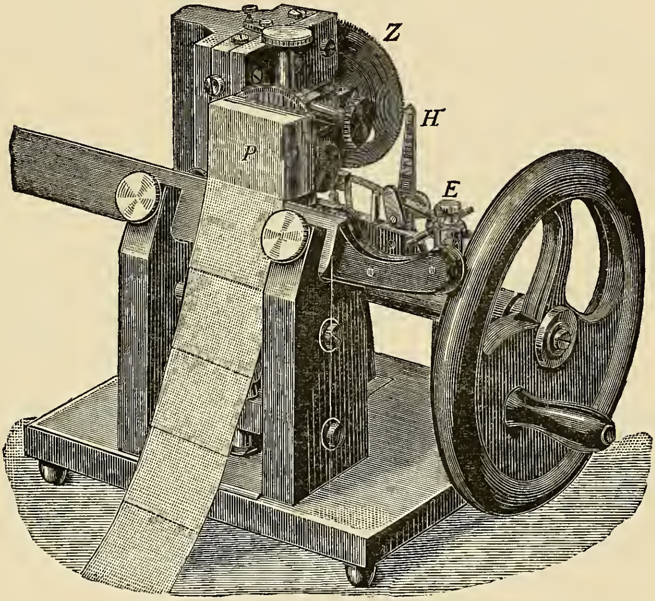
* St. Louis Med. and Surg. Journ., lv. (1888) p. 230, from Centralbl. Med. Wiss.

(3) Cutting, including Imbedding and Microtomes.

Minot's Automatic Microtome.*—The microtome of Dr. Minot is, in the opinion of Mr. J. S. Kingsley, the best of the automatic forms. Equipped with it and a Thoma or Schanze instrument for celloidin sections, any laboratory may be considered as well prepared for any ordinary section work.

In the Minot microtome, the general features of which can be seen from fig. 27, the knife is stationary, while the object is moved. Motion

Fig. 27.

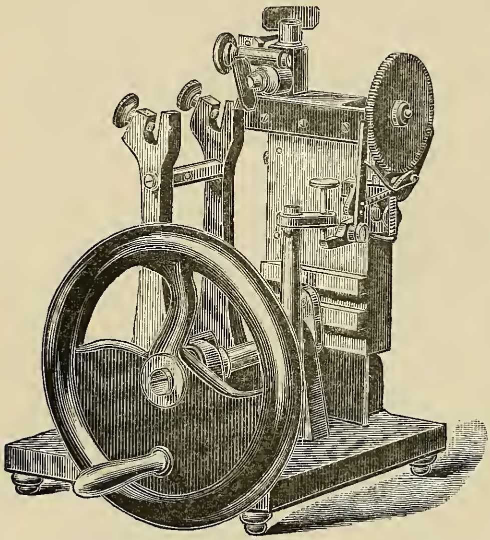


is communicated either by a crank or by a belt to the balance-wheel from a water-motor. Each revolution of the shaft raises and lowers the object-carrier, the section being cut on the downward stroke. The object-carrier is advanced towards the knife when at its extreme height, by means of a micrometer screw placed between the ways on which it runs. This screw has threads 0·5 mm. apart, and the large wheel Z which turns the screw bears 300 teeth upon its margin. This wheel is turned by means of a pall which strikes the upright lever H, seen in the fig., while a set-screw E allows the pall to engage from one to twelve teeth at a revolution. Thus the instrument has a capacity of cutting sections from 0·04 mm. to 0·0033 mm. as desired. The object P imbedded in paraffin is soldered with the same material to one of the section-holders, and this is then placed in its proper socket and clamped.

* The Microscope, viii. (1888) pp. 241–2 (1 fig.); and Zeitschr. f. Wiss. Mikr., v. (1888) p. 474 (1 fig.).

This part of the apparatus is provided with proper clamps and set-screws, so that motion is possible in the three dimensions of space, allowing perfect orientation of the specimen.

Fig. 28.



Mr. Kingsley has used this machine for about three months almost daily, and it has proved itself all that could be expected. It is well-made and simple, and it is an easy matter to cut with it ribbons three feet or more in length, without a break and without losing a single section.

A second view of the instrument is shown in fig. 28.

Plate Modelling Method or Plastic Reconstruction of the Object.*—Prof. G. Born once again attacks this subject in an article of twenty-three pages. At the end he apologizes for the length of his article, but bids his readers be of good courage, for the actual manipulation is not nearly so long as the description.

The method, which has been several times noticed in this Journal, essentially consists in making an enlarged model of the object, from which the sections are taken. The first principles are that no section should be lost, that they should be of the same thickness, and that they should be so marked that when laid together no difficulty should be experienced in applying them one to the other, or in cutting off or out the superfluous parts.

The object is as a rule imbedded in paraffin, and a block thereof made so that the sides are parallel and the angles right angles. Certain marks are intercalated on the block so that their correct position is easily noted. When the sections are cut, the next thing is to draw a magnified image of the object. This is done on sheets of wax, or rather a layer of wax on a sheet of paper. The magnified image is then cut out of the wax-paper, and all the sections having been laid together, an enlarged model of the original object is produced correct in all its details.

This of course sounds very simple, but the difficulty of manipulation is great but not insurmountable. After having imbedded the object very carefully in paraffin, it is laid in its rough state on the orthostat, an instrument shown in fig. 29, O, F. The adjacent part of the apparatus *a b* is then applied, and the outer space filled up with paraffin, so that a roughly rectangular block is produced. But in order to make the sides perfectly flat and level and at right angles, another instrument is required. This is shown in fig. 30, the uplifted arm being a knife and

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 433–55 (4 figs.).

the cut-out oblong the space into which the paraffin block is fitted. When the sides have been accurately pared down they are marked by means of the apparatus shown in fig. 31, which makes a series of holes in one of the planed-down sides. The holes and sides are then stained with soot or any other suitable medium, after which the block is dipped again in paraffin.

For the purpose of plastic reconstruction the author advises that ribbon sections should not be cut, and in order to unroll sections he advocates the use of the apparatus shown in fig. 32. This is essentially an iron table pro-

FIG. 30.

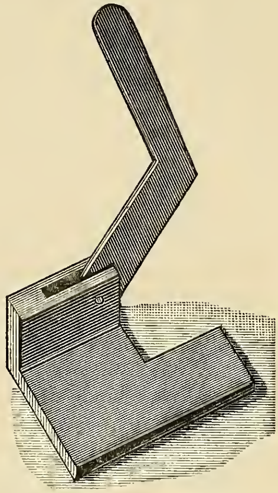
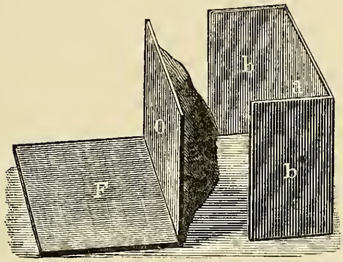


FIG. 29.



vided with a flap coming off at a right angle. Beneath the flap is placed a spirit-lamp, and on the table the section. The position on the table given to the section must of course vary with the heat. It should be so placed that it gently unrolls itself.

With regard to the modelling process it is only necessary to state that the chief difficulty lies in making the wax-paper plates. For this

FIG. 31.

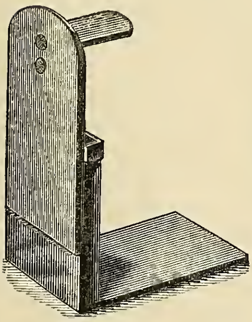
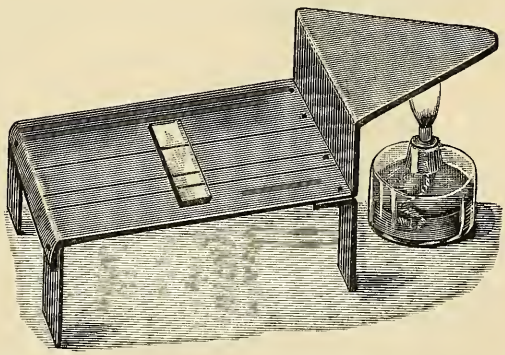


FIG. 32.



purpose are required a lithographer's stone, strips of metal which vary in thickness but not in length and breadth (50 cm. by 1·5 cm.), and an iron roller. The thicknesses given are 0·4, 0·6, 0·8, 0·9, 1, 1·2, 1·5, 1·8, and 2 mm. With such thicknesses if the sections be made 0·015, 0·02, 0·03, 0·04 in thickness, a suitable multiple will always be found. The principle of making the plates consists in rolling out a layer of wax on a sheet of paper, the thickness varying with the size of the model required. Upon the paper has already been drawn the magnified image of the object. Along the sides of the stone are laid two strips of metal; the surface is then brushed over with turpentine, the paper is placed on, and then the wax having been poured over the paper, the roller is used to make a flat and even layer.

When these wax-paper plates are finished, the superfluous parts are cut out, and then they are stuck together so as to produce the magnified model desired. In this last part of course a good deal of manipulative skill is required so that no parts are damaged and that the surface is quite regular.

Cutting Microscopical Objects for the purpose of Plastic Reconstruction.*—Dr. N. Kastschenko has devised two more modifications of his apparatus intended for being adjusted to the object-holder of microtomes, the first of which was described in this Journal, 1887, p. 511.

The original apparatus had for its object to pare down the sides of a paraffin block in such a way that some geometrical pattern might surround the object. This pattern or "definition line" was intended to facilitate the reproduction of the object in a magnified model (plastic reconstruction) from the sections made.

From the author's point of view of course it is important that the definition or boundary surfaces (which on section of the object are seen

Fig. 33.

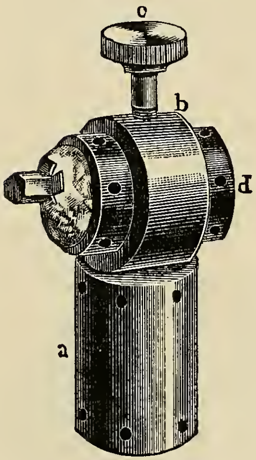
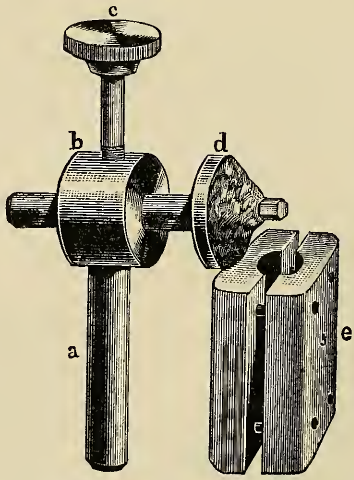


Fig. 34.



as definition or boundary lines) should be perfectly parallel, or at any rate have a fixed and determined position. The apparatus which he advocates is intended to effect this. The first or original model was intended for the Schanze microtome. The two models given above were constructed

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 173–81 (2 figs.).

for the Thoma-Jung, and for the Spengel-Becker microtomes. They are shown in figs. 33 and 34, their natural size.

In fig. 33 is shown the "cutter" or parer, as constructed for the Thoma-Jung object-holder. It may, however, be fitted to any microtome with a cylindrical object-holder. Its construction is extremely simple. It consists of a stout ring *b*, the internal diameter of which is exactly equal to that of the object-holder. The ring is immovably united to the piece *a*, which in its turn is exactly like the paraffin cylinder which fits into the object-holder. In the ring is seen the binding-screw *c*. The paraffin-holder *d*, which fits inside the ring, may be either solid or hollow.

The holes in *d* and *a* are for the purpose of turning round the apparatus. While the object is being pared down the part *a* is fixed firmly in the object-holder, and when the block has had its definition-surfaces thus prepared, it is removed from the cutter and fixed on the object-holder in such a way that it is cut in a direction perpendicular to the surfaces.

The second model, fig. 34, differs very little from the author's original apparatus. In this newer model the stem *a* is straight, instead of being bent at a right angle. This apparatus is intended to be used in any ordinary object-holder, and is of such dimensions that movement in any direction when it is fixed in the clamp is possible. This "parer" fits into the apparatus *e*, which consists of two blocks of wood loosely united by short metal wires. The wooden holder of course fits into the clamp while the block is being shaved down. When the boundary surfaces have been satisfactorily adjusted to the paraffin block, the latter is removed from the "cutter" or parer, and inserted into the wooden holder wherein it is sectioned.

COLMAN, W. S.—**Section Cutting and Staining.** A practical guide to the preparation of normal and morbid histological specimens.
viii. and 107 pp., 6 figs. 8vo, London (Lewis & Co., 136, Gower Street, W.C.), 1888.

(4) Staining and Injecting.

New Stains for Microscopical Purposes.†—Prof. E. Zschokke gives the results of his examination of the following six pigments, which he has used for staining animal and vegetable tissues:—

(1) Benzopurpurin B. An amorphous brown powder, soluble in water, and giving a cinnabar red solution and corresponding stain. It acts very much like acid fuchsin and is much superior to eosin, being unacted on by alcohol, anilin oil, oil of cloves, &c. It makes a good contrast stain to hæmatoxylin, and can be used after Gram's method.

(2) Benzopurpurin 4 B. An orange-red dye, soluble in spirit. The sections should be transferred from spirit to the alcoholic solution of the dye. It stains connective tissue orange. It is little altered by acids or alkalies. It may be used sometimes as a double stain with logwood.

(3) Deltapurpurin. A brownish-red powder, easily soluble in water. Preparations are stained in two minutes a diffuse purple-red. The dye is very stable and not easily extracted. Like the preceding two, it may be used as a contrast stain to hæmatoxylin.

(4) Benzoazurin. A brown powder, easily soluble in water, the

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 465–70.

solution having a blue-violet colour. Strong solutions stain rapidly, and the nuclei are darker than the protoplasm. Alkaline solutions change the blue hue to red, and eventually decolorize the section. Acids, alcohol, and clarifying media do not at all affect the dye. It appears to be a good substitute for hæmatoxylin.

(5) Chrysophenin. A sulphur-yellow pigment, but little soluble in water, easily soluble in alcohol. Preparations stained in an alcoholic solution assume a diffuse yellow colour. It is unaffected by acids and alkalies.

(6) Rhodanin-red and rhodanin-violet. Both are basic dyes, soluble in water and spirit. The stains imparted by their solution are carmine-red and reddish-violet. The pigment is rapidly extracted both by spirit and water. They stain bacteria, but no mordant has been found to fix them.

Of the foregoing six pigments, it will be seen that two are very suitable for histological purposes, viz. benzopurpurin B and benzoazurin.

Carmine Staining of Nervous Tissue.*—Dr. H. S. Upson gives the three following methods for staining nervous tissue after Müller's fluid or alcohol.

(1) The following alum-carmine solution is first made. 1 gram carmine is boiled with 100 ccm. of a 5 per cent. alum solution (rubidium alum is the best). To 5 ccm. of this solution are added 10–20 drops of acetic acid and 1 to 3 drops of molybdo-phosphoric acid, and then filtered. The sections are placed in this mixture for 2 to 10 minutes. or longer, and then carefully washed, dehydrated, cleared up, and imbedded. The axis-cylinders, ganglion-cells, and connective tissues are stained, and the nuclei very clearly.

(2) 5 ccm. of the foregoing alum-carmine solution are saturated with zinc sulphate and filtered. Sections are placed in this solution for 1/2 to 12 hours, and then treated as above. This method gives very good results, especially with peripheral nerves and spinal cord.

(3) 0·06 grm. carminic acid are dissolved in a mixture of 4 ccm. water and 1 ccm. spirit. The sections remain in the mixture for 3 to 10 minutes, are then washed for a short time in water, and are then placed in one of the following mordants for a few minutes. They are then washed in water and treated as before. The action of the mordants produces the following staining:—Dilute acetic acid, a yellowish-red; saturated solution of lead acetate, blue; iron sulphate, black; manganese sulphate, red; nickel sulphate or barium chloride, violet. The longer the tissue has remained in Müller's fluid or spirit the more lasting the stain will be.

Staining Microbes black for Photomicrography.†—Dr. R. Neuhauss stains bacteria black in the following way. Campeachy wood extract is dissolved in boiling water and the solution filtered as hot as possible. After this has stood for at least eight days it is warmed up every time it is to be used. The cover-glass to be stained is boiled in the solution for ten minutes. It is next washed in hot water and afterwards immersed for a long time in a weak solution of neutral chromate of soda. This solution is made by adding, drop by drop, a 5 per cent. soda solution to a weak boiling solution of chromic, and until the liquid gives a neutral reaction.

* Neurol. Centralbl., vii. (1888) pp. 319–21. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 525–6.

† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 484–6.

In order to obtain a deep black the whole process must be repeated three or four times.

The advantages of this black stain are that the negatives of bacteria are extraordinarily sharp and well defined both with sun and artificial light. The details in the bacteria, spores, &c., appear with the greatest clearness. The flagella, too, unstainable with anilin dyes, are stained quite black.

Lastly the preparations do not lose colour.

Nucina as a Staining Agent.*—Prof. N. Léon calls attention to the value of the black substance of "nuts" (Nucina) as a staining agent. Though chemists are, as it seems, still ignorant of its chemical formula, solutions are easily obtained. Nucina has the property of actively differentiating the parts of which cells are composed; it blackens nuclei, bacteria, and the leucites of vegetable cells and easily differentiates the constituent parts of spermatozoa. The aqueous solution is obtained by putting nuts into alcohol; as soon as the spirit becomes green, owing to the solution of chlorophyll, the nuts are carefully washed with water so as to extract the alcohol. 25 nuts were then placed in a porcelain vessel with 500 grams of distilled water, which was boiled till half the water had evaporated. The liquid, after being filtered several times, was boiled afresh with 10 per cent. of alum; the solution has a blood-red colour with direct light. The alcoholic solution is made by boiling nuts in water, removing them, and allowing the water to deposit the black nucina; 100 grams of alcohol at 80° were added for every three grams of nucina. This solution has a black colour; after its use a few drops of hydrochloric acid should be applied to the section.

Baumgarten's Triple Staining Method.†—This method as given by M. A. Lewin consists in the following series of operations:—

(1) After having washed the sections in absolute alcohol, they are placed for 5 minutes in borax-picrocarmine; excess of stain is then removed with blotting-paper. (Borax-picrocarmine is prepared by adding powdered picric acid to a solution of Grenacher's borax-carmine until the fluid assumes a blood-red colour.)

(2) The sections are then plunged for 2 minutes into absolute alcohol to which crystals of picric acid have been added until the spirit resembles hock. This operation is to be performed twice.

(3) The sections are next immersed for 1 minute in Ehrlich's gentian-violet solution. This solution should be freshly made. Excess of stain should be removed with filter-paper. (The gentian-violet solution is prepared by adding 11 volumes of a saturated alcoholic solution of the pigment to 100 volumes of a 5 per cent. solution of anilin oil in water and then filtering.

(4) The sections are next immersed for one minute in a solution of iodine (iodine, 1; iodide of potassium, 2; water, 300); from this they are transferred to absolute alcohol, wherein they remain for 30 seconds.

(5) Excess of gentian-violet is then removed with hydrochloric acid and alcohol (HCl 3; C_2H_6O 97). In performing this step it is necessary to watch the decoloration carefully, as the reaction is very delicate.

* Zool. Anzeig., xi. (1888) pp. 624–5.

† Journ. de Microgr., xii. (1888) pp. 415–6. Cf. Bull. Soc. Belg. Micr., 1887, No. 7.

(6) The preparations are next immersed for 5 minutes in absolute alcohol which has been rendered yellowish by means of a few crystals of picric acid.

(7) The preparations are then cleared up in oil of cloves and mounted in xylol balsam.

By this procedure a triple staining is obtained.

Staining Actinomyces.*—Dr. A. Baránski recommends picrocarmine for staining Actinomyces. A small quantity of the yellow granules or of the pus is spread out on a cover-glass, and having been dried in the air is drawn several times through the flame of a spirit-lamp. The cover-glass is then placed in the picrocarmine solution for 2 or 3 minutes, then washed in water or spirit and examined in water or glycerin. If for a permanent specimen the cover-glass is dried after having been washed and then mounted in balsam. Sections require to stay in the picrocarmine solution 2–3 minutes or longer. In other respects the manipulation is the same. The Actinomyces are stained in various shades of yellow, the surrounding tissue being dyed red.

Method for Distinguishing and Isolating Cholera Bacteria.†—Cholera bacilli, says Dr. O. Bujwid, form a scum on the surface of nutrient media, and this scum consists of a pure cultivation of cholera bacilli. This skin or scum when grown for 24 hours at 37° C. in an alkaline solution containing 1–2 per cent. peptone and 0·5 per cent. of salt resembles very much that formed by *Bacillus subtilis*. Now cholera bacilli give with certain mineral and organic acids, but specially with hydrochloric, a reaction which has been shown to be due to the formation of indol, and of a trace of nitrite. Impure cultivations and also bacteria resembling cholera bacilli also give this reaction, but it is much less intense, and only takes place after a longer time. For example, impure cultivations of cholera in a slightly alkaline 2 per cent. peptone solution, and kept for 24 hours at a temperature of 37° C., do not give any noticeable reaction, while pure cholera bacteria bred under similar conditions give a beautiful purple-red colour with hydrochloric acid. Hence it is possible to ascertain merely by the aid of hydrochloric acid if we are dealing with pure or impure cultivations of cholera spirilla.

It is of importance for the success of this reaction that the peptone should be very good and that the time and temperature limits should be carefully observed, because if cultivated at ordinary temperatures and for longer periods (3 or 4 days) the same result will be obtained with the acid from other bacilli, for example, Finkler's and Miller's. Hence the reaction is not only qualitative but quantitative.

Shellac Injection for the Vessels of the Eye.‡—Dr. Bellarminow has used shellac injection for the vessels of the eye with good results. Yellow shellac is used in a thick spirituous solution. About 1 part of shellac to $1\frac{1}{2}$ parts alcohol are placed in a flask for 24 hours and frequently shaken. The mixture is then heated at 45°–50° for 2–5 hours, and then filtered through two or three thicknesses of gauze. The syrupy filtrate is then stained with cinnabar or Berlin blue, and used for injecting arteries or veins. It will not penetrate the capillaries, and if required for this purpose should not be thicker than cream.

* Deutsch. Med. Wochenschr., 1887, p. 1065.
† Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 494–6.
‡ Anat. Anzeig., iii. (1888) pp. 618–50.

The pigments are first rubbed up with spirit, and having been filtered through gauze, added in the desired proportion to the shellac solution. In 10–12 minutes the injected mass is hard. Syringe and canula must be immersed in spirit previously and carefully washed therewith after injection. After injection the eyes are placed for 24 hours in 0·2–0·3 per cent. chromic acid, and then having been cleaned up with a brush, are washed in running water for 24 hours. The thicker parts and those which retain the pigment are then macerated in eau de Javelle for a longer or shorter time. If allowed to work too long the macerating fluid destroys the walls of the vessels and renders the preparation useless. It is then washed again in running water for 12 to 24 hours, and afterwards, having been mopped up with blotting-paper, it is stretched between two slides and allowed to dry.

Permanent preparations may be mounted dry and ringed round with paraffin or some quick-drying varnish, or may be cleared up in turpentine and mounted in balsam.

Double injection gives very good results, the arteries with cinnabar from the carotid, the veins with Berlin blue from the venæ verticosæ.

Black Injection-mass.*—Prof. A. Letellier advocates the use of a mixture of vanadate of ammonia and tannin as an injection-mass. The advantages of this mixture are that it is black in itself, and does not depend for its colour on solid particles in suspension; that it has no tendency to diffuse outside the vessels into the tissues; that the mass will pass through the finest canula and not block the point; that the walls of the vessels, even when not entirely filled, are stained black; and that when pieces of the injected tissue are placed in spirit the colouring matter is not withdrawn, as vanadate of ammonia is insoluble in alcohol.

The preparation of this injection-mass is extremely simple. Vanadate of ammonia is soluble in warm, and tannin in hot water. The two solutions are kept apart until required for use, when they are mixed in proportion to the tint required.

For the tannin, pyrogallic acid or a solution of nut-galls, made by macerating the bruised galls in cold water, may be substituted.

Technique of the "Corrosion" of Celloidin Preparations.†—Dr. Bellarminow recommends that celloidin sections of the eye injected with Berlin blue should be treated with eau de Javelle in order to destroy the pigment which interferes with the examination. Thick sections are placed for ten to thirty minutes in a solution of sodium carb., calcar. chlor., 12·5 each, water, 100 parts. Thinner sections in a weaker solution. They are then washed in running water for twenty-four hours. Then dehydration, clearing up, and Canada balsam. The celloidin imbedding increases the resistance of the sections to the action of eau de Javelle, consequently this reagent is very suitable for the purpose.

* Bull. Soc. Linn. Normandie, i. (1888) pp. 171–4.
† Anat. Anzeig., iii. (1888) pp. 650–1.

(5) Mounting, including Slides, Preservative Fluids, &c.

Preparation of Type-plates and arranged Groups of Diatoms.*—Mr. K. M. Cunningham says that Mr. R. Getschmann prepares his slides of arranged diatoms after the following method:—

A table is placed before a well-lighted window, and on this are the requisite appliances for work, the chief requisite being a small dissecting Microscope, fitted with simple achromatic lenses, varying in their focal length as the case might require, but a lens of about 1/4 in. focus answering for actual work. Preparatory to beginning a selection of diatoms for the design to be arranged, a quantity of cleaned diatom material is evenly spread over an ordinary slide, this is carefully examined, and from it are selected all the perfect forms likely to be used in a design, and transferred to a cover-glass; all forms of the same shape being grouped together, or arranged in lines for convenience afterwards. If necessary, several cover-glasses can be thus filled with perfect forms, free from cracks or other blemishes, and placed aside, protected from dust, until required. The diatoms are picked out from the spread layer of material by the aid of hair bristles of varying degrees of fineness mounted in a slender wooden handle, and projecting therefrom about a half-inch; the bristle should be straight and, if possible, have a fine taper to a sharp point; this is used with a free and steady hand, and, to facilitate steadiness in picking out, the two arms are rested upon two cushioned blocks of wood, tapering from the level of the stage of the Microscope to their bases on the table. A further indispensable piece is a glass slide, having an area at its centre of about a quarter of an inch, or somewhat less, ruled into minute squares at the rate of about forty lines to the quarter-inch; on this slide, and properly centered, must be placed the cover-glass upon which it is desired to produce the group. The cover-glass is prepared by spreading at its centre a minute drop of liquid gelatin, by means of a little brass spatula, and allowing it to dry. A number of cover-glasses, after having been carefully chosen and thoroughly cleaned, might be prepared, and also set aside for use later. The clear and transparent gelatin should be filtered before use by passing it through suitable filter-paper, so as to prevent all chance dirt from marring the mount. When ready to begin a group, fix the cover-glass centrally over the area of squares by means of three little touches of wax, and then also adjust, close to the same cover-glass, one of the cover-glasses containing the diatoms previously selected for the grouping; or, if necessary, two or more, according to the complexity of the proposed design. With the selecting bristle in the right hand, and the eye adjusted to the lens, bring the glass containing the selected diatoms into the field of view, then carefully select as a centre a perfect disc, say, a *Coscinodiscus*; now shift the gelatined cover-glass into view and deposit the disc at its centre, and carefully adjust it so that its centre shall seem to cover the intersection of a group of the small squares; around the disc, as a centre, adjust a series of small circular forms, spacing them at equal distances from each other. Should it next be desired to introduce a series of slender forms they may be adjusted into position by lining them over the guide lines radiating from the centre of the disc, or through the diagonals of the squares; in this manner proceed until the design is completed.

* The Microscope, viii. (1888) pp. 237–41 (2 figs.).

When the grouping is finally inspected, it is permanently fixed to the gelatin layer by holding the slide on a level, under the mouth, and breathing on it very carefully a few times. This is perfectly reliable and more expeditious than breathing through rubber or glass tubes for the same purpose.

For the purpose of mounting, it is well to have a quantity of cells finished on slides and kept on hand. The slides are centered on the turntable, and shallow cells of black shellac are built up to suit the diameter of the cover-glass to be mounted thereon. This cell is filled with a drop of Canada balsam pressed out of a metal tube. The cover-glass containing the arranged diatoms is now freely immersed in filtered spirits of turpentine, and also flushed with it, so as to expel all air from the diatoms and to clean off all motes or particles that may have lodged upon it during or after preparation of the same. The cover-glass is then set upon its edge to drain off superfluous turpentine, and while it drains gently soften the shellac cell over a spirit-lamp, pick up the cover-glass and gently lay it centrally over the cell, and press firmly into contact with the cell; the slide is then set aside with the cell-side down, and supported on a level, to obviate as much as possible the floating out of place of any of the forms, which are sometimes displaced while drying.

The procedure described above is essentially that followed by the leading preparers, with more or less slight variations as to finish of cells and media used in mounting.

For the arrangement of type-plates of diatoms, the guide-lines and squares ruled on the cover-glass carrier serve to allow the forms to be adjusted in lines and properly spaced with the same ease as in symmetrical grouping. When such beautiful results are produced by simple and inexpensive means, it does not seem to be worth while to attempt this class of work with compound Microscopes, with mechanical fingers and ruled guides set in the eye-piece.

Xylol-dammar.*—M. Martinotti advocates the use of dammar dissolved in xylol as a mounting medium to be preferred to balsam in certain cases. He prepares his solution in the following way:—

Forty grm. of dammar and 40 grm. of xylol are mixed together in a stoppered bottle, and allowed to stand for three or four days at the ordinary temperature. The solution is then filtered. The filtrate, which will amount to about 70 grm., is then evaporated in a water-bath down to about 45 grm.

The object of this concentration is to obtain a solution of the resin in the smallest quantity of xylol possible, just enough in fact to merely dissolve the resin. This concentrated solution becomes yellow, but retains its limpidity. The next step is to dilute this solution with oil of turpentine, by which means the yellowish colour is made to almost disappear.

Kaiser's Gelatin for arranging microscopical preparations in series.†—Dr. A. Poli arranges objects on the slide with Kaiser's gelatin in the following manner:—With a fine brush, just as many daubs are made with the melted gelatin as there are preparations to be mounted, the preparations are then transferred on the brush to the places where the thin layers of gelatin are, slight pressure being used in order to make them stick. Should the preparations not lie in the desired

* Malpighia, ii. (1888) p. 270.

† Ibid., pp. 107–9.

position, the slide may be heated a little, up to 45°, and when rearranged, allowed to cool. Glycerin is then added to the preparation, the cover-glass imposed, and the preparation fixed up in the usual way.

Limpid Copal Solution.*—A limpid and colourless solution of gum copal has long been a desideratum to microscopists, and Dr. F. L. James has spent many hours in trying to obtain one. The following process he found originally in a German journal, 'Der Techniker,' and having given it a fair trial, can say that if a high grade of bright copal is chosen, the product will be perfectly limpid and almost colourless. By sorting the copal, a solution as limpid as water may be obtained.

Dissolve 4 parts of camphor in 48 parts of sulphuric ether and add 16 parts of pulverized gum copal thereto. Cork the flask carefully, and stand aside with occasional agitations until the copal is partly dissolved and partly swollen to its fullest extent. Then add 16 parts of alcohol of 96° and 1 part rectified oil of turpentine, and agitate thoroughly. Let stand with occasional agitations for several days, and at the expiration of a week or so, the contents of the flask will be found to have separated into two layers, of which the lower is rather dark, thick, and possibly dirty, according to the quality of the copal, but above this a layer will be found rich in copal and as clear as crystal itself. The lower layer may be further treated with camphor and sulphuric ether, and afterwards with alcohol, and made to give a still further yield of the crystalline fluid. The only objection to this solution of copal is that it is somewhat brittle when dry. This may be obviated by adding a few drops of purified nut or poppy oil thereto.

Preserving-fluids for Fleshy and Succulent Plants.†—Herr R. Sadebeck recommends for this purpose a 4–5 per cent., i. e. a nearly saturated solution of barium-lead-nitrate, the object retaining its colour in it for one or two months, while the solution itself remains clear. Another good preserving-fluid for similar objects is a solution of corrosive sublimate of a 0·1 per cent. concentration, to which a few drops of hydrochloric acid have been added. Boracic acid does not prevent decay, even in a saturated solution. For Fungi which contain but little soluble matter, a 20 per cent. solution of alcohol may be recommended.

Determining the Thickness of Cover-glasses of Mounted Preparations.‡—Dr. S. Czapski gives the following method for ascertaining the thickness of cover-glasses where the preparation is already mounted. This is very desirable for high powers. The procedure presupposes the possession of some cover-glasses, the thickness of which is known, and that the head of the fine-adjustment screw is divided by radial lines.

The upper and under surface are focused with an objective of 0·6 to 0·9 aperture and central illumination, and the amount of turn given to the fine-adjustment screw noted for each cover-glass; of course it is unimportant whether the exact value of the screw turn is known or not. If the surfaces of the cover-glass do not present any obvious marks to focus on, an artificial one, such as dust or scratches, must be supplied. If the numbers thus obtained be compared with the known real thickness of the covers, a reduction factor is obtained from their quotients, which is available for determining measurements of a similar kind, that is to say for measurements of other cover-glasses with the same objective, ocular,

* St. Louis Med. and Surg. Journ., lv. (1888) p. 231.
† SB. Gesell. Bot. Hamburg, iii. (1887) p. 61. See Bot. Centralbl., xxxvi. (1888) p. 128.
‡ Zeitschr. f. Wiss. Mikr., v. (1888) pp. 482–4.

diaphragm, and tube-length. The focusing differences are always to be multiplied with this factor in order to obtain the true depth (thickness) of the layer.

As an example:—Objective DD Zeiss, diaphragm 8 mm. diameter, tube-length 155 mm., and four cover-glasses, the thicknesses of which, already ascertained, are 0·146, 0·168, 0·187, 0·22. The focusing differences marked by the head of the fine-adjustment screw were 35, 40, 45, 52 divisions. Then the reduction factors in 1/1000 μ are

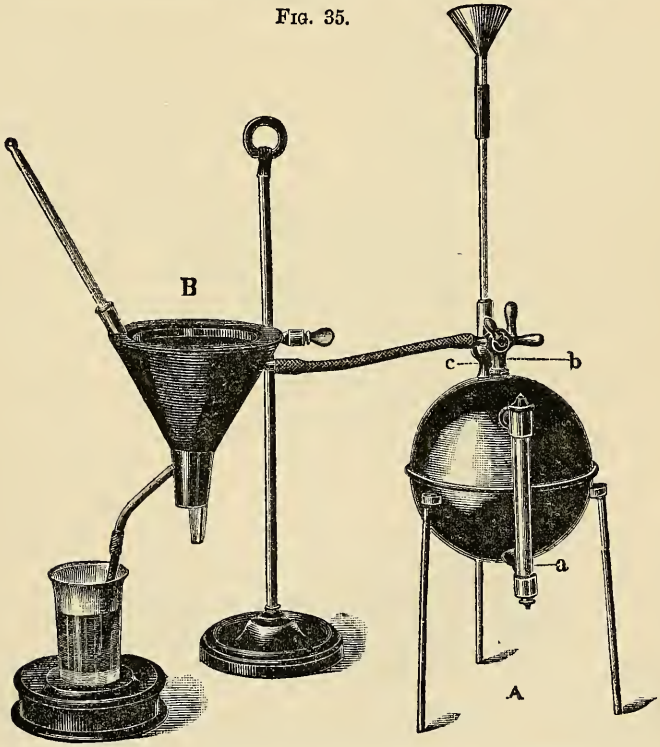
$$\frac{146}{35} = 4{\cdot}17, \quad \frac{168}{40} = 4{\cdot}20, \quad \frac{187}{45} = 4{\cdot}16, \quad \frac{220}{52} = 4{\cdot}23,$$

or on the average 4·19, say 4·2. If the thickness of these cover-glasses had not been known, but the focusing differences had been obtained and multiplied by 4·2, the results would have been 0·147, 0·168, 0·189, 0·218, instead of 0·146, 0·168, 0·187, 0·22. Differences of + 0·001, 0·0, + 0·002, − 0·002; a result more than sufficiently accurate for the purpose.

(6) Miscellaneous.

Garbini's small Steam-generator for Microscopical Technique.*— Dr. A. Garbini describes a small steam-producing apparatus which he

Fig. 35.



uses in microscopical technique, especially where paraffin and gelatin are required.

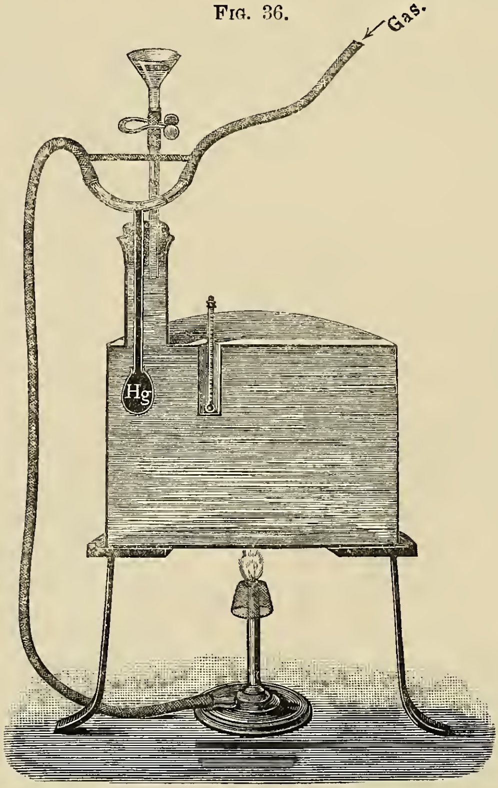
* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 168–71 (1 fig.).

The apparatus (fig. 35) consists of a spherical copper boiler A, supported on three legs, and having a water-gauge *a*, a steam exit pipe *b*, which is fitted with a stop-cock, opening two ways, and a pipe *c*, into which fits a funnel with a very long stem. This serves both for pouring water into the boiler, and also as a safety-valve. The funnel is connected with the boiler by means of a caoutchouc tube. The funnel B is fitted with three tubes, one through which the steam enters, and another through which it passes out. The diameter of the latter is less than half that of the former. The third tube is for a thermometer which is fixed by means of a cork bung.

It is necessary to plug the aperture between the rims of the copper and glass funnels with a piece of flannel in order to prevent the steam from escaping.

Paraffin Oven with simple arrangement for maintaining a constant temperature.*—Dr. E. Sehrwald describes a simple apparatus for heating paraffin, which is easily made and keeps a constant temperature.

FIG. 36.

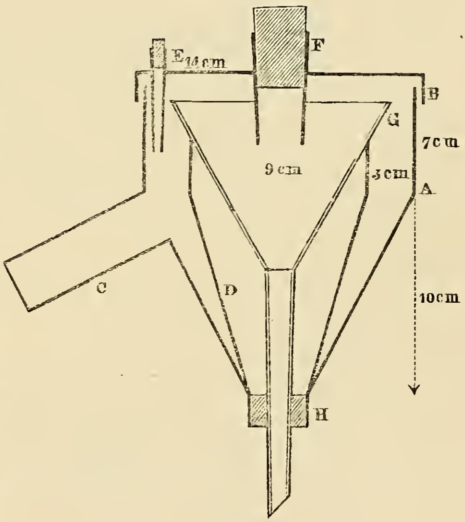


It consists of a copper box (fig. 36), from the top of which ascends a tube for filling with water, and a second smaller one descends for the reception of a thermometer. When the box is filled with water the

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 331–4 (1 fig.).

larger tube is closed with a cork bung, through which pass two tubes. One of these is Y-shaped, and has at its lower extremity a small bag made of vegetable parchment. The arms of the Y are connected by means of a cross tube having a narrow lumen, and the ends of the arms are joined on to a caoutchouc tube through which the gas passes. The effect of this arrangement is that when the water gets hot, the mercury with which the leg and bag of the Y-shaped tube are filled, rises into the Y, and thus shuts off the gas. The stream of gas, however, is still kept up through the narrow connecting tube, and this prevents the light from going out altogether. The second glass tube has a funnel connected by means of a short piece of rubber tubing and forms the arrangement whereby the apparatus is regulated for a given temperature. For when the water begins to get warm it rises up the tube and so into the funnel, the mercury remaining stationary. Directly the desired temperature is reached, a strong clamp is put on the short piece of rubber tubing, and then the mercury begins to regulate the supply of gas for this temperature. If a higher temperature be desired, it is only necessary to remove the clamp and allow the water to ascend until the proper point is reached, and then re-clamp. If a lower one be necessary the clamp is undone, and the gas-jet removed until the temperature has fallen.

Fig. 37.



Stein's Steam Funnel.*—Dr. L. v. Stein has constructed a funnel for facilitating the filtration of gelatin and agar solutions.

The outer funnel A, fig. 37, is made of copper, and has the following dimensions:—Diameter, 14 cm.; height 10 cm.; sides A B, 6–7 cm. The tube for heating it C, is seen at one side. The internal filter D has sides 3 cm. high, its diameter is 9 cm., and its height 10 cm. It is covered with the lid B, into which are soldered the two tubes E and F, both being closed with corks. The filter is filled with water through E, and through F passes the solution to be filtered. In the middle is seen the section of the glass funnel G, the stem of which is fixed tight by the cork bung H.

When required for use, the copper funnel is filled with water as far as A, and a filter-paper placed within the glass funnel. As the steam developes it exerts some pressure on the fluid, since it can only escape through the stem of the glass funnel. In one hour 100 cm. of a thick

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 329–30 (1 fig.).

agar solution can be filtered; while gelatin runs through with the rapidity of water, and the apparatus has the further advantage of sterilizing the solution at the same time that it filters it.

Distinguishing Stains of Human Blood.—We observe that in a recent criminal trial an analyst deposed that human blood-corpuscles could be distinguished from those of some other animals. This opinion was based on the size of the corpuscles.

It has been established by irrefragable evidence, both here and in the United States, that this view is an entire mistake, and it is to be hoped that the person charged in the case referred to will not be convicted and hanged before the error is corrected.

Methods for ascertaining the Number of Atmospheric Germs.*—M. P. Miquel, who has done much for the analysis of germ-laden air, has given up the insoluble "filter" for a plug consisting of a soluble material. This device was suggested twenty-five years ago by Pasteur, and dried Glauber's salt or dried sea salt have been recommended for the purpose. Indeed, any soluble substance, when dry and sterilized, and which does not act antiseptically, is suitable for the purpose; and in solving the problem required, i.e. of ascertaining how many germs were imprisoned in the plugs, it would appear that oscillations of temperature between 0° and 30° made little difference to the plugs.

For the development of germs the necessary conditions are threefold, viz. a suitable medium, a temperature of about 30°, and sufficiently long period of observation (30–40 days). From numerous experiments it was found that peptonized meat broth was far superior to peptonized gelatin as a nutrient medium, only about one-half the germs really existing in the air being developed on gelatin plates.

The author concludes by maintaining that the gelatin-plate method is inapplicable to air analysis in all those cases where the air contains more fungi than bacteria germs.

Method for determining the true Shape of Microscopic Objects.†—Dr. E. Berger uses the following method for determining the shape of the posterior chamber of the eye:—

The objects are imbedded in celloidin on threads placed vertically and set at a distance of 1 mm. The sections are made serially and are marked numerically. The outlines of each section and of the transverse sections of the rows are then drawn with the camera in such a way that the last overlap. Then, if the thickness of the sections be known, the projections, to adopt the phraseology of architects, &c., of the object examined can be ascertained.

The enlargement is found by calculating the distances of the images of two sections, next each other in a row, by means of their true distance, 1 mm. For each enlargement it is easy to construct a scale so that the real size of the object can be read off.

Bessey, C. E.—**Vacation Notes upon some Botanical Laboratories.** [Strassburg, Leipzig, and Berlin.] *The Microscope*, IX. (1889) pp. 5–7.
Brown, F. W.—**A Course in Animal Histology.** V., VI., VII. *The Microscope*, VIII. (1888) pp. 336–7, 375–7, IX. (1889) pp. 12–14.

* Ann. Instit. Pasteur, 1888, p. 346.
† Comptes Rendus Soc. Biol., v. (1888) pp. 215–6.

FORMAD, H. F.—[Liquids for Re-moistening Blood.]
The Microscope, VIII. (1888) pp. 339-40, from *Journ. of Comp. Med. and Surg.*

FREEBORN, G. C.—Notes on Histological Technique.
[Selective stain for connective tissue. Carminic acid. Macerating fluid for nerve-cells. Substitute for cork in imbedding. Application of methyl-green for demonstrating the chemical reaction and death of cells. Making sections of teeth and bone with the preservation of the delicate parts. Easy method of reproducing photographically histological sections.]
Amer. Mon. Micr. Journ., IX. (1888) pp. 231–2, X. (1889) pp. 9–10.

LATHAM, V. A.—Notes on Practical Examination of Muscle-fibres.
The Microscope, VIII. (1888) pp. 330–3.

[MANTON, W. P., and others.]—Reagents in Microscopy.
[Reagents should be "as mild and innocuous as can be obtained, and their effects carefully studied before we draw conclusions as to the structure of the objects examined.] *The Microscope*, VIII. (1888) pp. 246–8.

" " Rudiments of Practical Embryology.
[Celloidine method. Embryos as transparent objects. Labelling. Slide Cabinet.]
The Microscope, VIII. (1888) pp. 334–5, 374–5.

S., D.—A Microscopist's Table. *Engl. Mech.*, XLVIII. (1888) p. 333 (1 fig.).

WHELPLEY, H. M.—Microscopy of the United States Pharmacopœia.
The Microscope, VIII. (1888) pp. 317–8.

WOTHTSCHALL, E.—Ueber die mikrochemischen Reactionen des Solanin. (On the microchemical reactions of solanin.) II.
Zeitschr. f. Wiss. Mikr., V. (1888) pp. 182–95.

PROCEEDINGS OF THE SOCIETY.

Meeting of 12th December, 1888, at King's College, Strand, W.C., Dr. C. T. Hudson, M.A., LL.D., President, in the Chair.

The Minutes of the meeting of 14th November last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Colman, W. S., Section Cutting and Staining. vi. and 107 pp., 6 figs. (8vo, London, 1888)	*The Author.*
Griffith's Patent Turntable	*Mr. E. H. Griffith.*
Lubbock, Sir J., On the Senses, Instincts, and Intelligence of Animals, with special reference to Insects. xxix. and 292 pp., 118 figs. (8vo, London, 1888)	*The Author.*
Whelpley, H. M., Chemical Lecture Notes. 2nd ed., iv. and 211 pp., 102 figs. (8vo, St. Louis, Mo., 1888)	"
Zeiss, C., Special-Catalog über Apparate für Mikrophotographie. 52 pp., 16 pls., and 9 figs. (4to, Jena, 1888)	"

Mr. T. Christy exhibited and described a new device as an attachment to a lamp for use with the Microscope. He met with it in the first instance whilst attending the Medical Congress at Cologne, where it attracted a great deal of attention, and was in such demand by the many German visitors that he found it was quite uncertain how long he might have to wait to get one made. He therefore endeavoured to make one for himself, and had done this by inclosing the chimney of an ordinary lamp in a tin tube, into one side of which, on a level with the flame, a short nozzle was inserted. A piece of solid glass rod, about 5/8 in. in diameter, and bent to the required shape, was fitted into this nozzle by passing it through a perforated cork, the other end of the rod curving upwards under the stage of the Microscope. The light from the lamp entering the end of the glass, and being prevented from emerging by the limiting angle, was totally reflected throughout its entire length, and finally escaping at the extremity below the stage, illuminated the object in a very satisfactory manner; by simply turning the tube the beam of light could be directed upon or through the object in any required direction. He had some difficulty in the first instance in getting any one to undertake its manufacture, from a belief that it was already the subject of an English patent. He found, however, on inquiry at the Patent Office, that although a similar lamp had been made about four years ago, and steps had been taken at that time to secure patent rights, the matter had not been taken up within the time allowed, so that it had now lapsed. The intending patentee had wanted it for the purpose of passing light down the throat and elsewhere for medical purposes, but had given it up in favour of the more convenient electric lamp. He was told that in making it there was a good deal to be worked out, because a special sort of glass was needed to secure the best results. It was found that no advantage arose from covering the outside of the glass with tin-foil or black varnish. The German professors found they could work much more easily with light conveyed in this way, because no stray light from the lamp could enter the eyes, and they had thus the great advantage of working in the dark with a good light on the object. They also found it very convenient to be able, from the same lamp, to furnish light separately to the Microscopes of four or five students sitting round a table.

Prof. Pritchard said he had worked with a lamp of this kind three or four years ago, using it successfully as a light whilst operating in the ear. It looked at first very extraordinary to get light to come through a rod in that manner; but there was no difficulty in explaining how it occurred; because the light once getting into the rod was prevented from getting out again at the sides by internal reflection. There seemed some little difficulty in getting a good light, because of the amount of heat from the lamp, and the necessity for a particular kind of flame. The one he used was lent to him by Messrs. Ash, the dentists' instrument-makers.

Mr. Crisp said the German form of it was described and figured in the Journal just published, at p. 1025.

Mr. Karop said that on looking through the Microscope the illumination of the object was fairly good, but there was too little light for use with any but low powers, and the arrangement entirely precluded the use of the condenser.

The President thought this was a fatal objection to it, because practically for all delicate work one required the condenser constantly going in some form or other.

Mr. C. L. Curties exhibited and described a new form of portable Microscope, intended for the use of medical men. It consisted chiefly in the folding tripod foot adapted to one of Baker's histological Microscopes. The body-tube was of the Continental length, 9 in. closing to 6 in., and there was a centering substage.

Mr. Ahrens' new erecting Microscope was exhibited. In this two right-angled prisms are made use of over the objective, Mr. Ahrens claiming that by this method there was less distortion than when lenses were used for erecting the image (see this Journal, 1888, p. 1020).

Mr. Crisp handed round for inspection a curious little Microscope, in which he remarked that both Science and Art were combined. A seated figure of a monkey held the stage and mirror in its extended hands, a small brass arm screwed to the head of the figure serving to carry the tube (*supra*, p. 113).

Mr. Griffith's description of a new form of camera for microphotography, consisting of a conical wire spiral covered with black cloth, was laid before the meeting (see this Journal, 1888, p. 1031).

Mr. C. L. Curties said he had tried this plan, but found the spiral troublesome to close, as it had a tendency to shoot out sideways. It did not offer much advantage in point of space over the portable bellows camera, which, though extending to 3 ft., could be shut up to 5 in. by 4 in., inclusive of the back.

Mr. H. Jackson's note was read, recommending monobromide of naphthaline as a medium for homogeneous immersion (*supra*, p. 119).

The President said that the Society would regret to hear of the death of Dr. Zeiss, of Jena, which had taken place since the date of their last meeting. He had lived to the good old age of seventy-three years, and was known to many amongst them, though not to himself. But he knew a great deal about his lenses, because it had come to this, that practically he had been obliged to put aside all large-angled English lenses in favour of those of Zeiss's manufacture. For delicate and flat work nothing could be better than the lenses produced by our best English makers; but when they had to deal with an active animal not more than 1/250 in. in length, it was of immense advantage to get that additional focal distance which these foreign lenses afforded. Then another thing in which Dr. Zeiss had departed from the English plan was in not attempting to make screw collars to his high-power objectives, but fixed the combination once for all at a given thickness which his experience found to be the best average working distance. The benefit of this was found at once when a delicate animal of about 1/300 in. was being held in such a way that the slightest pressure would crush it, and perhaps it was also the only one of its kind yet seen. At such a time it was best to have a lens that was fixed, and did not require a troublesome adjustment to be made at the time. Then he found also a further advantage in the fact that this kind of lens admitted of the use of dark-field illumination to a greater extent than our own. Even with the very highest powers some kind of dark field could be obtained, and would show what could not otherwise be made out so well. Some people said that this was only a matter of display; but this was not all, for with many of the Rotifera it was necessary to use this method of illumination in order to obtain a true idea of their structure.

Mr. Crisp said he must add some tribute to the memory of Dr. Zeiss, on account of the great courtesy he had always extended to them as a Society. There was nothing they had ever asked for but they had got it immediately.

Mr. J. Mayall, jun., said he should like to add his testimony also as to the value of the services rendered to microscopy by the late Dr. Zeiss. When he was at Jena some time ago, in discussing with Prof. Abbe the progress that had been made in the Microscope since the introduction of achromatic objectives, his attention was called to the fact that Dr. Zeiss had devoted himself specially in his early days to perfecting the simple or dissecting Microscope, and that he had succeeded in obtaining such large apertures with his doublets and triplets that, in resolving power, they were nearly on a par with the best contemporaneous German compound Microscopes. Prof. Abbe thought the technical skill shown by Dr. Zeiss in the production of these doublets and triplets had led him to neglect for many years the compound Microscope, and hence, probably, to retard the development of the compound Microscope in Germany. Simple Microscopes had been much more in vogue on the Continent than in England until about thirty years ago, and the favour they had met with was largely due, without doubt, to the enormous apertures obtained by certain skilled opticians, notably the late Dr. Zeiss.

Mr. John Rattray gave a *résumé* of his paper "On a Revision of the Genus Auliscus Ehrb. and of some of the Allied Genera" (see this Journal, 1888, p. 861).

The President was sure that all would feel greatly obliged to Mr. Rattray for this communication, for nothing could be more useful than to have these revisions from time to time, embodying as they did all that was known of the particular group dealt with. He thought it was very fortunate that the Society possessed a Secretary and staff who did so much in the way of collecting together and classifying facts in microscopy as was the case. Those who recollected the old 'Monthly Microscopical Journal,' and compared it with the Journal of the Society at the present time, would fully understand the great difference between them and the great advance made.

The President called attention to M. Weber's paper "On Rotifera from the Neighbourhood of Geneva," which he criticized in detail, showing the ridiculous mistakes into which the author had fallen. Amongst other points, M. Weber declared that a structure which the President and others had recorded as having been seen by them (but which M. Weber could not see) had been seen by the eye of faith only! It might, perhaps, be said that more consideration should be shown to the author. He thought, however, that it would be well sometimes to express a little more freely than usual a strong sense of the grievous mischief done by the kind of papers which they sometimes met with upon these and other subjects, in which the want of knowledge and care on the part of the writers led them into a statement of errors of the most remarkable kind, calculated not only to mislead, but to bring discredit upon the investigations of others with whose work they were unacquainted, and upon the branch of science to which the subjects belonged.

Mr. Crisp said that the same mischief which the President had referred to in connection with zoological matters had recently been manifested in a similarly aggravated form in the branch of microscopical optics.

Mr. J. Mayall, jun., said it would be remembered that at the previous meeting a paper by Prof. Govi had been read, in which it was sought to prove that the compound Microscope was invented by Galileo in 1610. Apart from the question as to whether Prof. Govi was justified in regarding the Galilean combination of a convex object-glass and a concave eye-lens as strictly a compound Microscope, he thought the magnifying power obtained by Galileo was probably much exaggerated by the testimony of witnesses who were thus describing their first experience in viewing magnified objects. He did not think it possible to obtain a magnification of 36 diameters by the Galilean Microscope, as stated in one of Govi's quotations. That any one looking through a Microscope for the first time should exclaim that a flea appeared as big as an elephant was matter of common experience; but such random observations were of no value, for in the great majority of cases the actual magnification amounted to 10 or 15 diameters only, such as might be obtained with an ordinary pocket-lens. He questioned the possibility of obtaining a useful magnification of 36 diameters with any Galilean combination, and certainly not with the so-called

Galileo Microscopes in Florence. Prof. Govi's paper had brought to a focus his own desire to examine thoroughly the so-called Janssen Microscope at Middelburg, which he had not been able to do to his satisfaction when it was exhibited at the South Kensington Loan Collection in 1876. Since the previous meeting he had therefore been to Middelburg, and by the courtesy of the curator of the museum (Mr. Fredericks) he had had every facility to enable him to examine and photograph the Microscope, and also the telescope with which it was traditionally associated. Mr. Mayall said the question of the authenticity of these instruments—the possibility of referring their construction to the hands of "Janse"—one of the two or three alleged Dutch inventors of the Microscope and telescope, and whose house is commemorated as having existed against the church wall in 1590 by a tablet on the spot—was a difficult matter on which he could only touch with diffidence. The facts seem to be that in 1866 a member of a well-known family in Middelburg named Sniders presented to the museum two instruments which he designated telescopes, saying they had been in the possession of his family for a long time, and that they had always been considered as made by Janssen. The authorities of the museum requested the late Prof. Harting, of Utrecht University, to examine and report upon the instruments, which he did, explaining, of course, that the smaller one was evidently a Microscope. He (Mr. Mayall) had no difficulty in admitting the possibility of the instruments being of great age. Viewing them with a somewhat experienced eye in the examination of old optical instruments in the various collections in Europe, he thought their design and construction clearly indicated very early forms. It should also be noted that in a quiet, stay-at-home town like Middelburg, where generations of families have occupied the same houses in many cases for two or three centuries, the mere traditional association of the instruments with the name of Janssen would be far more likely to be transmitted truthfully than would obtain, for instance, in London, where the rule was incessant change of people and their surroundings. On the supposition that the instruments were genuine productions representing the types in vogue when they were made, he should unhesitatingly affirm the Microscope to be older than the so-called Galileo Microscopes; while as to the telescope, the built-up iron fixed tube of 14 feet in length, with the funnel-like eye-piece having a few inches range of motion, in which there was probably inserted an eye-lens consisting of a large disc of glass having a small concave ground and polished in the centre of one side, he thought the arrangement all pointed to an extremely primitive type of instrument.

The President thought they were much indebted to Mr. Mayall for his very interesting account of these old instruments. He thought he understood him to say he had seen an eye-lens made of a plate of glass with a concavity in the centre. Was that so?

Mr. Mayall said he had one of that construction in his possession. The telescope had a focus of 30 in. to 40 in., and bore the name IACOB CVNIGHAM, and the date 1661.

The President said nothing was more curious than the different estimates which a number of people or children unaccustomed to make comparisons would make as to the apparent size of any given object—for instance, the moon; one would say as big as a saucer; another, a yard; and so on.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Melicerta tubicolaria.*

Mr. T. Christy:—New Microscope Lamp.

Mr. Crisp:—Ahrens' New Erecting Microscope; Griffith's Photo-micrographic Camera; "Monkey" Microscope.

Mr. Curties:—Portable Medical Microscope.

Mr. J. Mayall, jun.:—Photographs and reproductions of Janssen Microscope.

Mr. Rousselet:—*Asplanchna Brightwellii.*

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. B. D. Loveland, M.D., Thomas F. Smith, F. W. Sutcliffe, Walter H. Tyas, and James H. Veitch; the President of the Nottingham Naturalist's Society was also elected an *Ex-officio* Fellow.

Meeting of 9th January, 1889, at King's College, Strand, W.C., Dr. C. T. Hudson, M.A., LL.D., President, in the Chair.

The Minutes of the meeting of 12th December, 1888, were read and confirmed, and were signed by the President.

The List of Nominations for the Council was read.

Mr. Parsons and Mr. Guimaraens were elected Auditors.

Mr. Karop said he had brought to the meeting and exhibited under a Microscope in the room, a slide showing something, the nature of which he was unable to determine, and should therefore be very glad if any of the Fellows of the Society could help him in the matter. Some years ago he collected a large number of samples of sea-sand, from amongst which he selected and mounted numerous specimens, the chief interest of which was due to the fact that many of the calcareous particles were found to be marked in a peculiar way by the action of fungi or algæ or some other cause. A short time ago he was going through these slides so as to select from them those most worth keeping, when he came across one which was of a very peculiar character. In this the marking showed numerous slender rays which appeared to branch out in all directions, and one which seemed to have touched the cover-glass was turned on one side as if by the contact. Further examination showed that there were several other particles identical with this one, and the questions arose, were they endolithic crystals or were they produced by fungi? If crystals, what of, and how produced, seeing that the particles were mounted in Canada balsam?

Mr. Crisp said the appearance was so exactly like those of a Radiolarian, that one could hardly believe it to be a specimen of crystallization.

The President, after inspecting the specimen, agreed that it looked exactly like a living Radiolarian.

Mr. J. G. Waller said that on examining this specimen he felt quite sure that it did not belong to the same class as any of those of which he had made a collection. His series were all excavations made by fungi in calcareous particles; the one before them differed entirely from these.

Mr. H. Epps exhibited a Culpeper Microscope with wooden base.

Mr. Mayall said this Microscope was an interesting model, but it was not a very uncommon form. By removing the body-tube they had what was known as the old Wilson form of Microscope, which afterwards became so very popular in connection with the heliostat. This was the same form as several examples in the cabinet of the Society. The maker was Edmund Culpeper, a very careful workman, accustomed to ornament his apparatus with engraved patterns. The general style and finish of the instrument were evidently due to his training as a mathematical instrument-maker.

Mr. T. F. Smith said that about three months ago he brought before the notice of the Society his ideas of what he conceived to be the structure of *Pleurosigma formosum;* since that time he had made some further researches upon this diatom and also upon *P. angulatum.* He then stated that he thought *P. formosum* might, on closer investigation, prove to consist of more than three layers of structure, but he had come to the conclusion that there were not more than three. By means of drawings on the board, Mr. Smith further explained his views, and illustrated the subject by the exhibition of numerous photomicrographs as well as by specimens under the Microscope of *P. angulatum*, showing a fine grating hitherto undescribed.

Mr. E. M. Nelson said, though he could add nothing to what Mr. Smith had told them, he thought it was most difficult work to carry out, indeed the difficulty might be understood from the fact that although this diatom had been of all others the most persistently examined, yet the structure described by Mr. Smith had hitherto escaped notice.

The President said no doubt it would be extremely desirable to get at what was the real structure of the diatom valve, but he often thought that, considering the conditions, it might be impossible after all to get at it. He did not profess to be competent to judge on a matter of this kind, but he often met with illustrations in the Rotifera which led him towards that conclusion. He was once greatly struck by the apparent alteration in the striations in the muscle of one of the Rotifera, which he had been very carefully observing and measuring. In watching *Triarthra* he distinctly saw the size of the striæ alter in fineness whilst under observation. Owing to there being parallel layers through which he was looking, the movement of the muscle caused an alteration in their relative positions, and so entirely changed the appearance, as to render all his previous measurements useless.

Mr. Crisp exhibited the Bausch and Lomb Optical Co.'s spirit-lamp, the reservoir of which was facetted instead of globular, so that it might be used in various positions—vertical, inclined, or horizontal. Also Mawson and Swan's photomicrographic arrangement for fixing on the front of an ordinary camera. Also the fitting for the binocular prism of Messrs. Bausch and Lomb, by which the prism instead of sliding was rotated out of the field. Also Falk's rotating object disc for bringing a number of objects in succession under the objective.

Mr. A. D. Michael gave a *résumé* of his paper "On the Special Internal Anatomy of *Uropoda Krameri*," the subject being illustrated by drawings on the board, as well as by coloured diagrams and preparations exhibited under Microscopes in the room (*supra*, p. 1).

Prof. Bell said he had listened with great pleasure to the most interesting paper of Mr. Michael, and in so doing he noted that attention was called to a very curious anomaly in the nomenclature of anatomists with regard to the terminal portion of the intestinal canal. It was the usual practice to call this terminal tube the rectum, although it might, as in the case mentioned by Mr. Michael, receive the Malpighian tubes giving off renal products. But it was also a fact that those very anatomists who were in the habit of teaching students of these subjects in various places, did adopt the nomenclature advocated by Mr. Michael when they came to deal with certain of the Vertebrata. By drawings upon the blackboard it was then pointed out that in the bird, by universal agreement, one portion was called the rectum and the other the cloaca. He regarded the question of name as being in this case of small importance, the really important consideration being that in both cases they had the primitive intestine form. Whether, however, it was called the rectum or the cloaca, he thought it would be well to get the terms into agreement. He noticed that in the diagram there was no body-cavity shown, and inquired if it had been found to exist?

Mr. Michael said that he had not found that there was any special lining of the body-cavity.

Prof. Bell said that was of course very interesting in relation to what was found elsewhere, because there was in the crayfish what was known as cœlom, which was analogous to the body-cavity. If they were to define it in usual terms then they would say there was none either in the crayfish or in the lobster, although what was found seemed to him to be much the same thing only reduced to a minimum.

Mr. Bowman's paper "On the Frustule of *Surirella gemma*" was read.

Count F. Castracane's paper "On the Reproduction and Multiplication of Diatoms" (*supra*, p. 22) was read.

Mr. Crisp explained the changes intended to be introduced, in the current year, in the botanical section of the Journal by Mr. Bennett, in order to bring it into harmony with the most recent views of the classification and terminology of Cryptogams, as embodied in Bennett and Murray's 'Handbook of Cryptogamic Botany.' The Lichenes will be discontinued as a separate group, and included under the head of Fungi; while, on the other hand, the Mycetozoa will be separated from the Fungi, and form an independent group of the first rank. The Protophyta will be divided into two sub-groups: (α) Schizophyceæ, and (β) Schizomycetes. Under the former will be included the Diatomaceæ, hitherto ranked as Algæ; the latter will comprise the Bacteria only, the Saccharomycetes being regarded as a degraded group of Ascomycetes. In terminology, the most extensive change will be the anglicizing of the termination of a large number of terms, such as sporange, antherid, archegone, plasmode, cœnobe, epiderm, &c. For macrosporangium, macrospore, and macrozoospore, the more correct terms megasporange, megaspore, and megazoospore will be substituted. The term spore, and its derivatives zoospore, tetraspore, &c., &c., will be limited to propagative cells of non-sexual origin; while for those reproductive cells which are the result of a process of sexual union, terms will be used compounded of the termination sperm, e. g. oosperm, zygosperm, carposperm, &c.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—(1 and 2) Bausch and Lomb Optical Co.'s Spirit-lamp and fitting for Wenham Binocular Prism; (3) Mawson and Swan's Photomicrographic Attachment; (4) Falk's Rotating Object-disc.

Mr. Karop:—Particle of Quartz (?) sand with radiating lines (crystals?).

Mr. Michael:—*Uropoda Krameri.* Alimentary canal and female reproductive organs *in situ.*

Mr. T. F. Smith:—*Pleurosigma angulatum* showing fine grating.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. W. I. Chapman, Thomas Craig, Rev. James Horn, Alexis A. Julien, Ph.D., Rev. Albert Mann, jun., F. S. Newcomer, M.D., C. W. Plyer, and Henry M. Whelpley.

The Journal is issued on the second Wednesday of
February, April, June, August, October, and December.

1889. Part 2. APRIL. To Non-Fellows, Price 5s.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED,] [STAMFORD STREET AND CHARING CROSS.

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Arthropoda.

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γ. Prototracheata.

δ. Arachnida.

ε. Crustacea.

Vermes.

α. Annelida.

β. Nemathelminthes.

γ. Platyhelminthes.

APERTURE TABLE

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1 \cdot 00$).	*Water* ($n = 1 \cdot 33$).	*Homogeneous Immersion* ($n = 1 \cdot 52$).	White Light. ($\lambda = 0 \cdot 5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0 \cdot 4861\ \mu$, Line F.)	Photography. ($\lambda = 0 \cdot 4000\ \mu$, near Line h.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·741
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·08	..	108° 30′	90° 34′	104,123	112,864	137,158	1·166	·926
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

Table showing the Corresponding Degrees of the Fahrenheit and Centigrade Thermometers.

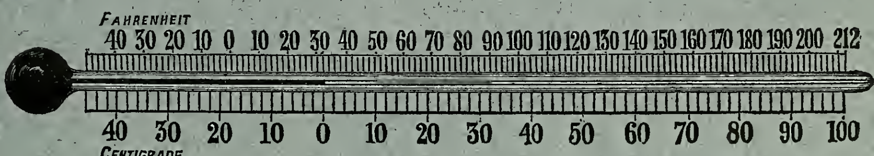
Fahr.	Centigr.
°	°
212	100
210·2	99
210	98·89
208·4	98
208	97·78
206·6	97
206	96·7
204·8	96
204	95·56
203	95
202	94·44
201·2	94
200	93·33
199·4	93
198	92·22
197·6	92
196	91·11
195·8	91
194	90
192·2	89
192	88·89
190·4	88
190	87·78
188·6	87
188	86·67
186·8	86
186	85·56
185	85
184	84·44
183·2	84
182	83·33
181·4	83
180	82·22
179·6	82
178	81·11
177·8	81
176	80
174·2	79
174	78·89
172·4	78
172	77·78
170·6	77
170	76·67
168·8	76
168	75·56
167	75
166	74·44
165·2	74
164	73·33
163·4	73
162	72·22
161·6	72
160	71·11
159·8	71

Fahr.	Centigr.
°	°
158	70
156·2	69
156	68·89
154·4	68
154	67·78
152·6	67
152	66·67
150·8	66
150	65·56
149	65
148	64·44
147·2	64
146	63·33
145·4	63
144	62·22
143·6	62
142	61·11
141·8	61
140	60
138·2	59
138	58·89
136·4	58
136	57·78
134·6	57
134	56·67
132·8	56
132	55·56
131	55
130	54·44
129·2	54
128	53·33
127·4	53
126	52·22
125·6	52
124	51·11
123·8	51
122	50
120·2	49
120	48·89
118·4	48
118	47·78
116·6	47
116	46·67
114·8	46
114	45·56
113	45
112	44·44
111·2	44
110	43·33
109·4	43
108	42·22
107·6	42
106	41·11
105·8	41

Fahr.	Centigr.
°	°
104	40
102·2	39
102	38·89
100·4	38
100	37·78
98·6	37
98	36·67
96·8	36
96	35·56
95	35
94	34·44
93·2	34
92	33·33
91·4	33
90	32·22
89·6	32
88	31·11
87·8	31
86	30
84·2	29
84	28·89
82·4	28
82	27·78
80·6	27
80	26·67
78·8	26
78	25·56
77	25
76	24·44
75·2	24
74	23·33
73·4	23
72	22·22
71·6	22
70	21·11
69·8	21
68	20
66·2	19
66	18·89
64·4	18
64	17·78
62·6	17
62	16·67
60·8	16
60	15·56
59	15
58	14·44
57·2	14
56	13·33
55·4	13
54	12·22
53·6	12
52	11·11
51·8	11

Fahr.	Centigr.
°	°
50	10
48·2	9
48	8·89
46·4	8
46	7·78
44·6	7
44	6·67
42·8	6
42	5·56
41	5
40	4·44
39·2	4
38	3·33
37·4	3
36	2·22
35·6	2
34	1·11
33·8	1
32	0
30·2	- 1
30	- 1·11
28·4	- 2
28	- 2·22
26·6	- 3
26	- 3·33
24·8	- 4
24	- 4·44
23	- 5
22	- 5·56
21·2	- 6
20	- 6·67
19·4	- 7
18	- 7·78
17·6	- 8
16	- 8·89
15·8	- 9
14	- 10
12·2	- 11
12	- 11·11
10·4	- 12
10	- 12·22
8·6	- 13
8	- 13·33
6·8	- 14
6	- 14·44
5	- 15
4	- 15·56
3·2	- 16
2	- 16·67
1·4	- 17
1	- 17·22
0	- 17·78
- 0·4	- 18
- 1	- 18·33
- 2	- 18·89
- 2·2	- 19

Fahr.	Centigr.
°	°
- 4	- 20
- 5·8	- 21
- 6	- 21·11
- 7·6	- 22
- 8	- 22·22
- 9·4	- 23
- 10	- 23·33
- 11·2	- 24
- 12	- 24·44
- 13	- 25
- 14	- 25·56
- 14·8	- 26
- 16	- 26·67
- 16·6	- 27
- 18	- 27·78
- 18·4	- 28
- 20	- 28·89
- 20·2	- 29
- 22	- 30
- 23·8	- 31
- 24	- 31·11
- 25·6	- 32
- 26	- 32·22
- 27·4	- 33
- 28	- 33·33
- 29·2	- 34
- 30	- 34·44
- 31	- 35
- 32	- 35·56
- 32·8	- 36
- 34	- 36·67
- 34·6	- 37
- 36	- 37·78
- 36·4	- 38
- 38	- 38·89
- 38·2	- 39
- 40	- 40



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				No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
		°	£ s. d.					
100	4 inches	9	1 10 0	10	16	30	40	50
101	3 inches	7	1 10 0	} 15	24	45	60	75
102	3 inches	12	2 10 0					
103	2 inches	10	1 10 0	} 22	36	67	90	112
104	2 inches	17	2 10 0					
105	1½ inch	23	2 10 0	30	48	90	120	150
106	⅔ inch	25	2 0 0	} 70	112	210	280	350
107	⅔ inch	32	2 10 0					
108	½ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
112	⅕ inch	120	4 10 0	250	400	750	1000	1250
113	⅛ inch	130	5 0 0	400	640	1200	1600	2000
114	$\frac{1}{10}$ imm.	180	5 5 0	500	800	1500	2000	2500
115	$\frac{1}{15}$ imm.	180	8 0 0	750	1200	2250	3000	3750
116	$\frac{1}{20}$ imm.	180	10 0 0	1000	1600	3000	4000	5000
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		°	£ s. d.			
150	3 inches	6	1 0 0	12	15	27
151	2 inches	8	1 0 0	18	23	41
152	1 inch	18	1 5 0	46	61	106
153	½ inch	38	1 5 0	90	116	205
154	¼ inch	80	1 5 0	170	220	415
155	⅙ inch	110	2 5 0	250	330	630
156	⅛ inch	110	3 10 0	350	450	800
157	$\frac{1}{15}$ imm.	180	6 0 0	654	844	1500

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1889.

TRANSACTIONS OF THE SOCIETY.

IV.—*The President's Address.*

By C. T. Hudson, M.A., LL.D. (Cantab.).

(*Annual Meeting*, 13*th February*, 1889.)

It is no longer possible, I think, for your President to give, as the substance of his Address, a summary of the most important improvements of the Microscope, and of the most remarkable results of microscopical research, which have been recorded in the preceding twelve months.

All this is now so fully and so admirably done in your own Journal, by your energetic Secretary and his able colleagues, that your Presidents will most probably, in future years, have to follow the excellent precedent set by Dr. Dallinger, and choose for the subject of their Addresses some topic directly springing from their own special studies. For, on an occasion like this, each President would wish to give the Society the best he can, and it is clear that this best must be sought for among matters of which he has a special knowledge.

Unfortunately, an accident, which befell me early last year, not only robbed me of the pleasure of being present at several of your monthly meetings, but also produced consequences that compelled me to put my Microscope aside; and, as I had not long before finished my share of the 'Rotifera,' I feared at first that I had lost the power of pursuing any new investigation, just at the very time when I had published the results of all my old ones.

There is, however, still a portion of my subject with which I am familiar, and which, I believe, has not as yet been touched upon by any one; and I venture to hope I may make it interesting to you. It relates to what may be called the foreign Rotifera; that is to say, to those Rotifera which have not as yet been found in our islands. One would naturally like to know what proportion these foreign species bear to the British; whether there are any families or genera entirely absent from the British fauna; whether there appears to be any law of distribution among the Rotifera; and how far it is possible to account for the existence of the same species in places which are thousands of miles apart. But many of the numerous memoirs, from which information on these points is to be derived, are only to be found scattered widely in various European periodicals, and so are difficult to be procured; while, of those that have been published separately, the best are rare.

Under these circumstances I thought it not improbable, that the members of our Society might be glad to know that the task of studying and condensing these memoirs had been in the main accomplished, and that I am able now to present them with some of the results.

In the first place, I made a list of all the known species, and marked against each the various localities in which it has been found. It was curious to see, as the table grew, how certain well-known Rotifera were picked out by their rapidly advancing scores, till at last about fifty typical Rotifera were separated from the rest, while of these a smaller group enjoyed the further distinction of having a very wide range, not only in latitude and longitude, but also in altitude.

The same table showed, at a glance, that Great Britain decidedly outstripped all other countries in the number of its recorded species, having quite two-thirds of the whole. Nor was this all; for the Rotifera seemed, like trade, to follow the flag, and to haunt the British colonies, just as if they were British ships.

The reason for this curious pre-eminence of British Rotifera is clearly seen, when we notice how those species are distributed, which have as yet been found in one country only. There are about 240 such species; and of these no fewer than 173 (that is to say, more than two-thirds) are peculiar to Great Britain. It is of course obvious that this apparent selection of Great Britain as the fatherland of the Rotifera is simply due to the greater energy, industry, and skill with which the search for new species has been pursued in this country. It is, however, very remarkable that the naturalists of Great Britain should in late years have added to the Rotiferous fauna two-and-a-half times as many species, as the naturalists of all other countries put together have done; and this highly honourable result is mainly due to members of your own Society, and especially to my deeply lamented colleague and dear friend, the late Mr. Philip Henry Gosse, F.R.S.

After I had seen how greatly the value of the recorded distribution of the Rotifera was affected by what I may term the "personal equation," I at first feared that I should obtain little else from my tables than a well-merited tribute to the energy of British naturalists. Further inspection, however, showed other points that are well worth your notice.

In the first place, my lists showed that Germany, Switzerland, and Hungary come next in order to Great Britain in the total number of species that each records, and I have only to mention the names of Ehrenberg, Leydig, Cohn, Grenacher, Zacharias, Eckstein, Plate, Imhof, Perty, Bartsch, Vejdovský, Zelinka, not to say many others, to make it obvious that the result is due, not to the real distribution of the species in these countries, but to the comparative skill and industry of their naturalists.

Next, my table shows clearly that in all cases a considerable number, and in some the great majority, of the above-named fifty typical Rotifera, range throughout Britain, France, North and South Germany, Denmark, Switzerland, Hungary, and Russia, so that we may reasonably conclude that a considerable proportion, of the 450 known species, would probably be found in almost any part of Europe, if they were diligently searched for. Here, for instance, is a list of thirty well-known Rotifera, all of different genera, and all recorded in at least five of the above eight European countries:—

Floscularia ornata.
Stephanoceros Eichornii.
Melicerta ringens.
Limnias ceratophylli.
Lacinularia socialis.
Philodina roseola.
Rotifer vulgaris.
Actinurus Neptunius.
Asplanchna Helvetica.
Triarthra mystacina.
Hydatina senta.
Notommata aurita.
Proales decipiens.
Furcularia forficula.
Eosphora aurita.
Diglena catellina.
Mastigocerca carinata.
Rattulus lunaris.
Dinocharis pocillum.
Scaridium longicaudum.
Salpina mucronata.
Euchlanis dilatata.
Cathypna luna.
Monostyla cornuta.
Colurus uncinatus.
Metopidia lepadella.
Pterodina patina.
Brachionus urceolaris.
Anuræa aculeata.
Notholca striata.

Besides, many of the Rotifera are very tolerant of climate, and appear to be able to live anywhere that they can get food. For instance, *Rotifer vulgaris* is to be found all over Europe, and at all heights, thriving under moss near the top of the Sidelhorn, and on the Tibia, at an altitude of 9000 feet above the sea. It has been met with also in Nubia, on the slopes of the Altai Mountains in Siberia, in Ceylon at the top of Adam's Peak, in Jamaica, and in the Pampas of La Plata. *Brachionus pala* has nearly as great a range, for it has been found in many parts of Europe, in Egypt, at the Cape of Good Hope, in Siberia, Ceylon, Jamaica, and New Zealand. Besides these, *Diglena catellina, Hydatina senta, Actinurus Neptunius*, and a few others, have all been met with in different quarters of the globe.

But the distribution of the Rotifera presents us with other facts quite as curious as these. For not only are European species to be found ranging over Asia and Africa; but America, and even Australia and New Zealand, in spite of their ocean belts, possess the same familiar creatures; and, moreover, seem to have hardly any peculiar to themselves. Here, for example, is a list of Rotifera that have been found in Sydney by Mr. Whitelegge, and in Queensland by Mr. Gunson Thorpe, M.R.C.S., of H.M.S. 'Paluma':—

Floscularia ornata.
„ *campanulata.*
„ *chimæra* (n. sp.) T.
„ *cornuta.*
„ *Millsii.*
„ *coronetta* (var.) W.
Melicerta ringens.
„ *conifera.*
Œcistes crystallinus.
„ *Janus*
Limnias ceratophylli.
„ *annulatus.*
„ *cornuella.*
Lacinularia socialis.
„ *pedunculata* (n. sp.) W.
Cephalosiphon limnias.

Trochosphæra æquatorialis; & male, T.
Megalotrocha bullata (n. sp.) T.
Conochilus volvox.
Philodina citrina.
Rotifer vulgaris.
„ *tardus.*
Actinurus Neptunius.
Asplanchna Brightwellii.
„ *Ebbesbornii.*
Polyarthra platyptera.
Triarthra longiseta.
Notops clavulatus.
Notommata centrura.
Copeus pachyurus.
Furcularia longiseta.
Diglena biraphis.
Mastigocerca stylata.
Rattulus lunaris.
Cœlopus tenuior.
Dinocharis pocillum.
„ *triremis* (n. sp.) W.
Scaridium longicaudum.
„ *eudactylotum.*
Diploïs Daviesiæ.
Euchlanis triquetra (var.).
Cathypna luna.
Monostyla lunaris.
Colurus amblytelus.
Metopidia solidus.
Pterodina patina.
Brachionus Bakeri.
Orthurus militaris.
„ *apertus* (n. sp.) T.
Anuræa aculeata.
„ *cochlearis.*
Pedalion mirum.

Who would ever have imagined that in a sea-girt continent, at the opposite side of the globe, in a land whose fauna and flora are so strange as those of Australia, we should find that forty-five out of fifty-two recorded species were British, and that, of the remaining seven, one (*Floscularia Millsii*) had a habitat in the United States?

The United States, too, Jamaica, and Ceylon, all reproduce the same phenomenon, though on a reduced scale, so that the question at once arises, how could these minute creatures, who are inhabitants of lakes, ponds, ditches, and sea-shore pools, contrive to spread themselves so widely over the earth? Take, for instance, the case of *Asplanchna Ebbesbornii*, which till quite lately had but one known habitat, viz. a small duck-pond in a vicarage garden in Wiltshire. The very same animal has been found by Mr. Whitelegge in the Botanical Gardens at Sydney, New South Wales. No doubt in time it will be found elsewhere also; but how, or when, did it pass from the one spot to the other?

That extraordinary spherical Rotiferon, too, *Trochosphæra æquatorialis*, discovered by Dr. C. Semper in the Philippine Islands, had, for the last thirty years, no other known habitat; yet both sexes have been found, quite lately, by Mr. Gunson Thorpe, in the Fern-island pond of the Botanical Gardens of Brisbane.

Again, there is the strange Floscule *F. Millsii*, a Rotiferon apparently linking together the genera *Floscularia* and *Stephanoceros*, and which has been found almost simultaneously by Mr. Whitelegge at Sydney and Dr. Kellicott at Ontario; the possibility of its journeying between two such points seems quite as hopeless as that of *Asplanchna Ebbesbornii's* passing from New South Wales to Wiltshire.

And such cases are numerous. How did *Hydatina senta* and *Brachionus pala* get to New Zealand? or *Notops brachionus*, and *Rotifer vulgaris* to the top of Adam's Peak and the Pampas of La Plata? Again, there is *Pedalion mirum*: since I first found it in a pond at the top of Nightingale Valley at Clifton, it has been met with in four or five other places in England, including a warm-water lily-tank at Eaton Hall, but till quite lately in no other country. Now I have just received a letter from Mr. Gunson Thorpe, telling me that he has found it swarming in a pool on a rocky headland in Queensland.

You have no doubt, long ere this, anticipated the solution of the puzzle; and see clearly enough that living creatures, to whom a yard of sea-water is as impassable a barrier as a thousand miles of ocean, could only have reached or left Australia, New Zealand, Jamaica, Ceylon, &c., in the egg; not the soft, delicately shelled, quickly hatching, summer egg, but the ephippial egg, which is protected by a much harder and thicker covering, which is constructed so as to bear without injury a long absence from the water, and which hatches, so far as is known, some months after it has been laid.

But this explanation still requires to be explained. The case of the free-swimming Rotifera is simple enough. They are most of them to be found, at some time or another, in small shallow pools; and their eggs either fall to the bottom of the water, or are attached to the small confervoid growth on the stones in it. Such pools frequently dry up, leaving the ephippial eggs to wait for the rainy warm weather of next year. Then comes boisterous weather, and the dusty surface of the exposed bottom of the pool is swept by a wind which raises the dust high into the air, ephippial eggs and all. For these latter are minute things, few exceeding 1/300 in. in length, and many even half that size. Once raised in the air, I see no reason why they should not be driven by aerial currents, unharmed, half round the globe, falling occasionally in places where water, temperature, and food are alike suitable. The dust of the eruption at Krakatoa, which gave us such wonderful sunsets and green moons in 1883, travelled from the Sunda Isles to England in three months, and so the ephippial eggs of *Asplanchna Ebbesbornii* and other Rotifera may have traversed the distance from England to Australia, and yet have been capable of hatching at the end of the journey.

It may perhaps seem a fanciful notion to account for the stocking of the ponds at Sydney by eggs carried thousands of miles in the air, but several well-known facts warrant the hypothesis. The tops of our houses, the heights of the Alps, the slopes of the Siberian mountain-ranges, are the haunts of the Philodines; which, being an exceptionally hardy race, have accommodated themselves to living in damp mosses at the edge of a glacier; or in a gutter, which now holds a mere handful of stagnant water, now is a racing current, and now a dusty leaden basin, glowing under a blazing sun. No doubt eggs of all sorts of species fall on the same spots, but only to perish under trials that none but a Philodine could survive.

How various are the species, whose eggs are thus wafted up by the air, has been well shown by Mr. J. E. Lord; who has given a list of no fewer than forty-five species (contained in twenty-nine genera) that he found in the course of twelve months in the same garden-pond. It was, however, admirably situated for catching whatever there was to be caught; for it lay in a flat plot of ground, where there was an entire absence of trees and shade, so that its surface was fully exposed to every wind that blew.

The eggs, of course, must often fall on unsuitable places, and be carried past suitable ones; and this accounts for the capricious appearances of Rotifera in some well-watched pond, and for the frequent disappointments of the naturalists who visit it. To this aerial carriage of the eggs is also due the otherwise perplexing fact, that when any rare Rotiferon is found in one spot, it is frequently found at the same time in closely neighbouring ponds and ditches, even in such an unlikely hole as the print of a cow's foot filled with rain, but not at all in more promising places at some distance off.

Admitting then this fitful shower of eggs as proven, we at once see another way in which they may readily travel to distant lands. For it is quite possible that now and then they may fall on the cargo of an outgoing ship. Here they would lie safely in cracks and creases till, the journey being over, the knocking apart of packing-cases and the shaking of wrappers would set them afloat again, to drop down, it may be, into the Botanical Gardens of Sydney, the shore-pools of Ceylon, or the ponds of Jamaica. In fact these Rotifera would have really done what I have already pointed out that they seemed to do, they would have followed the flag.

The eggs of the tube-makers, however, and of such Rotifera as live only in the clear waters of lakes and deep ponds, present a greater difficulty; for their eggs either lie within their tubes, or are attached to growing weeds, or fall down to a bottom which lies covered all the year round with several feet of water. The wind and sun here cannot be the only means of dispersion. Aquatic birds and insects are probably assisting agents. These, as they swim among the water-plants, must frequently set free the eggs from the tubes of the Rhizota, as well as those which adhere to confervæ, potomogetons, and water-lilies, and so get them attached to their bodies. Then away they fly, carrying the eggs to some far distant lake, or shaking them off into the air with the beating of their wings.

In confirmation of this idea I may mention that the well-known naturalist Mr. John Hood of Dundee, who has added so many remarkable species of Rhizota to our rotiferous fauna, informs me that the Scotch lakes most prolific in new and rare species are those which are visited annually by wild-fowl from the north. Prof. Leidy also informs me that his collector, Mr. Seal, noticed sandpipers haunting the duck-pond where he found an *Asplanchna* very similar to *Ebbesbornii*, and that he thought that "these birds were especially instrumental in distributing the lower forms of aquatic life." I may add also that, on one occasion, I found in a temporary rain-puddle, barely a yard across, a living ciliated ovum of *Plumatella repens*. Of course the puddle itself contained no adult forms, and the ovum must have been brought by some bird the distance of at least half a mile. The twin polypes were already partially developed inside the ovum, and it is curious that so delicate a thing should have borne the transport safely.

Dogs probably play only a humble part in the dispersion of the Rotifera, but they cannot help taking some part in it; by intercepting, as they swim, eggs that are slowly sinking to the bottom; or by brushing off, on to their coats, eggs which have been already caught by the weeds. For the ephippial eggs are frequently armed with hooks or spines, which make them adhere easily to a pond-weed or to a hairy coat, and yet would not prevent a dog's vigorous shake, after his bath, from sending them flying into the air, or on to the dust, where sun and wind would do the rest.

Perhaps one of the most curious illustrations, of this aerial conveyance of Rotiferous eggs, is the account of *Callidina symbiotica*, which we owe to Dr. Carl Zelinka. It was in the depth of last winter that I read his interesting memoir concerning a new *Callidina*, that he had discovered inhabiting the little green cups on the under surfaces of the leaves of a scale-moss (*Frullania dilatata*). As I knew that this plant grew on the elms of our Clifton promenade, I started off at once on the rather forlorn hope of finding some living specimens of the new Rotiferon. When I arrived at the promenade I passed patch after patch of the scale-moss, hoping in vain to find something more promising than the withered, liver-coloured stuff, which alone was to be seen on the tree-trunks. At last I gave up further search, and pulling off a scrap of what looked like old ragged carpet, I carried it home. There I put a bit of it into a watch-glass, covered it with water, and gently teased it out with needles, till I found an under-frond that had some pretension to being green. This I transferred to a glass cell, and placed it under the Microscope with the cups turned towards me; and it was with no little pleasure that, in about a quarter of an hour, I saw first one *Callidina* and then another stretch its proboscis out of a cup, unfurl its wheels, and begin to feed.

No wonder that these *Philodinidæ* are to be found everywhere when they can bear to be frozen alive in the cell of a plant, or roasted by a midsummer sun in a leaden gutter.

Some chance breeze must have first wafted a *Callidina's* egg on to the scale-moss, just after a shower, when the whole plant was wet, and the little green cups were filled with water. The young *Callidina*, when hatched, could not have desired a better home. The rainfall, on an elm, flows down its furrowed bark in tracks as constant as those of a river and its tributaries; and the growth of the Jungerman follows these tracks. Every shower fills the spaces between its flat layers of overlapping leaves with water; and the lower layers, sheltered by the upper, retain for a long time water enough for the *Callidina* to creep about or swim in. And when at last the sun and air have dried up the water, the creature retreats into its green cup, which presents so small an aperture to the air, and is so fenced round with thick juicy cells, that the contained water is almost certain to hold out till the next shower. If it does not, the *Callidina* is still content; it becomes conscious of the coming crisis, draws in its head and foot, rounds its trunk into a ball, secretes round itself a gelatinous covering, and waits for better times.

But the Rotifera owe their wide dispersion not only to the ease with which their eggs are blown from one place to another, but also to their powers of endurance, and to their marvellous capacity for adapting themselves to new surroundings. A Philodine may say with Howell, "I came tumbling out into the world a true cosmopolite." I have already noticed how the *Philodinidæ* will endure such extremities of heat, cold, and dryness as Nature inflicts on them; but she does not put their full powers to the test; for, when time is given to them to don their protective coats, they can bear a heat gradually advancing to 200° Fahr., or a 50 days' exposure to a dryness produced over sulphuric acid in the receiver of a good air-pump. Ehrenberg tells us that whereas he killed *Volvox globator* with one electric shock, it took two of the same intensity to kill *Hydatina senta;* and that *Rotifer vulgaris* will swallow laudanum and "yet be lively;" adding that a solution of Cantharides seemed "to give it new life." The same irrepressible creature will flourish in water containing a perceptible quantity of sulphuric acid; while *Asplanchna priodonta* will swim about actively for twenty-four hours in a weak solution of salicylic acid; and *Synchæta pectinata* will do the same in chromic acid. The great majority of the fresh-water species die when dropped into sea water, but some will bear sudden immersion in a mixture of one part sea water to two fresh. We should not be surprised, therefore, to find not only that there are thirty-four known marine species of Rotifera, but that seventeen of these species are to be met with alike in salt water and in fresh.

The following is the list of Rotifera found in salt or brackish water; those marked wlth a star are also the inhabitants of fresh water.

*Floscularia campanulata.**
*Melicerta tubicolaria.**
*Rotifer citrinus.**
Synchæta Baltica.
" *tremula* (?).*
Pleurotrocha leptura (?).*
*Notommata Naias.**
*Proales decipiens.**
*Furcularia forficula.**
" *gracilis.**
" *Reinhardti.*
*Diglena catellina.**
" *grandis.**
Distemma raptor.
" *marinum.*
Rattulus calyptus.
Monostyla quadridentata.
Colurus amblytelus.
" *caudatus.**
" *dactylotus.*
" *pedatus.*
" *uncinatus.**
Mytilia Tavina.
Pterodina clypeata.
*Brachionus Bakeri.**
" *Mülleri.*
*Notholca striata.**
" *spinifera.*
" *inermis.*
" *scapha.**
" *thalassia.*
*Anuræa valga.**
" *biremis.*
Hexarthra polyptera.

Although this is, doubtless, a very imperfect list, still it is sufficient to show how these fresh-water animals are slowly spreading into the tide pools on the sea-shore. Some may have commenced their change of habitat in the field drains, which are periodically invaded by the brackish waters of a tidal river. It was precisely in such a locality that I first found *Brachionus Mülleri*, in water only faintly salt, and at a height of 30 feet above the Severn. Ditches of this kind are to be found all down the Avon, from the highest point that the tide reaches to its mouth. As they approach the Severn, their water becomes more and more brackish, and the preponderance of marine species in them more pronounced; so that it is easy to see how the descendants of a fresh-water Rotiferon, passing slowly down the river-side from ditch to ditch, may, in course of many generations, come to endure the sea itself.

In other cases the air-borne eggs may have dropped into the pools, of every degree of brackishness, which usually skirt the shores of our river estuaries. It is in such places, on the Scottish shore, that Mr. John Hood has found so many new marine species; and where no doubt so many more are yet to be found.

But the most noteworthy point about the above list is that the number of distinct genera is so great. One would rather have expected to find but four or five genera hardy enough to endure salt water; and yet here are no fewer than nineteen genera for the thirty-four known marine species; and, of these latter, seventeen species are yet in the transitional state, inhabiting alike salt waters and fresh. Still more curious is it to find that all the four orders are represented and that *Rhizota, Bdelloida*, and *Scirtopoda* have each furnished a contingent to the marine forms, as well as the more frequent *Ploïma*. It is, of course, rather startling to hear that *Melicerta* and *Floscularia* are to be found inhabiting sea water; but I know of no reason why any doubt should be thrown on Dr. Weisse's record of having so found them on the sea-shore at Hapsal.

The capacity of the Rotifera, for adapting themselves to new surroundings, is shown by a mere enumeration of the strange places in which they are found. For these fresh-water creatures, the common inhabitants of lakes and ponds, are to be found in brackish ditches, sea-pools, the mud of ponds, the dust of gutters, in tufts of moss, on the blades of wet grass, in the rolled-up leaves and in the cups of liverworts, in the cells of *Volvox*, the stems and sporangia of *Vaucheria;* in vegetable infusions; on the backs of *Entomostraca*, on their abdominal plates, on their branchial feet; on fresh-water fleas, wood-lice, shrimps, and worms; in the viscera of slugs, earth-worms, and Naiades; and in the body-cavities of *Synaptæ*.

But the great variability of every part of the external and internal structure of the Rotifera, points to their fitness for playing the parts of cosmopolites. See how, in *Floscularia* and *Stephanoceros*, the head and its appendages are so developed that they dwarf all the rest; how in *Apsilus* the trunk predominates; while in *Actinurus* both head and trunk become appendages of a huge foot. The corona diminishes continually from the large complex organs of *Melicerta, Hydatina*, and *Brachionus*, down to the furred face of *Adineta* and the tuft of *Seison;* and vanishes altogether in *Acyclus*. The antennæ can be traced from long infolding or telescopic tubes, furnished with setiferous pistons, special muscles and nerves, through a succession of shorter and simpler structures till they become mere pimples, or even setiferous pits in the body-surface. The skin is hardened into a perfect lorica in *Brachionus;* is partially hardened in *Dapidia;* is merely tough in *Mastigocerca;* and is soft and quite unarmed in *Notommata.* The appendages of the body in *Pedalion* rise almost to the dignity of crustaceous limbs, for they have joints, and are worked by opposing pairs of muscles, passing across their cavities from point to point. In *Asplanchna* these appendages become stumpy projections; and the muscles, though still passing freely across the body-cavity, are reduced to threads. In *Triarthra* the appendages become chitinous spines; and at last, when we reach *Adineta, Taphrocampa,* and *Albertia,* we find that we have passed from a Rotiferon closely resembling a Nauplius larva, to one that is a simple worm.

The internal structure is just as plastic. The characteristic trophi exhibit a series of striking changes as we pass from one genus to another. In one direction the change is due to the degradation of the *mallei;* in the other to that of the *incus;* and in both this degradation is pushed so far that the changing parts may be said almost to disappear. For in *Brachionus* and *Euchlanis* the *mallei* are well developed; in *Furcularia* mere needle-shaped curved rods; in *Asplanchna* so evanescent that it is hardly possible to find them in an animal killed by pressure.

By another set of changes the *rami* are, in their turn, reduced almost to evanescence, becoming feeble loops in *Stephanoceros,* and in *Floscularia* two membranes attached to the *unci.*

Changes, great in degree, if not in variety, occur also in the excreto-respiratory system. For the contractile vesicle, which fills quite half the body-cavity in some *Asplanchnæ,* dwindles down in various species till it seems to vanish in *Pterodina* and *Pedalion;* while in one abnormal form, *Trochosphæra,* the connection between the lateral canals and the contractile vesicle is snapped, and the latter becomes an appendage of the cloaca only.

The nervous system, wherever it has been made out, is indeed always on the same plan; but its central organ, the nervous ganglion, is in *Copeus* and *Euchlanis* a great cylindrical sac, stretching from the head below the mastax; while in *Floscularia* it shrinks into a small star-shaped body between the eyes and the organ of taste.

The alimentary and reproductive systems are those which vary the least; but even here the difference in proportionate size is very great between the stomachs of *Sacculus* and *Synchæta;* and also between the ovaries of *Asplanchnopus myrmeleo* and *Asplanchna priodonta.*

But not only do most of the external parts and internal organs vary in turn almost to vanishing, but these variations are not in any way simultaneous. The result is, that we find an organ, of a form characteristic of one family or genus, occurring in a species that belongs to another.

Thus, for instance, the trophi of the *Melicertidæ* appear in *Pompholyx*, one of the *Triarthridæ*. Nay, more, it is easy to point out Rotifera that bear some striking characteristics of two or three other genera, or even of two or three other families. *Microcodon clavus*, for example, has the central mouth and double ciliary wreaths of the *Flosculariidæ*, the eye of a *Notommata*, the trophi of a *Diglena*, and the foot of a *Monostyla*. Again, *Pterodina patina* has the corona of *Philodina*, the lorica and transversely-wrinkled retractile foot of *Brachionus*, the foot-ending of a young Rhizotan, and the mastax of the *Melicertidæ*. Then there is Mr. Thorpe's new Australian Floscule, which swims freely like one of the Ploïma, has the buccal cup and wreath of *Floscularia*, the dorsal eye of *Notommata*, and the body and forked foot of *Proales*.

To sum up, we may say that in the female Rotiferon, the corona, head, foot, toes, appendages of the trunk, antennæ, eyes, and contractile vesicle vary down to almost absolute extinction; while, if we include the male in our survey, we must add that even the whole of the alimentary tract may disappear also. Moreover, the characteristics of the various groups interlace in so many ways, that no organ—nor indeed any combination of two or three organs—can be relied upon to determine with certainty an animal's true position.

Two conclusions are, in consequence, irresistibly forced on us: the first, that the Rotifera, from *Pedalion* to *Albertia*, are related by descent; the second, that their curious habitats, wide dispersion, and great variations in their structure are due to causes that have been at work for a very long period of time.

One other fact has also been made clear in this review: namely, that the British Rotifera give a very fair idea of the whole class. No doubt there are many foreign species, and some of these are very remarkable, and of great interest; but the greater number fall readily enough into the divisions that contain our own species.

And, indeed, it is a fortunate thing that we can here, at our own doors, study so many typical forms from life. For what books or drawings can give us the delight which we derive from observing the animals themselves?

To gaze into that wonderful world which lies in a drop of water, crossed by some atoms of green weed; to see transparent living mechanism at work, and to gain some idea of its modes of action; to watch a tiny speck that can sail through the prick of a needle's point; to see its crystal armour flashing with ever-varying tint, its head glorious with the halo of its quivering cilia; to see it gliding through the emerald stems, hunting for its food, snatching at its prey, fleeing from its enemy, chasing its mate (the fiercest of our passions blazing in an invisible speck); to see it whirling in a mad dance to the sound of its own music, the music of its happiness, the exquisite happiness of living—can any one, who has once enjoyed this sight, ever turn from it to mere books and drawings, without the sense that he has left all fairyland behind him?

V.—*Description of a New Dipterous Insect, Psamathiomya pectinata.*

By Julien Deby, F.R.M.S.

(*Read* 13*th March*, 1889.)

Plate IV.

At the meeting of the Society held on the 9th of May last, I exhibited slides of an interesting dipteron found by myself in abundance during the latter days of last April, at Biarritz, in the South of France. At the time I was not prepared to name or to describe it, but having since come to the conclusion that it belongs to a new genus and species, I now describe it in detail.

Psamathiomya pectinata is a marine insect, living below water during its early existence, the larvæ feeding on Enteromorpha. The adult escapes from the pupa case while the descending tide has laid bare the algæ-covered rocks; these small insects swarm at such times, being especially active when the sun shines on them. The males are more numerous than the females, and are also much more rapid in their motions. I have often seen several males surrounding one female, but I never caught any of these insects actually *in copula*, though I frequently saw the males seize the heavy pregnant females by the back of the head or neck by means of their formidable anal forceps, and drag them forcibly along after them, stopping occasionally, as if to rest, when the female would bend down her ovipositor and probing right and left with it, would, I believe, deposit each time an egg among the green weeds or in some cranny of the rocks below them.

Both sexes have very rudimentary wings, quite useless as organs of flight, so that these insects cannot possibly escape from the rising tide, which on this coast is accompanied by heavy surf and breakers. I presume therefore that the life of the imago does not exceed the few hours during which the tide has receded. Several specimens which I immersed in a phial of sea water were immediately drowned. The insects being small have to be looked for with atten-

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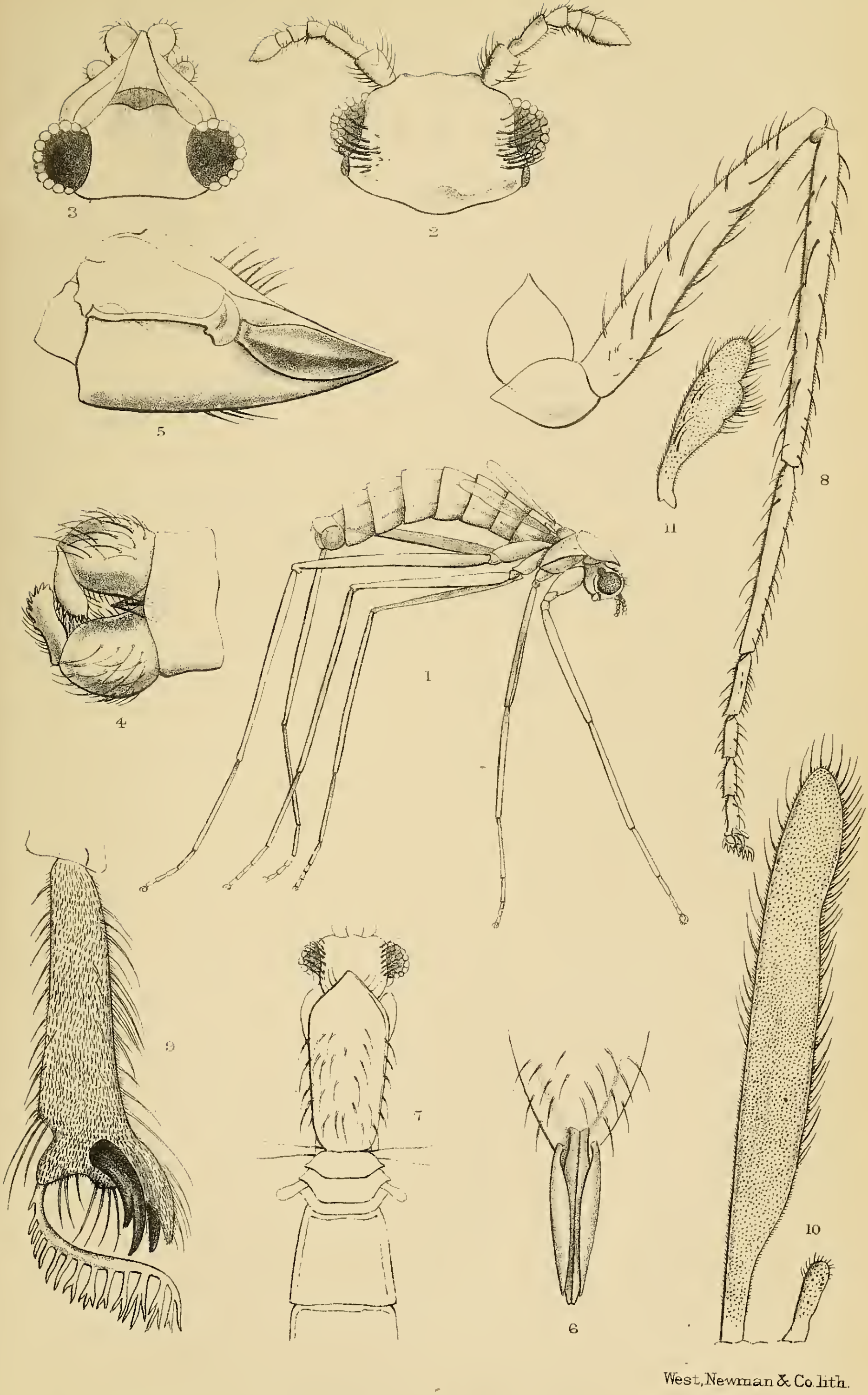
EXPLANATION OF PLATE IV.

Fig. 1.—*Psamathiomya pectinata* Deby, male 12/1.
„ 2.—Head seen from above.
„ 3.— „ below.
„ 4.—Anal forceps of male.
„ 5.—Ovipositor seen laterally.
„ 6.— „ from above. The internal blades are figured too long.
„ 7.—Head and thorax from above.
„ 8.—Leg of male.
„ 9.—Terminal tarsal joint of male with its appendages 300/1.
„ 10.—Wing and haltere of male, 60/1.
„ 11.— „ „ female.

Note.—The arrangement of the setæ in some of the above figures, which were executed during my absence from England, is not quite true to nature, so that references to the text only must be relied upon in case of apparent discrepancies.



West, Newman & Co. lith.

Psamathiomya pectinata.

tion, but once discovered they are easily recognized; the black, very long-legged males looking like minute spiders, while the dingy brown louse-like females which they drag after them, have the appearance, from a distance, of the cocoons some spiders carry behind them.

As was kindly pointed out to me by Mr. C. Waterhouse of the British Museum, this insect is exceedingly similar in its habits to *Halirytus amphibius*, discovered by the Rev. A. E. Eaton, in Kerguelen's Land, and which was fully described in vol. clxviii. of the Phil. Trans. of the Royal Society (special volume on the Zoology of Kerguelen and of Rodriguez), p. 24, pl. xiv. fig. 6. It is, however, generically distinct from its antipodal representative, although belonging to the same group of aberrant *Chironomidæ*, in which the antennæ are only six-jointed and unfeathered.

Dr. A. S. Packard has described another marine dipterous insect under the name of *Chironomus oceanicus*, the larvæ of which he found on floating "eel-grass" and in green sea-weed at low-water mark in Salem Harbour, U.S.A. Besides the two-winged insects above named, several more have been noticed, and among these:— *Ephydra californicus*, *Ephydra gracilis*, *Ephydra halophila*, as well as the larvæ of a species of *Tanypus* and of a *Stratiomys*, all of which were inhabitants of salt water. Nothing further is known of their respective life-histories.

I have some remembrance of having myself seen, very many years ago, a very similar insect, running over sea-weed and mussels, upon the Ostend breakwater at low tide. If looked for in this site, I should advise that this be done during the first days of spring, as it no doubt is a precocious insect.

As *Psamathiomya pectinata* will probably be found to live on other shores besides those of Biarritz, I have, in order to facilitate identification or comparison, prepared the following description of the insect which forms the subject of this communication.

Genus.—PSAMATHIOMYA.

Characters.—Antennæ six-jointed in both sexes, three middle joints submoniliform, neither feathered nor plumed, much shorter than the head and thorax; mesonotum cucullate, projecting over the head; legs very long and slender, especially in the males, the terminal joint of the tarsus being furnished (along with the usual claws), with a special finger-like projection, extending over and between the claws, while a doubly curved curious comb-like appendage faces it from below.

Wings rudimentary; much smaller in the females than in the males; without nervures. Halteres distinct. The convex eyes are distant in both sexes, but farthest apart in the females. Both the ordinary claws on the end joint of the tarsi in the male are deeply cleft or bifid; those in the female being simple. The comb-like appendages are similar in both sexes.

The external genitalia of the male consist of a powerful two-jointed pair of forceps, the lower joints of which are large, massive, subglobular, while the terminal joints are small and linear, and so articulated to the first as to curve inwardly between them when not in use. These terminal joints of the forceps carry at their tips an armature of short, sharp, scattered, horny spines. The ovipositor of the female is conical, narrowing towards the acute apex; it is constituted of two lateral plates or valves which cover and protect two very delicate, parallel, acute, membraneous spiculæ.

Specific Description of PSAMATHIOMYA PECTINATA.

I. Head.—The head in both the male and female is of average size and of the full width of the mesonotum, which projects conically over it. The eyes are prominent and convex. The facets are large and project hemispherically. Twelve facets occupy the whole antero-posterior convexity of the compound eye, as seen from above. Ocelli absent. The truncate vertex projects bluntly beyond and between the eyes. The cheeks are prominent and rounded behind. The anterior termination of the mesonotum reaches as far as the middle of the eyes. Eyes protected by a group of 10 or 12 stout and long setæ or bristles, which are inserted above them as eyebrows. The clypeus carries two parallel rows of distant, stiff bristles. Each eye carries at its posterior lateral edge a black chitinous appendage of an oblong shape and of unknown use.

The *trophi*.—I have not been able to make these out to my satisfaction. They are very short and consist apparently of a geniculate haustellum, and of conspicuous, two-jointed palpi, the terminal joints of which are rich in sensory bristles.

The *antennæ* in both sexes are six-jointed and much shorter than the head and thorax together.

The basal joint is the stoutest, it is broadly truncate at its apex and is four times wider at this point than the base of the following joint inserted into it. The apical joint is oval or somewhat pyriform; its extreme tip is slightly produced and narrowed to an obtuse point. The second joint of the antennæ is the longest; then follow about equal in length the first and the last joints, while the remaining three joints are small, subglobular, and nearly equal in size. The second joint, near its basal third, is constricted and slightly contorted, while an indentation is also noticeable near the anterior third, on the opposite side. The basal joint of the antennæ is liberally furnished with stout and stiff bristles, which are of the same length as the joint which carries them. One or two much smaller bristles show themselves frequently on the sides of the sixth joint, but all the intermediate joints, namely the second, third, fourth and fifth, are always without any setæ, and carry nothing but a rough, short inconspicuous pubescence, visible only under the Microscope.

Dimensions of the Head and its Parts.

		Mikrons.
Head ..	Antero-posterior length	240
	Lateral (extra-ocular) width	440
Eyes ..	Diameter in ♂	160
	,, ♀	128
	Inter-ocular space ♂	240
	,, ,, ♀	280
	Diameter of individual facets	16
Antennæ.	Average total length	352
	1st or basal joint, length	80
	2nd ,, ,, ...	80–96
	3rd ,, ,, ...	40
	4th ,, ,, ...	32
	5th ,, ,, ...	24
	6th or apical ,, ,, ...	88
	Inter-antennal space ♂	80
	,, ,, ♀	136
Trophi.	Haustellum	80
	Palpi	160

Thorax.—The scutum of the mesothorax or mesonotum for a length of 0·15 mm. from its anterior apex is bluntly conical. Its lateral sides are after this nearly parallel, with a very slight rounded constriction in the middle. The dorsum carries on each side two irregular longitudinal rows of spare stout bristles, with a few scattered ones in the middle between the two internal rows. Lateral appendages, or *calli humerales*, project from either side of the anterior portion of the mesonotum just above the insertion of the anterior coxæ.

The scutellum is narrow, transverse, with acute lateral angles, near to each of which six to eight bristles are planted, while the dorsal portion is glabrous. The metathoracic scutum is well developed, transverse, and shows by transparency a dorsal transverse trachea.

Dimensions of the Mesonotum and Scutellum.

		Mikrons.
Mesonotum ..	Length	540
,, ..	Breadth	420
Scutellum ..	Length (antero-posterior)	90
,, ..	Breadth (transverse)	240

Thoracic Appendages.

A. *Legs.*—The legs in both sexes are long and slender in all their parts, especially in the ♂, the coxæ being the stoutest portion. These latter carry a few stiff curved bristles near their extremities, on their lower surface. The linear, middle, and hind femurs and tibias are very slightly arched. The trochanters are small and insignificant. Both the femurs, the tibias, and the first two joints of the tarsi carry several longitudinal rows of stiff, sparse bristles. The three terminal joints of the tarsi have bristles only on their upper surface.

The legs increase in length from the first to the last pair. The tarsi of the third pair of legs are much the longest, while those of the second pair are the shortest. The hinder coxæ are one-third longer than the coxæ of the middle and front legs. The insertion of the legs into the sternum is as follows : : ˙., the front pair being distant from the approximating posterior limbs and also further apart laterally from each other.

The female differs from the male only as regards the legs, by these being but half as long. This is readily seen by the simple inspection of the femurs, tibias, and first joints of the tarsi, in both sexes.

The ungual, or terminal joint of the tarsus is furnished with two claws, which in the male are deeply cleft or bifid, while in the female they are simple. In both sexes a prominent finger-like fleshy projection of the tarsal joint projects above and between the claws for nearly their length.

In opposition to this interungual appendage and starting from the opposite angle of the truncate extremity or heel of the tarsal joint, a very remarkable S-shaped comb exists. This singular apparatus ends beyond the apex of the claws. Its outer edge is deeply fringed by a series of lengthened simple as well as forked or bifid teeth, while its inner edge is quite smooth. This tarsal comb is similar in both the male and the female, which proves its use to be ambulatory or adhesive and not sexual. This appendage is hyaline, of glassy aspect.

Dimensions of the Legs of the Male.

	First Leg.	Second Leg.	Third Leg.
	mm.	mm.	mm.
Coxa	0·42	0·42	0·60
Trochanter	0·15	0·15	0·15
Femur	1·26	1·65	1·65
Tibia	1·20	1·56	1·86
Tarsus (total)	1·275	1·14	1·755
„ 1st joint	0·63	0·57	0·90
„ 2nd „	0·21	0·18	0·405
„ 3rd „	0·135	0·12	0·15
„ 4th „	0·12	0·09	0·12
„ 5th „ .. .. (claws included)	0·18	0·18	0·18
Total length of legs ..	4·305	4·920	6·015

B. *Wings and Halteres.*—The rudimentary wings are opaque, linear, and show a constriction at a distance equal to 1/4 of their length, measured from their apex. They are fringed with long hairs on their lower margin, the breadth of which fringe is equal to the diameter of the wing. The halteres are distinct and spatulate. No traces of nervures are discernible on the surface of the wings.

The total length of the wings in the males is 1·20–1·26 mm., in the female 0·51 mm. only. The maximum width is only 0·15 mm. The halteres measure in the male 0·12 mm. in length. These abortive wings seem to be useless to the insects.

Abdomen.—The tergites in both sexes number eight. A few scattered bristles occupy the dorsum of each of them and a transverse trachea, seen by transparency, runs near and parallel to their anterior border, curving down along each side. This is best seen by means of the paraboloid. The tergites of the male measure in length 0·36 mm. each; equal to 2·88 mm. for the whole length of the abdomen; those of the female measure 0·45 mm. each in length; equal to 3·60 mm. for the whole length of the abdomen. The maximum breadth of the tergites is 0·57 mm. in the male and 0·75 mm. in the pregnant female.

Abdominal Appendages.—♂. Each branch of the powerful anal forceps of the male is bi-articulate; the basal joint being massive and carrying long scattered bristles. The terminal joint is less than half as long and half as broad as the preceding one which supports it. The apex of this small joint is provided with a number of short, hard, acute teeth intermixed with which are some fine bristles. The apical joints articulate into the basal joints, so as to permit their folding back between these last, when not in use, so that their points are turned inwards.

The ovipositor in the female is formed of two plates or valves which cover two internal styles. These protecting plates, viewed laterally, are somewhat lunate and rounded below, obliquely truncate at the apices and clothed with a very short or obsolete pubescence. The inclosed stylets are delicate, membraneous, and end very acutely at some short distance from the tip of the outer sheaths of the ovipositor. The length of the ovipositor is 0·33 mm.

The total length of the imago averages for the males 3·99 mm.; for the females, 4·50 mm.

The colour of the males is dark cinereous, nearly black, the feet and antennæ being somewhat lighter; the females have a lurid hue, the abdomen when distended with eggs having a dirty yellowish or greenish tinge.

The Larva.—The larva of *Psamathiomya* is linear, vermiform, and of a yellow colour.

The apparent number of segments of the body, including the head, is twelve, one for the head, three for the thorax, and eight for the abdomen.

The thoracic segments are shorter than the following; the apical one, into which the head is retractile, being the smallest. The thoracic anterior inferior angles of the somites carry inconspicuous minute bristly tubercules, while the abdominal segments, with the exception of the first and of the anal segment, are supplied in the same place with prominent rounded elevations or cushions which infringe on the anterior edge of the preceding segment. These appendages carry nine to ten parallel rows of very minute dark-coloured teeth, giving them a resemblance to microscopical convex curry-combs. In front of each row of these teeth, and standing at some distance, one much stouter spine is visible.

The anal segment terminates in five conical and somewhat incurved fleshy appendages, one of which is ventral and much larger and broader than the others. This appendage carries near its apex a large bunch of short curved bristles, while those opposed to it bear several tufts of similar bristles, and the intermediate appendages are quite glabrous.

The total length of this larva is 5·10 mm. The length of the anal segment including its appendages is 0·66 mm.; that of the three thoracic segments 0·66 mm., while the middle segments of the abdomen measure 0·45 mm. in length, by 0·90 mm. in width.

The chinitous mandibles are distinctly visible; they appear, as far as I can make them out, to be widely three-lobed or toothed, and to be in communication with two long internal chitinous rods, with slightly swollen heads, which terminate as far back as the last thoracic segment.

Pupa of Male.—The pupa-case, after the imago has escaped through a dorsal slit in the mesonotum, shows distinctly the three sternal divisions of the thorax, as well as the various segments of the abdomen. These are eight in number, unless the anal terminal process is considered as a segment, in which case the abdomen has nine segments.

The sheaths of the legs are quite free, bag-shaped, distinctly jointed, rounded at the ends. The hinder ones are convolute. The mesonotum shows a median transverse depression. The total length of the pupa is 4·50 mm.

As during my flying visit to Biarritz I found only one larva, and a single pupa, from which the perfect insect, a male, was escaping, my material has proved too scanty for a completely satisfactory study of the external metamorphoses of this insect, the further elucidation of which I must leave to some more successful collector, who should be on the hunting ground as early as March or the beginning of April, in order to secure the younger states of our insect.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

α. Embryology.†

Evolution of the Central Nervous System of Vertebrata.‡—Prof. J. Bland Sutton, who has published the suggestion that the central canal of the nervous system may be regarded as a modified portion of bowel, finds support in the opinions of Dr. Gaskell. Prof. Sutton urges that the approximation of the edges of the archenteron of the gastrula of *Echinus* at one point would produce a thickening and divide the cavity into a dorsal and a ventral portion, the part below corresponding to the bowel or cœlom, while the parts on the dorsal aspect would represent the medullary folds of Vertebrata. By occluding the blastopore we should get an arrangement of parts which would correspond in transverse section to what obtains in the early vertebrate embryo, and in longitudinal section with the U-shaped tube with which his hypothesis starts.

This view tends to show that the upgrowths known as the medullary laminæ, and the downgrowths forming somatopleure and splanchnopleure represent a modification or an abridgment of the invagination process so universal among Invertebrata. This view of the origin of the central canal absolutely removes the objection that its epithelium is epiblastic, whereas that which lines the gut is hypoblastic. In its simplest form, the hypoblast is that portion of the epiblast which, after invagination, lines the archenteron. According to this view the epithelium of the central canal of the nervous system from the infundibulum of the third ventricle to the extremity of the cord, that lining the neurenteric passage, as well as others, are of hypoblastic origin.

The discovery of His that the cells which make up the medullary folds are not, as is usually taught, metamorphosed into nerve-cells, but form the sustentaculum of the nervous axis, is an important fact in support of the intestinal origin of the spinal cord.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Brain, xi. (1888) pp. 336–42.

Development of Central Nervous System of Amphibians.*—Dr. H. Orr finds that the central nervous system of Amphibians first appears as a transverse epiblastic thickening dorsal to the mouth-fusion, and continues with paired elongated epiblastic thickenings lying dorsally on either side of the median line. The primary cranial flexure is due to the presence of this transverse epiblastic thickening or anterior medullary plate. When the brain is inclosed this thickening forms that part of the brain-wall which lies between the infundibulum and the optic groove. The first nerve-fibres which develope in the brain appear on what was originally the internal surface of the primitive epiblastic thickenings which run longitudinally in the dorsal region and unite continuously in the region of the primitive transverse thickening. A subsequent development of nerve-fibres gives rise to a continuous ventral commissure which extends through the floor of the mid- and hind-brain and of the spinal cord, as well as to the anterior and posterior commissures of the brain. The fibres of the optic nerves are intimately connected with and are developed in the same manner as the main bundle of fibres in the region of the primitive transverse epiblastic thickening. The mode of development of the hypophysis of *Amblystoma* has been studied, and it has been found to be intermediate between that of the lizard and that of the frog.

The structure of the larval rod-like organs which Clarke called "balancers" in *Amblystoma* has been investigated, and they have been found to be homologous with external gills, so that we have the case of a homologue of the external gills being metamorphosed into an organ for the support of the body. It is possible that further research will show that the suckers on the tadpole of the frog are similar organs.

Protandric Hermaphroditism of Myxine.†—Mr. F. Nansen finds that *Myxine glutinosa* is, ordinarily, a protandric hermaphrodite. Till its body is about 32 cm. long it is a male, and after that it produces ova. The proportions of the male and female portions of the gonad are not constant, but the male is generally one-third of the whole length of the organ. In a few cases what are called "true" males were observed, but they are probably transformed hermaphrodites. This strange irregularity in the occurrence and extent of the male and female organs seems to show that *Myxine* is an animal which, in sexual respects, is just at present in a transition stage; it seems still to be seeking, without yet reaching, that mode of reproduction which is most profitable for it in the struggle for existence.

The young testicular follicles are similar in structure to the young ovarian; they contain a large sexual cell, spermatogon, which is enveloped by an epithelium, follicular epithelium, and a connective-tissue envelope. This spermatogon undergoes subdivision and becomes converted into spermatides which are separated from one another and swim in a fluid contained in the testicular capsules. The nucleus and whole cell gradually elongate, and, on the bursting of the testicular capsules, ripe spermatozoa pass into the body-cavity. Mr. Nansen does not agree with Mr. J. T. Cunningham's account of the form of the spermatozoa, and thinks that observer's specimens must have been in some way altered. Nearly ripe spermatozoa may be found in specimens of *Myxine* at all

* Quart. Journ. Micr. Sci., xxix. (1888) pp. 295-324 (3 pls.).

† Bergen's Museum Aarsberetning for 1887 (1888) No. 7, 34 pp. (2 pls.).

seasons of the year; little is known as to the characters of freshly deposited ova, but, from the evidence which he has been able to collect, the author is of opinion that ova are deposited throughout the year, and that there is no special breeding season.

Maturation and Fertilization of Ovum in the Lamprey.*—Herr A. A. Böhm gives a more detailed account than that previously published of his investigations on the maturation and fertilization of the ovum of *Petromyzon planeri.*

A. *Maturation.*—An account of previous observations is as usual prefixed. The author then follows Rathke in a description of the ovary. In young *Ammocœtes*, 5 cm. in length, the ovary is a single median sac. An apical portion, bent sideways, was the seat of formation of new ova; in the main median portion all the ova were of the same stage. The evolution of the ovarian folds is then traced. In the last months before metamorphosis it was seen that all the ova were arranged in the same way, with the vegetative pole towards the body-cavity, and the animal pole (with the approximated nucleus) towards the axial blood-vessels.

In *Ammocœtes* 5 cm. in length the ova exhibited a central germinal vesicle; they grow continuously to the time of metamorphosis; the yolk appears while the nucleus is still central. At the time of metamorphosis, the ova are inclosed in a double membrane, and this by a layer of granulosa. The substance exhibits crystal-like yolk-granules and numerous "vacuoles," perhaps of connective material like that which sparsely unites the granules. A two-layered cortical zone and a pellucid central area are conspicuous. The nucleus becomes eccentric in position. Between it and the surface lies a peculiar disc-like mass, the lid of A. Müller. This is only a transitory structure, not seen in the ovarian ova of mature lampreys, in which the germinal vesicle is quite superficial and polar. The granulosa undergoes mucous degeneration, more marked at the vegetative pole. In the freed ovum within the body-cavity the karyoplasma of the germinal vesicle expands like a cup, and forms the "pole-plasma."

B. *Fertilization.*—The author gives a report of the results reached by A. Müller, Calberla, Kupffer, and Benecke. He then proceeds to detail his own observations at successive periods, first of minutes, and then of hours after fertilization. The fresh laid egg exhibits a mucous envelope, and at the animal pole a hyaline cupola. This is situated on a watch-glass-like arch of the egg-shell, which here as elsewhere consists of an internal radially porous, and an external homogeneous layer. On such unfertilized eggs no micropyle is to be seen. Several spermatozoa enter at the cupola; elsewhere the ovum is impenetrable. Within the cupola the spermatozoa are to be seen, which steer towards the centre of the ovum. Only one, however, penetrates. But, before the spermatozoa have touched the egg-membrane, a constriction is formed at the margin of the watch-glass-like elevation, the pole-plasma separates from the membrane, and forms in so doing a space traversed by numerous thin threads. Even this several spermatozoa may reach, but get no further.

During the further retraction of the ovum, in the region of the pole-plasma, the above-mentioned threads and a thicker axial strand are withdrawn into the main mass, which has meanwhile assumed a spherical form. At the same time the first polar body is extruded. The yolk-

* Arch. f. Mikr. Anat., xxxii. (1888), pp. 613–70 (2 pls.).

membrane is formed round the entire egg, and the main mass of the pole-plasma surrounds itself internally with an undulating membrane at the contact surface with the yolk. Within the pole-plasma one then finds the spermatozoon and the provisional female pronucleus. Their position is not fixed, for the plasma is very mobile. Some time after the retraction of the axial strand the apical knob is raised towards the watch-glass-like arch, comes in contact with its inner surface, receives particles from the already-mentioned imprisoned or impeded spermatozoa, and is retracted into the main mass. The second polar body is formed; the final female pronucleus remains; and the sperm takes up a definite position in relation to it.

A quarter of an hour after fertilization both elements begin to change. The female pronucleus becomes pale, diffuse, and rather larger. The sperm-head breaks up into spherical, connected, linearly disposed elements. The formation of an associated "sun-figure" is described. The "spermatomerites" come into contact with the female nucleus, which takes or has taken the form of a group of spherical "ovomerites." The two sets of elements come into intimate contact, undergo binary division into smaller and smaller portions, but do not fuse. Each merite consists of a body and one or two granules or microsomata. At the end of the third hour the bodies of the merites fuse, the segmentation nucleus is formed, and the undulating membrane of the pole-plasma dissolves.

The microsomata, which become free when the merites fuse, arrange themselves in short chains. They become grouped in an axial plate. The central mass of the sun probably falls into two masses with two suns, disposed at opposite poles in relation to the plate. Spindle strands appear, the short chains of the plate curve into loops, and a metaphasis sets in. After the formation of daughter-nuclei the pole-plasma begins to constrict in the axis of ovum. The author concludes his memoir with a comparison between his results and those of other investigators of fertilization.

Observations on Human Spermatozoa.*—Mr. E. M. Nelson gives an account of some observations on the human spermatozoon. He thinks that the head or spore, as he calls it, has not been correctly figured hitherto. Its outline is oviform, the part towards the tail being the small end, but in all drawings which he has met with, the reverse of this is represented. The spore fits into a cup, and the edge of this can be distinctly seen both in front and side views, though the outline of the head has always been represented as unbroken. At the bottom of the cup there is what Mr. Nelson calls the calyx; this is exceedingly variable. Between the cup and the tail proper there is the stem, which varies in thickness; then there is the break which the author calls the joint; the tail is fairly constant in thickness and length. On the spore there is a process which it is proposed to call the filament, and not the flagellum (though it is like one), inasmuch as it is regarded as a director, or kind of antenna for the purpose of guiding the spore into an aperture in the ovum. As many as four nuclei have been observed in the spore of a human spermatozoon, but, though Mr. Nelson does not say so, this must be a very abnormal case.

Epithelial Glands in Batrachian Larvæ.†—Prof. F. E. Schulze reports an interesting histological discovery made by him, while ex-

* Journ. Quek. Mikr. Club, iii. (1889) pp. 310–4 (1 pl.).

† Biol. Centralbl., viii. (1888) pp. 580–2; Abh. K. Preuss. Akad. Berlin, 1888, pp. 46–9.

amining the larvæ of *Pelobates fuscus*. He found in the posterior region of the roof of the pharyngeal cavity (from ceratohyal to œsophagus), a highly developed system of multicellular glands differing from all other known multicellular glands of vertebrate animals in that they are not imbedded in the connective-tissue layer, but are entirely limited to the epithelium, which at that point is fourfold. Each gland is in shape like a more or less broad, round pumpkin flattened in the main axis. The flattened basal surface is seated on the connective-tissue layer, while the upper surface reaches to the surface of the epithelium. The cells which form the glands consist of longitudinally extended prisms closely pressed together. The glands form a belt of about 2 mm. in breadth. At the edges of this belt they are comparatively far apart, but in the middle they stand so close together that their edges touch.

Factors in the Evolution of Cave Animals.*—Prof. A. S. Packard, in the advance sheets of an essay on the cave animals of North America, contends that the phrase "Natural Selection" expresses rather the result of a series of causes than a *vera causa* in itself; and that the constant use of such a phrase tends to obscure vision, and to prevent the discovery, by observation and experiment, of the tangible, genuine, efficient factors of organic evolution. He enumerates the following as the most important and potent factors in the evolution of cave animals:—(1) Change in environment from light, even partial, to twilight or total darkness, involving diminution of food, and compensating for the loss of certain organs by the hypertrophy of others. (2) Disuse of certain organs. (3) Adaptation, enabling the more plastic forms to survive and perpetuate their stock. (4) Isolation, preventing intercrossing with out-of-door forms, thus insuring the permanence of the new varieties, species, or genera. (5) Heredity, operating to secure the permanence of the newly originated forms, as long as the physical conditions remain the same. Prof. Packard gives illustrations of the action of these factors, citing facts both new and old, and argues on behalf of what he calls "Neo-Lamarckism."

β. Histology.†

Division of Red Blood-corpuscles in Amphibia.‡—Dr. L. Török has investigated the phenomena of cell-division in the red blood-corpuscles of Amphibians (*Salamandra maculata*), in regard to which Flemming and others had previously noticed certain deviations from the normal type. In the resting stage the chromatin is present in relatively greater abundance and denser disposition than in the resting nuclei of other kinds of cells. The large size of the subsequent nuclear figures is interpreted as due partly to the dissolution of the filaments and strands from their previously close arrangement, partly to a change of the chromatin into a less dense state. The processes of division are described in detail —the formation of the close coil, of the loose coil, of the loops and the aster; the longitudinal division of the filaments in the loose coil and star-figure, or even in the first stage; the disappearance of the nuclear membrane in the loose coil and the consequent mingling of cell-proto-

* Amer. Natural., 1888, pp. 808–21.
† This section is limited to papers relating to Cells and Fibres.
‡ Arch. f. Mikr. Anat., xxxii. (1888) pp. 603–13 (1 pl.).

plasm and enlarged nucleus. The metakinesis is very brief, and few observations of this phase were made; except that the loops extend almost over the entire cell, the process seems typical enough. The regular barrel form of the separate nuclei, the daughter-asters and coils, and the like, are followed out.

γ. General.

Adelphotaxy.*—Prof. M. M. Hartog has a note on an undescribed form of irritability, which he calls adelphotaxy. It may be defined as consisting in the tendency of spontaneously mobile cells to assume definite positions with regard to their fellows. In *Achlya* the zoospores lie in the sporange before liberation closely appressed together, with their long axes parallel; on liberation, they do not separate and swim off each on its own account, but remain near the mouth of the sporange. They there form a hollow sphere, each zoospore rotating round its long axis before encysting in its place. The only explanation of these phenomena is that the zoospores are endowed with a peculiar irritability, in virtue of which they tend to place themselves close together side by side, with their long axes parallel.

Though rare in the Vegetable Kingdom, two good instances occur in the Chlorophytes, in *Pediastrum* and *Hydrodictyon;* possibly the formation of plasmodia is a mode of adelphotaxy. The principle appears to afford a ready explanation of many cases of cellular aggregations in the animal embryo, and the formation of the spermatophores of many animals.

Functions and Homologies of Contractile Vacuole in Plants and Animals.†—Prof. M. M. Hartog has a preliminary note on the contractile vacuole. He finds that all naked protoplasmic bodies living in fresh water have at least one contractile vacuole; the possession of this is quite independent of the systematic position of the organism, and of the presence of chlorophyll. The vacuole loses its contractility on the formation of a strong cell-wall or cyst, and may even disappear. It is absent from *Opalina*, Gregarinida, and the Radiolaria which inhabit saline liquids. When, owing to morbid conditions, the efficiency of the contractile vacuole is impaired, excessive vacuolation and diffluence ensue. Conversely, as soon as contractile vacuoles appear, the tendency to excessive vacuolation and diffluence is arrested. Prof. Hartog suggests that the perforation of the nephridial cells in Vermes and embryonic Molluscs, and of the epiblastic gland-cells of Vermes and Arthropods are due to persistence of the contractile vacuole, the opening of which has become permanent.

Annelidan Affinities in Ontogeny of Vertebrate Nervous System.‡—Dr. J. Beard gives an account of some observations on the development of the central nervous system of a lizard. He points out that the cranial and spinal ganglia do not arise as outgrowths of the central nervous system, but from epiblasts outside and beyond its limits; this is just what happens with the parapodial ganglia of Annelids. Dr. Beard thinks he has discovered evidence of the bilateral origin of the central nervous system, for the two bands of neuro-epithelium are separated

* Ann. and Mag. Nat. Hist., iii. (1889) pp. 66–7. † Ibid., pp. 64–6.
‡ Nature, xxxix. (1889) pp. 259–61.

from one another by a ciliated groove, and this, too, is found in Annelids; it is this ciliated groove which by the growth and increase of its elements forms most, if not all, of the ciliated epithelium of the permanent central canal.

Other points which favour the annelidan affinities of the Vertebrates are the formation of the notochord and swimming bladder, the lateral sense-organs, the characters of the nephridial system, and the agreement between the development of the hypophysis cerebri of Vertebrates and the development of the permanent œsophagus and its special nervous system in Annelids.

The Modern Cell-Theory.*—Prof. J. G. M'Kendrick traces the development of the modern cell-theory through a long series of classical investigations. The constitution and *rôle* of the nucleus and the phenomena of division are discussed, while notice is taken of recent progress concerning oogenesis, spermatogenesis, and fertilization. The bearing of recent researches on the problems of heredity is then emphasized, and several formidable objections are urged against Weismann's position relative to acquired characters.

B. INVERTEBRATA.

Transversely Striated Muscular Fibre.†—Prof. A. Kölliker, in view of the, as he thinks, erroneous teaching lately promulgated by A. v. Gehuchten and Ramon y Cajal, gives an account of his own long continued observations on the structure of transversely striated muscular fibre. The chief object of his investigations have been the fibrillar wing-muscles of Insects: these are not found in all flying insects; they all consist essentially of two constituents, muscular fibrils and an intermediate substance—sarcoplasm; the fibrils are from 1–4 μ broad, are contractile along their whole length, and in a state of contraction, all the parts are doubly refractive. When the fibres are at work there is an active chemical action, and the rapidity of contraction in insects' fibres may be ascribed to the large supply of tracheæ. The chief seat of this activity is the sarcoplasm, as the large quantity present and the fat-molecules which are found in it are sufficient to show; it is not to be supposed, however, that the substance of the fibrils is not also energetically changed. There is no coagulation of an albuminoid body during contraction. If these views are correct it may further be supposed that the fibrils consist of typically formed particles (the disdiaklasts of Brücke), the arrangement of which is the cause of isotropy or of anisotropy, and which, during contraction, undergo changes of position and form, the causes of which are to be found in electrical or as yet unknown chemical processes.

Number of Polar Bodies.‡—Prof. A. Weismann replies at length to an attack made upon him by Prof. Blochmann, in reference to the discovery of the fact that only one polar body is formed in parthenogenetic ova. The question is one both of priority and of accuracy of statement, in regard to both of which Weismann more than vindicates himself.

* Proc. Phil. Soc. Glasgow, xix. (1888) pp. 71–125.
† Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 689–710 (2 pls.).
‡ Morphol. Jahrb., xiv. (1888) pp. 490–506.

Irish Marine Fauna.*—In the second report of the Dredging Committee of the Royal Irish Academy, Prof. A. C. Haddon gives a general account of the forms observed. The erect variety of *Epizoanthus papillosus* with a *Pagurus* was taken; this form has the remarkable power of dissolving away the hard molluscan shell, and replacing it with its own sand-impregnated tissues; in this way the shelter of the Pagurid is formed entirely by the Actinian, and as it grows with the growth of the hermit-crab, *Paguri* associated with *Epizoanthus* have not to seek a fresh home after each moult. *Strongylocentrotus lividus* was found in Lough Hyne merely resting on the rock; it is probably on account of their sheltered position that these specimens had not made "nests" for themselves, as do specimens found on the exposed coasts of Clare and Kerry. Ninety-two specimens of *Pontaster tenuispinus* and ten of *Brisinga endacnemos* were obtained. *Holothuria tremula* was dredged not far from the coast. A fine addition to our fauna is *Chitonactis richardi*, of Marion, first found in deep water in the Bay of Biscay. This is a very useful report to those who are interested in the fauna of our seas.

Marine Invertebrates of Bermuda Islands.†—Prof. A. Heilprin gives a list of species collected within a depth of 16 fathoms in the lagoons of the Bermuda Islands. Although the Actinozoa were numerous the common genus *Madrepora* appears to be absent; the largest specimen of "brain-coral" obtained had a diameter of 28 in.; one was seen which was four feet in diameter, but efforts to dislodge it were unsuccessful. Of the Echinodermata four novelties were found among the Holothurians, viz. *Holothuria abbreviata*, *Stichopus diaboli*, *S. xanthomela*, and *Semperia Bermudensis*. Pacific and old-world types were recognized both among the Crustacea and the Mollusca; of the former no new species are recorded, though the list of species now given is much longer than any of its predecessors; more than one hundred species of Mollusca were obtained, and among these *Octopus chromatus*, *Aplysia æquorea*, *Chromodoris zebra*, and *Onchidium* (*Onchidiella*) *transatlanticum* appear to be new.

Zoology of Victoria.‡—The seventeenth decade of Prof. F. M'Coy's Prodromus contains further descriptions and figures of Polyzoa by Mr. M'Gillivray; thirteen species of *Cellepora* are now described. The author considers that the holostomatous and schizostomatous divisions of *Cellepora* are of generic value, and he retains the name of *Cellepora* for the former, and proposes that of *Schismopora* for the latter; nine of the species appear to be new. A new genus of Squid—*Ommastrephes Gouldi*—is described by Prof. M'Coy; it appears to be most closely allied to *O. equipeda* Rüppell.

Mollusca.

β. Pteropoda.

Morphology of Pteropods.§—Prof. C. Grobben writes in regard to a passage from one of his papers, which has been misunderstood by Boas and Pelseneer. By "Rückdrehung" he meant the movement of the visceral sac on the dorso-ventral axis, not an "Aufrollung" or untwist-

* Proc. R. Irish Acad., i. (1888) pp. 29–56.
† Proc. Acad. Nat. Sci. Philad., 1888, pp. 302–28.
‡ 'Prodromus of the Zoology of Victoria,' xvii. (1888).
§ Arbeit. Zool. Inst. Univ. Wien (Claus), viii. (1888) pp. 155–7.

ing. The Pteropods are now regarded as Gastropods; in this Fol, Spengel, and Grobben, who refer them to the Euthyneura, as well as Boas and Pelseneer, who rank them with Opisthobranchiata, agree with the older views of Souleyet and de Blainville, who placed the Pteropods beside *Bulla*, *Gastropteron*, and *Aplysia*. They are Gastropods modified for pelagic life, and on such an understanding their peculiarities are to be interpreted. The protopodium of Pteropods is the sole of the Gastropod foot, not only morphologically, but also in function, as Souleyet pointed out for *Pneumodermon*. The epipodia are paired derivatives of the protopodium, as Grobben has previously mentioned in regard to the pterygopodium of Heteropods. In a certain sense they may be termed new structures.

γ. Gastropoda.

Generative Apparatus of Lymnæus.*—Dr. J. Klotz supports Brock and Rouzaud in the statement that the generative apparatus of the Pulmonata begins to be developed before the escape of the embryo. The penis is developed independently at the hinder margin of the tentacle, and is an ectodermal invagination which is hollow, and not solid, as stated by Eisig. There is no "migration ontogénique" of the penis, as supposed by Rouzaud, in *Lymnæus;* further investigations must show whether, in other Basommatophora, the penis is to be regarded as a diverticulum of the female efferent duct. Both uterus and prostate are at first hollow, and, apparently, mesodermal in origin. The cylindrical portion of the vas deferens forms a secondary connection between the penis and the uterine prostatic portions; there is no rudimentary male duct in the sense of Brock. The hermaphrodite gland has an independent mesodermal origin, as Eisig and Brock have correctly stated; Rouzaud was wrong in affirming it to be ectodermal. The general statement of previous writers that the uterus and prostate are separated only by the ingrowth of a fold into the common duct is correct; a further dorsal fold in the prostate is the cause of the formation of the pyriform body. The receptaculum seminis is formed by a further fission of the uterus. By a fold similar to that of the prostate the small tube at the proximal part of the rudiment of the penis is formed. The albumen-gland is an evagination of the oviduct. The folds in the uterus appear very early, and the glandular cells in it are, in the Basommatophora, only epithelial cells, but those of the prostate are not so, and they are differently arranged to those in the uterus. The glandular cells of the albumen-gland are likewise epithelial, but they do not, as Semper supposed, lie freely in the follicles, for they are connected with an efferent duct. Folds similar to those of the uterus are found in the receptaculum, but are not so numerous. The small tube is separated peripherally from the copulatory organ, and can be completely invaginated. In a large number of points the author agrees with Brock and Rouzaud, and in an almost larger number he contradicts Eisig.

Anatomy of Aplysia.†—M. R. Saint-Loup has some anatomical notes on a form of *Aplysia fasciata*, which is smaller, more active, and more highly coloured than ordinary examples. He finds that its

* Jenaische Zeitschr. f. Naturwiss., xxiii. (1888) pp. 1–40 (2 pls.).
† Comptes Rendus, cvii. (1888) pp. 1010–12.

"hermaphrodite gland" contained only spermatozoa, but the author is not certain whether this is a case of protandry or of separate sexes. Herr Kollmann has erroneously stated that the arterial system of *Aplysia* is completely closed, for the capillaries were found to communicate with intermuscular lacunæ or with the general cavity. The purple-gland plays a very active part in the depuration of the blood and in the elimination of substances which are hurtful to the animal; if methylen-blue be injected into a living specimen the glandular capsules of the gland will be found gorged with this substance.

The Heteropod Eye.*—In the second of a series of papers on the comparative anatomy of visual organs, Prof. H. Grenacher describes the eye of Heteropoda, and specially that of *Pterotrachea coronata* Forsk. He sums up his conclusions as follows:—

(1) The retina of the Heteropoda, like that of the Cephalopoda, is not to be considered as made up of histologically distinct layers. It consists of a single layer of cells, whose individual elements are made up of nucleus-bearing portions, rod-sockets, and rods. The first named lie outside, both the others inside a thin limiting membrane.

(2) The striated or fibrillated contents of the nucleus-bearing portions of the retina cell cannot be referred, with any sufficient ground, to a disruption into nerve-fibres; rather are the striations related to the formation of the so-called radiculæ, which, as root-like processes, seem destined to fix the retina cells to the cuticle.

(3) The rod-sockets, also finely striated, are segments of varying length, which is determined by the height of their point of insertion in the rods above the bounding-membrane.

(4) The rods must be considered as compound structures, since a number of socket-parts are in connection with each of them, and indeed because each rod owes its origin to a number of retinal cells. This is also the case in the rhabdoms of the Arthropoda and Cephalopoda; but while the components of a rhabdom are placed side by side, they are here in rows over one another, one end free, the other uniting with the corresponding socket-parts. Their transverse striation, contrary to M. Schultze's statement, is due to a relatively simple lamellar texture.

(5) The rods are arranged in longitudinal rows (of which there are six in *Pterotrachea*) which extend over the retina in nearly parallel courses.

(6) The retina is traversed by a cleft to the whole depth of the rows of rods, running parallel to them, and separating them into dorsal and ventral halves. In the dorsal half are *two*, in the ventral *four* rows. The dorsal rows have their free side ventral, the ventral rows are free dorsally.

(7) The retina is innervated from a layer of nerve-fibres which run between or under the basal ends of the retinal cells. They run to that part of the retinal cells where these split up into radiculæ, and there unite with them. There is no ground for supposing that the nerve-fibres pass into the retinal cells on the analogy of the Cephalopoda. Besides the nerve-fibres, in the dorsal half, there are small ganglionic cells.

(8) The structureless limiting membrane which extends between the free ends of the rods and the vitreous body gives off, on the side next the rods, rows of fine fibres which insinuate themselves between the

* Abh. Nat. Gesell. Halle, xvii. (1888) pp. 1–64 (2 pls.).

rods. They are most probably united with the cellular elements which lie between the nucleus-bearing portions of the retina cells, and whose distribution, in the ventral half at least of the retina, exactly resembles that of the fibres. These cells are probably, as in the Cephalopoda, the material for the formation of the fibres, and also for the limiting-membrane itself. A further net of circular fibres arises apparently from cellular elements which lie in the retinal cleft.

(9) The nervous layer of the retina extends over this, out into the pigmented epithelium of the so-called costal region, where it can be followed with gradual diminutions to certain areas marked by epithelial projections. On the ventral side of the eye, the fibres can be traced to large cells surrounded by the pigment-epithelium. This points to an analogous condition on the dorsal side, where the said cells are smaller, but there the point cannot be settled. Whether it can be shown that these cells are of secretory function, it is impossible to determine. The relations of the Heteropod eye to the visual organs of the other Cephalophora, and the general morphology of the latter are then discussed.

Entocolax Ludwigii, Parasitic in a Holothurian.*—Dr. W. Voigt gives an account of a remarkable Mollusc found by Prof. Ludwig living parasitically on *Myriotrochus Rinkii;* the specimen which carried the parasite was collected in Behring's Sea. It belongs, in the author's opinion, to the group of Prosobranchiate Mollusca, of which it must form the representative of a special suborder to be called *Cochlosyringia*, These may be defined as endoparasitic Gastropods which, when adult, have the form of an acephalous naked tube, which by means of its knoblike anterior end, penetrates into the body-wall of its host. At the tip of the anterior end there is an orifice which leads into the oral invagination. This has neither jaws nor radula. There are no circulatory or respiratory organs. The female gonads have a rudimentary efferent duct, and a well-developed receptaculum seminis; the ova are evacuated by tearing the wall of the ovary. The female of *Entocolax* is as yet alone known; its body is 1 cm. long, tubular, narrower behind than in front; for a short distance behind its anterior end it forms a large sphere 3 mm. thick, which contains the ova.

Mouth-parts of Ancylus fluviatilis and Velletia lacustris.†—Herr J. Uličny describes the jaw and radula of the above forms. The jaw of *Ancylus* is a deep arch formed of about 100 plates, which are somewhat rectangular, and have their long axis directed towards the mouth of the arch. Their surface is granular, and they are fringed at the lower end. The centre of the arch and its extremities have only one row of plates, but in the middle of each side they are six or seven irregular rows thick.

In the jaw of *Velletia*, there are about 50 plates pointed at each end, i. e. somewhat lancet-shaped, and finely striated. They form a single row still more deeply arched than in *Ancylus*. No one plate can be said to have a central position. At the sides they lie pointing downwards and outwards, thus touching one another laterally only.

The radula in *Ancylus* is composed of some 140 transverse rows of teeth, curved so as to be convex backwards. The central tooth is

* Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 658–88 (3 pls.).
† Verh. Nat. Ver. Brünn, xxvi. (1888) pp. 120–4.

symmetrical about itself, and on each side of it are from 25 to 32 teeth, so that there are in all 51 to 65 longitudinal rows.

In *Velletia* the radula has some 84 transverse rows of teeth. The well-developed central tooth is smaller than in *Ancylus;* 11 to 13 teeth lie on each side of it, and outside these come 4 to 7 little plates, the row thus containing 35 to 37 pieces. Comparing these with the mouth-organs of other members of the family, Herr Uličny concludes that a natural classification demands the breaking up of the family Limnæidæ into several independent families.

δ. Lamellibranchiata.

Edge of Mantle of Acephala.*—Dr. B. Rawitz deals, in his first account of the mantle of acephalous Lamellibranchs, with the Ostreacea. In *Anomia ephippium* the margin forms a thickening of the mantle which is best developed in the middle, and gradually passes to a simple ridge at the edges. The left margin of the mantle is feebler than the right; its inner surface is generally flat, and has only rarely an elongated brownish swelling which is always at some distance from the edge; the inner surface of the right half has a rounded swelling of the tissue which, though varying with the age of the animal, is always better developed than that of the left. Both edges are beset with several rows of conical papillæ or tentacles, of which the innermost are the longest and the outermost the shortest. This arrangement obtains also in *Ostrea, Lima, Spondylus*, and *Pecten.*

The edge of the mantle of *Ostrea edulis* is pigmented at the centre of its curve, but is free of pigment on the dorsal and ventral sides of the animal. As in *Anomia* the two halves of the mantle are separate along their whole extent; macroscopically, these two halves are exactly similar.

In *Lima* the tentacles are all marginal in position; the mantle-valve is extraordinarily long, as is, in the Spondylidæ and Pectinidæ, the valve which hangs down inwardly; in the latter, however, its free margin may carry several rows of short tentacles.

The nerves which supply the mantle and its edge, arise from the cerebral and visceral ganglia. Each of the former gives off one nerve, the nervus pallialis anterior; it divides dichotomously into two branches which fork and end in very fine branches in the substance of the margin; it is principally supplied to the anterior fourth. The median pallial nerve arises as a strong trunk from the visceral ganglion, and has at first a direction perpendicular to the long axis of the animal; at the margin it divides into two equal branches which diverge and supply a large part of the edge with finer branches. The hinder pallial nerve is relatively delicate, and divides into three fine branches which supply the greater part of the hinder fourth of the margin. The finest branches of this nerve supply pass into a nervus pallialis circularis.

The differences in the minute structure of the mantle and its margin in the five families of Ostreacea which were examined are so great that the author describes each separately; this he does in greater detail than we are able to follow him. But some points of interest may be noted.

In the Anomiidæ the epithelia which cover the marginal tentacles in several rows are sensory or indifferent; the latter may or may not be

* Jenaische Zeitschr. f. Naturwiss., xxii. (1888) pp. 415–556 (6 pls.).

pigmented; there are noticeable differences between the epithelia of the right and left margins. The sensory cells are very delicate, and there are two kinds of them. Some are like the typical forms described by Flemming, and have a capitulum which is only very rarely distinctly marked off, and which is covered by stiff hairs; the long neck has a basal spindle-shaped swelling which contains the nucleus; the nerve-fibre which enters the cell is not in direct contact with the nucleus. The second kind of sensory cell is represented by delicate structures having nearly the form of an equilateral triangle; the base carries the cilia, while the tip is continued into a varicose terminal nerve-fibre.

The left mantle margin is beset with five rows of tentacles; those of all but the fourth row are simple, and those of the fourth are branched; they are all pigmented, but the pigment is distributed irregularly; each of these rows are separately considered, as are those of the right side. While the musculature of the true mantle is exclusively longitudinal, the tentacles have longitudinal, transverse, and circular muscles; all these kinds have numerous small nuclei, which stain intensely.

The connective substance of the two halves of mantle which contain the already mentioned swellings has a peculiar structure. In its meshes there is a mass which, like that seen in the tentacles, does not appear to be connected with definite histological elements. It is in some parts so well developed as to completely obscure the other constituents of the mantle-substance; mucous cells are found in the amorphous mass. It is possible that we have here to do with mucous cells, the substance of which has passed into an amorphous mass.

In the Ostreidæ the circular nerve of the mantle lies closer to the outer than the inner surface, and has a ganglionic cortex and nerve-fibres; it is surrounded by a delicate covering, which accompanies the branches that pass into and occupy the axis of the tentacles. There are two kinds of goblet-cells in the connective substance, and they are present in large numbers. Their secretion appears to be protective. The author is of opinion that Ryder's observations quoted by Sharp do not serve to prove that Oysters are sensitive to light; they are quite blind, and their pigment-cells are indifferent structures.

In the Radulidæ, of which *Lima hians* and *L. inflata* are taken as the types, Dr. Rawitz has already reported the presence of two forms of marginal tentacles, which may be distinguished as sensory and glandular filaments; the differences in the microscopic structure of these are fully described. There are three kinds of unicellular glands, all of which agree in wanting a true cell-membrane. The secretion of the glandular filaments is, no doubt, of use in forming the nest of *Lima*, which consists of various inorganic particles and remains of organic structures held together by very delicate filaments. The great quantity of secretion suggests that it has also some other function, and it may be that it is a kind of defensive apparatus.

In the Pectinidæ and Spondylidæ the edge of the mantle has an extraordinary number of tentacles which are arranged in several rows; these vary in various species; the innermost tentacles are the longest. Pigment is found associated with indifferent epithelial cells, and is so intensely developed in *Spondylus* as to render the investigation of the minute structure exceedingly difficult. The several species examined are discussed in great detail.

In conclusion, the author gives an account of his examination of the eyes of the Pectinida, which he prefaces by a critical and historical notice of the works of his predecessors. The smaller species have more eyes on the mantle than have the large. These eyes are placed on stalks, the substance of which is a direct continuation of that of the edge of the mantle, and is covered by epithelial cells which vary in form in different regions. The stalk, which varies in length, is generally cylindrical in form; the fibrils, of which its connective substance is formed, are less numerous, and the meshes are larger than in the tactile filaments on the edge of the mantle, and the whole tissue has a more homogeneous appearance. Patten was right in asserting the presence of vascular lumina; there are also muscles, but these are not formed, as Patten declares, of elongated spindle-shaped cells, but they form long multinuclear cords, the cellular components of which are closely packed against one another; the whole forms a contractile subepithelial tube. The ciliaris of Patten does not appear to exist, that observer having mistaken connective-tissue fibrils for muscular fibres.

The epithelium of the optic stalk is flat or low, but becomes higher at about the equator of the organ; here the cells contain pigment which varies in colour in various species. Hensen was quite right in objecting to the term choroid being applied to the pigment-mantle, for it is the vascularization and not the pigmentation which is the characteristic of the choroid. The pellucida of Hensen or cornea of most authors has an outer layer which is formed on one of three types; it is succeeded by an inner layer which is a direct continuation of the connective substance of the stalk.

The true optic organ consists of two parts which differ from one another in structure and formation; the distal portion is the dioptric, the proximal that which perceives the light. Bütschli was wrong in doubting the existence of the septum which Krohn discovered to separate these two regions. The dioptric apparatus is formed by the lens; this is biconvex in form, and its greater diameter is along the lateral axis of the eyeballs. It consists of numerous cells, which are generally polyhedral in form; the plasma of these is thick and granular and stains very intensely, especially with eosin; the nucleus is generally present, and small; these cells have no investing membrane, but present a distinct contour after treatment with corrosive sublimate. The author cannot agree with Patten in the latter's statement that the lens is invested by a membrane.

The proximal part of the eye consists of three layers—retina, tapetum, and pigment-membrane. In the retina there are again three layers, which can be seen in longitudinal sections, which lie in the following order proximally to the septum: layer of ganglion-cells, layer of rod-cells, and layer of rods; these are described in detail, and the differences between the author's results and those of preceding writers carefully pointed out. The innervation of the eye is also discussed.

An explanation of the morphological difficulty that the rods of the eye of *Pecten* are turned away from the light, has been attempted by Bütschli, who ascribes the difference from the eye of other Molluscs to the different mode of development of the lens; in Vertebrates and in *Pecten* it is formed outside the optic vesicle, but in other Molluscs within the eye. If, however, the eyes of *Pecten* are not, as Patten says, homologous but only analogous with those of other Molluscs, the eye of *Pecten* will remain a histological and morphological unique.

Another problem is offered by the multiplication of the eyes in the Pectinidæ. Patten's explanation is altogether rejected, and a kind of mosaic theory is suggested. The aberrant structure is due to the special conditions of life of these Lamellibranchs, for the only free surface on which eyes can be developed is the edge of the mantle.

Nervous Elements of Adductor Muscles of Lamellibranchs.*—Signor R. Galeazzi has investigated the nervous element of the adductor muscles of *Mytilus edulis* and of *Ostrea.* He finds that these muscles are very rich in nerve-fibres and ganglion-cells. The former give rise to a very fine reticulum in the muscle; the terminal nerve-fibrils are united to the nucleus of the fibre-cell, or rather with its protoplasmic nuclear prolongations. He is of opinion that all the muscular fibres may have a nerve-fibre, and he cannot agree with those who think that it is absolutely impossible for every muscular fibre to have a nerve. The large number of ganglionic cells in the connective tissue between the muscular bundles leads us to admit the presence of certain automatic nervous centres in the muscle itself; the presence of these would explain the considerable power possessed by the adductor muscles.

Swelling of Foot of Solen pellucidus.†—Herr K. Möbius states that if young (1–2 cm. long) examples of *Solen pellucidus* be magnified from twenty to thirty times they may be seen to suddenly protrude their foot and to swell it out. While this is being done fluid may be seen to pass from the basal parts to the free end, and this can be nothing but blood which comes from the pallial reservoirs.

Molluscoida.

β. Bryozoa.

Stalked Bryozoon.‡—Mr. J. Walter Fewkes gives the name of *Ascorhiza occidentalis* to a new Bryozoon found at Santa Barbara. It is remarkable for having the zoarium massed into a spherical or oval capitulum, which is mounted on a jointed stem; the latter is flexible and highly sensitive to the touch. It is about an inch in height, and is of a uniform brownish red, the colour closely approximating to that of the giant kelp (*Macrocystis*), with which it was found associating. It has a carnose body which recalls that of *Alcyonidium;* it differs from the entoproctous genera in its colonial form, though its stem closely resembles that of *Urnatella*, with which it is probably homologous. It also has some likeness to Busk's genus *Ascopodaria*, in which there is a barrel-shaped body at the base of the peduncle. The structure of this form is possibly to be explained by regarding it as a Ctenostomatous form allied to *Alcyonidium*, but with a stem. If this be so, the new genus presents characters of both the great divisions of the Byozoa, but a new family will have to be formed for it. Sufficient knowledge of the polypide has not yet been obtained for us to say whether it is ctenostomatous or cheilostomatous.

* Arch. Ital. Biol. x. (1888) pp. 388–93 (1 pl.).
† SB. Gesell. Naturf. Freunde, 1888, p. 34.
‡ Ann. and Mag. Nat. Hist., iii. (1889) pp. 1–6 (1 pl.).

γ. Brachiopoda.

Recent Brachiopoda.*—The late Dr. T. Davidson's monograph of recent Brachiopoda is now completed. The two groups Arthropomata and Lyopomata each contain three families; the former, which has the greater number of species, is divided into the Terebratulidæ, in which a number of subfamilies are recognized, the Thecidiidæ, and the Rhynchonellidæ; and there are in all seventeen genera or subgenera. The Lyopomata embrace the Craniidæ, Discinidæ, and Lingulidæ, the only subgenera being *Discinisca* and *Glottidia*. Some additional notes are added by Miss A. Crane, who has had the editorial charge of the work.

Arthropoda.

Vision of Arthropods.†—Prof. F. Plateau gives a short summary of the results of his long continued experiments on the phenomena of vision in Arthropods. Those that have no eye, such as certain Myriopods, distinguish light from darkness. These dermatoptic perceptions very probably exist in most Arthropods whether or no they have visual organs, and they explain most of the special facts presented by individuals who have been artificially blinded. In Arthropods with simple eyes only, vision is, as a rule, very bad. Some, like Myriopods, Spinning Spiders, and Phalangida, do not seem to perceive the form of a body at any distance at all; others, like Hunting Spiders, Scorpions, and larvæ, seem to see the contours of objects more or less confusedly; but the distance seen is always small. A large number of Arthropods perceive the displacements of mobile bodies; all aid their insufficient visual organs by a skilful use of the organs of touch. Notwithstanding the absence of a power of really distinct vision, in the sense understood of Vertebrates, there are three chief factors which cause Arthropods with simple eyes to move about with sufficient adroitness to provide food, and to sometimes present such a bearing as to lead a superficial observer to believe that they are endowed with good sight. When an Arthropod has both compound and simple eyes the latter are of hardly any use.

An Insect with compound eyes has no sharp perception of form; from the functional point of view facetted eyes are inferior to the eyes of Vertebrates. Though they have no complete perception of form some perceive movements which are not too rapid, as do the Lepidoptera, Hymenoptera, Diptera, and Odonata; at distances which vary between 58 cm. and 2 metres these animals see displacements of objects of a certain size much better than they see the objects themselves. What, in a general way, happens with a flying insect is this—the animal moving in air with a very lively perception of light and shadow is able to avoid masses, such as trunks of trees, rocks, or walls, and passes them at a suitable distance. If by chance he should be in the midst of underwood or any other group of plants, he profits by the solutions of continuity through which light is filtered, or which offer him the largest surface. If the wind agitates the leaves the openings oscillate, but, thanks to his power of perceiving movement, he sees them all the better; he describes, in flying, undulations so as to follow the direction of the displacements, and to get out without injuring himself. When his mode of feeding

* Trans. Linn. Soc. Lond., iv. pp. 1–74, pls. i.–xiii. (1886); pp. 75–182, pls. xiv.–xxv. (1887); pp. 183–248, pls. xxvi.–xxx. (1888).

† Bull. Acad. R. Sci. Belg., lviii. (1888) pp. 395–457 (1 pl.).

requires him to visit certain flowers he comes to them with certainty, if his sense of smell is well developed, or by chance, if it is not. Incapable of distinguishing different flowers by their forms, he hastens towards coloured spots, hesitates, and only decides when he is close enough to know by their odour whether he has found what he was seeking. The same is true of living prey; if it is ordinarily immobile it is known by its odour, if it is agile it is recognized by its movements. Smell or smell with sight bring about the congress of the sexes. The perception of movements warns the insect of the approach of an enemy. Prof. Plateau feels that in thus insisting on the imperfect visual power of Insects he is taking up a position which is opposed to deeply seated beliefs, but he bases himself on his experiments, and demands that he be answered by experiments alone.

α. Insecta.

Anatomy and Biology of Physapoda.*—Dr. K. Jordan gives an account of the group of Insects to which the term Thysanoptera is often applied, and which Prof. Claus—for example—more correctly calls Physopoda. The author would separate these insects from the Orthoptera, and establish a special order for them. He is of opinion that the difference between Insecta metabola and ametabola is only apparent; the mode of development of the latter is not opposed to that of the former; in the one case there is continuous, in the other interrupted change, and between the two extreme types there are intermediate stages. It is not true that all Orthoptera or Rhynchota are now ametabolous. The Orthoptera amphibiotica have larvæ which are unlike their imagines, and may be called hemimetabola. Change goes still further in the Coccidæ among the Rhynchota, and the metamorphosis of the Physopoda is quite similar to that of the Coccidæ.

The palæozoic insects are allied to Orthoptera, Thysanura, Homoptera or Neuroptera, and the other orders of Insects only appear in mesozoic or cainozoic periods; palæontology tells us nothing as to the point of origin of recent insects. The Hemiptera appear to be derived from the Homoptera, while all the rest are further developments of orthopteroid or neuropteroid forms. The carboniferous Homoptera and Neuroptera were probably derived from orthopteroid forms. And there appear, therefore, to have been two series of developments arising from the broad base of the Orthoptera—one to the Insecta holometabola, the other through the Homoptera to the Heteroptera. The latter group have the germinal stripes internal, and includes those insects whose larval stages are anatomically similar to the imaginal; among these the Physopoda must be placed.

When we come to inquire more closely as to their position we must consider their special anatomy and biology. They, especially in their larval state, resemble the small Cicadellinæ; the hypognathism of the vesicular feet is so strongly marked that the oral cone comes to lie under the prothorax; the number and position of the ocelli calls to mind the Orthoptera rather than the Hemiptera, while the position of the antennæ is as much orthopteroid as aphidoid. In the development of the mandibular organs the Physopoda do not differ as much as do the Rhynchota; the physopod proboscis is intermediate in type between

* Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 541–620 (3 pls.).

that of the biting Orthoptera and the sucking Rhynchota. With both they agree in having a free prothorax; with regard to other parts of their exoskeleton they agree sometimes with one and sometimes with the other group. The wing is of the pterophorine type. In the possession of a concentrated nervous system the Physopoda come very near to the Rhynchota, and are widely separated from the Orthoptera, the aberrant Mallophaga, however, having also a concentrated nervous system. The tracheal system has only three or four pairs of stigmata, but such a reduction is often seen among holometabolous insects. The digestive apparatus is characterized by having only four Malpighian vessels, as is the case in most Rhynchota, except the Aphides which have none, and the Coccidæ which have only two tubes. Most Orthoptera have a number, but the Termites and the Psocidæ have only six, and the Mallophaga four.

The male generative apparatus with its simple, often pyriform testicular tubes, is somewhat like that of both the Mallophaga and the Phytophthira; the female organ, by the rosette-like arrangement of the few ovarian tubes, resembles the tubes of the Rhynchota. On the whole, then, the Physopoda appear to have a closer anatomical resemblance to the Homoptera than to the Orthoptera, and there are certain biological facts which sustain this conclusion; and there can be no doubt that the Physopoda should be separated from the Orthoptera.

It depends upon the view which we take as to the general classification of Insects as to what we shall next do; if we hold to the old views, we must place the Physopoda with the Rhynchota, and divide that order into Heteroptera, Homoptera, and Physopoda. If, however, we break up the "conglomerate" of Orthoptera into several orders equal in value to such as the Coleoptera or Diptera, we should destroy the true rhynchote type by inserting the Physopoda under it, and we must, in that case, make a special order for them. Such an order would stand between the Rhynchota and the Conodontia (or Mallophaga, Psocidæ, and Termites). It might be defined as having, among others, these characters: a very small body; a hypognathous head; unsymmetrical, sucking mouth-parts; antennæ with seven to nine joints; facetted eyes, large; generally three ocelli. Thoracic rings pretty long; prothorax free; metanotum longer than mesonotum; mesophragm free, metaphragm absent; abdomen with ten segments, anal segment often tubular. Legs short; tarsus with one or two joints. Two pairs of very small wings, with nervures reduced. Three or four pairs of stigmata. Four Malpighian vessels; two pairs of salivary glands. Nervous system concentrated. Heart small. With or without an ovipositor, female orifice between eighth and ninth or ninth and tenth abdominal segments; male orifice between ninth and tenth. Reproduction sexual or parthenogenetic. Germinal stripe completely internal. Larva like imago, nymph does not feed, but larva and imago phytophagous.

New Organ and Structure of Hypodermis in Periplaneta orientalis.*—Mr. E. A. Minchin gives an account of an undescribed organ in the Cockroach. Two pouch-like invaginations of the cuticle lie close on each side of the middle line, between the fifth and sixth terga of the abdomen. They are lined by a continuation of the chitinous cuticle, which forms, within the pouches, numerous stiff, branched, finely pointed

* Quart. Journ. Micr. Sci., xxix. (1888) pp. 229-31 (1 pl.).

hairs, beneath which are a number of glandular epithelial cells. They have no special muscles. The function of these bodies is probably that of a stink-organ.

Mr. Minchin gives a somewhat different account of the structure of the hypodermis than that which is found in Miall and Denny's work on the Cockroach. He finds that the hypodermis does not consist of a single, but of two layers of cells, except where the cuticle is folded to form an articulation, when the upper alone remains. In certain parts the cells of the lower layer become giant-cells, and are undoubtedly ganglionic; they are extremely abundant in the fore-part of each tergum. The nerve-end cells are probably connected with a seta where the terga are exposed, but where these are overlapped they seem to be merely connected with small papillæ.

New Mode of Closing Tracheæ of Insects.*—M. G. Carlet describes a mode of closing the tracheæ of insects which has been hitherto undescribed. He calls it "fermeture operculaire." In the Hymenoptera there is between the genital armature and the integument a piece which he calls the fenestrated scale, as it is pierced by a large stigma. Within this stigma the trachea resembles one of the baskets with an oblique cover which are carried by fishermen. A tracheal muscle is spread on this cover (operculum); when the latter is raised, the trachea is closed and its contents isolated from the outer air.

New Organ of Hymenoptera.†—M. G. Carlet has found it difficult to understand how the sting of Hymenoptera, or even the movements of respiration, can fail to affect injuriously the delicate tracheal apparatus described in the preceding note. He has now, however, found a new organ, which he calls the *coussinet;* this has a plano-convex form and is fixed by its plane surface against the anal scale, while its convex side answers to the portion of the fenestrated side not occupied by the tracheal apparatus. By its means this last is kept free from the anal scale; the operculum is in contact with no other piece of the poison apparatus, and may be raised or depressed freely by the contraction or relaxation of the tracheal muscle. This new organ is composed of spheroidal cells with granular protoplasm, which are connected with one another by a fine and transparent chitinous substance; this last connects the mass of cells with the anal scale. It may be said to form a pivot for the poison apparatus, the movements of which it facilitates.

Male Copulatory Apparatus of Pompilidæ.‡—General Radoszkowski finds that the structure of the copulatory apparatus of the genera of this family of Hymenoptera is of a common type. He considers it under the five heads of preparatory apparatus, forceps, basilar piece, genital operculum, and genital palpi.

The preparatory apparatus is composed of two bodies united by a membrane which it is very difficult to detach; the hooks are more or less elongated, and their terminations may be rounded, or cut sharply off, or forked. The forceps is composed of a long and wide arm, which is always provided with hairs, of a basal piece of varying form, and of a "volvella," at the base of which are two or three teeth. The basilar piece is always more or less large. The genital operculum is composed

* Comptes Rendus, cvii. (1888) pp. 755–7.
† T.c., pp. 955–6.
‡ Bull. Soc. Imp. Moscou, 1888, pp. 462–93 (4 pls.).

of two parts, which vary in form, while the genital palps are elongated or round, and are always provided with hairs. The several genera examined are described in detail, and some new forms are to be found among the species.

Enteric Canal of Ephemeridæ.*—Herr A. Fritze finds that the digestive tract of the Ephemeridæ consists, in all stages of development, of fore-, mid-, and hind-gut. The œsophagus of the larva is spacious, but in the imago it is very narrow, so as to hinder the exit of the air contained in the tract. The mid-gut of the larva has the form of a cylindrical tube which extends from the beginning of the thorax as far as the seventh segment of the thorax; it consists, histologically, of a strong layer of circular muscles and a high palisade-like epithelium, the cells of which are filled with granular matter. In the imago the muscular layer has disappeared, and the epithelium has become flattened. The hind-gut, which in the larva serves for the passage of the fæces and the secretion of the Malpighian tubes, and in the imago for that of the latter only, is divisible into small intestine, large intestine, and rectum. The first of these portions is, in the imago, converted into a very complicated sphincter, the function of which is to hinder the escape of the air contained in the mid-gut. The large intestine has a very peculiar lining epithelium, the function of which is, probably, excretory; its cells are constantly being destroyed and renewed.

The enteric canal of the Ephemeridæ is in no stage rudimentary, but is everywhere completely formed histologically; in the various stages of the development of the animal it alters its function, for while in the larva it serves for purposes of digestion, in the imago it contains air, &c., and serves as a parachute on the one hand, and aids, on the other, the functions of the reproductive organs. This change of function affects its external form and its histological structure; the metamorphosis occurs in the nymph and subimago stages. Among the species examined were *Ephemera vulgata* (imago), *Bætis fluminum* (larva, nymph, subimago, and imago), *Cloe diptera* (all four stages), and *Cænis lactea* (imago).

Lepidopterous Larvæ.†—Mr. E. B. Poulton gives, in detail, an account of his observations on Lepidopterous larvæ in 1887. He commences with complete accounts of the life-history of *Sphinx convoluti* and *Aglia tau*. The ovum of the former is remarkable for its extremely small size; its development is at about the same rate as that of *S. ligustri*, namely, from eight to ten days. In the ontogeny of the latter there are a number of important characters by which it shows itself related to the Sphingidæ, and especially to *Smerinthus*; these have led the author to consider the natural position of the Sphingidæ, and he concludes that there is a large body of evidence in favour of the view that they are a specialization of Saturnian Bombyces. From a consideration of the larvæ Mr. Poulton concludes that the characteristic Sphinx attitude is to be explained as the combined effect of gravity and of muscular reaction upon the anterior unsupported parts of the body. An account is given of the use of the graphic method of representing the growth of lepidopterous larvæ. The means of defence adopted by the larva of *Stauropus fagi* are next considered; the irritated larva

* Ber. Naturf. Gesell. Freiburg, iv. (1888) pp. 59–82 (2 pls.).
† Trans. Entomol. Soc. Lond., 1888, pp. 515–606 (3 pls.).

assumes a spider-like attitude for the purpose of alarming its enemies. He discusses the matter at some length, and finds that "the larva of *Stauropus fagi* bristles with defensive structures and methods. When at rest it is concealed by a combination of the most beautiful protective resemblances to the commonest objects which are characteristic of its food-plant. Attacked, it defends itself by a terrifying posture, which is made up of many distinct and highly elaborate features, all contributing to this one end. Further attacked by an insect-enemy it reveals marks which suggest that it is of no interest to its enemy, for another parasite is already in possession.

The black colour of the eggs of *Paniscus cephalotes* appears to serve as a warning to the other insect parasites belonging to the same and other species that the larva of *Cerura vinula* is already occupied. The defensive value of "tussocks" and the associated black intersegmental markings are next considered. A "tussock" may be defined as a tuft of fine hairs, very closely placed, and of approximately equal length, so that the structure is flat-topped; the constituent hairs bristle with minute lateral branches; if seized the fine hairs come out in immense numbers in the mouth of the enemy, and produce such an effect that the larva escapes unhurt. When the larva is irritated the tussocks are held in an especially conspicuous manner, while the black markings are revealed, and assist by rendering the tussocks more obvious and giving an appearance of increased projection.

The larvæ of the Cochliopodidæ gain protection by assuming a form which is quite unlike that of a caterpillar, and does not suggest the appearance of the food of any insect-eating vertebrate. Other points on which, in this interesting paper, Mr. Poulton has notes are the protective resemblances of the larvæ of *Geometra papilionaria*, a proof of the protective value of dimorphism in larvæ, the protective resemblance of the pupa of *Apatura iris*, the defensive secretion of the larva of *Crœsus varus*, the geometriform structure and attitudes of *Euclidia mi*, and the determination of sex in certain living lepidopterous larvæ. As to the last point, use has been made of the distinctness of the testes which lie beneath the skin of the fifth abdominal segment, and which can be easily seen beneath the skin of all fairly transparent larvæ, and by careful examination in moderately transparent forms.

New Genus of Pyralidæ.*—Lord Walsingham describes a remarkable Indian Pyralid, which he calls *Cœnodomus hockingii.* The larvæ are gregarious, and live in strong tubes of white silk, of the consistency of stout cardboard; these are open at both ends, and from three to fifteen are agglomerated together, the heads of the larvæ projecting from one or other end, according to the position of the leaves of their food, to which the whole mass of tubes is attached by stout silken threads consisting of many strands. The walls of these tubes are double, and of very curious construction; the inner lining of white silk is smooth and rather shining, while the outer layer is much stouter and has an uneven surface; this last is due to the interposition of larval excrement between the two walls. A more perfect arrangement for keeping off heat from the body of the larvæ cannot be imagined. The silk at the ends of the tube is frayed out, and has apparently been used for attaching them to the leaves and twigs, or for changing the position of the

* Trans. Linn. Soc. Lond., v. (1888) pp. 47–52 (1 pl.).

common dwelling, according to the feeding requirements of its various inmates.

Parthenogenesis of Death's-head Moth.*—Sig. C. Massa describes a case of parthenogenetic birth in the Death's-head moth (*Sphinx atropos*). The insects were isolated in the larval stage, only one survived, a female which laid eggs, a few of which hatched, though none survived. If this is the first time the fact has been noticed in *Sphinx atropos* an addition must be made to the already long list of occasionally parthenogenetic moths.

Mouth-organs of two species of Rhysodidæ.†—Mr. G. Lewis gives an account of the mouth-organs of *Rhysodes niponensis* and *Clinidium veneficum*, which have been dissected out by the Rev. A. Matthews. The gnathites of the latter are exceedingly fragile, while the surrounding integument is almost as hard as iron, and cannot be penetrated without more or less danger to the finer parts. These organs are the most extraordinary that Mr. Matthews has ever seen; the labrum is very large, the clypeus and mentum very large and of the hardest and most impenetrable horn; the maxillary palpi are very long, the maxillæ, labium, and lingua exceedingly fragile and minute. The labium appears to be extensile, like that of *Stenus*; the lingua is very large and broad, and so thin as to be perfectly transparent. The mandibles are abnormal, being inclosed in a horny envelope open on the inside.

Thysanura and Collembola.‡—Dr. J. T. Oudemans has a contribution to our knowledge of these Insects, He finds that the Thysanura present many points of agreement with one another; all have ten abdominal segments, the last of which carries cerci, and several of those in front have actively moving, laterally placed legs. In the Collembola the number of abdominal segments varies, but is always less than ten; there are no appendages on the last segment, for the anal hooks cannot be considered as such; there is a springing apparatus on the median line of the ventral surface. Eyes may or may not be present; in the former case the Thysanura have compound, but the Collembola merely simple eyes. The body may or may not be covered with scales. The eversible vesicles on the hind-body of *Machilis*, *Nicoletia*, and *Campodea* have a very similar structure to the eversible parts of the ventral tube of the Collembola.

The abdominal nervous system of the Thysanura has eight ganglia; in *Campodea* there appear to be only seven; the fusion of ganglia seems to be less marked in elongate forms (e.g. Templetoniinæ and Lipurinæ) than in the compressed Sminthurinæ. The eyeless forms appear to have lost their eyes in consequence of their mode of life under stones, in earth, bark of trees, and so on.

The form of the mouth-parts in the two groups is very similar; the labium is always deeply cleft, as in the Orthoptera. In the Thysanura the mandibles and maxillæ are open internally, and by this orifice the muscles pass which are attached to the outer wall; it is probable, though not certain, that the same is true of the Collembola. The enteric canal is always straight and never longer than the body; a masticatory stomach is found in *Lepisma* only. The epithelium of the

* Bull. Soc. Entom. Ital., xx. (1888) pp. 64–5.
† Ann. and Mag. Nat. Hist., ii. (1888) pp. 483–4.
‡ Bijdragen tot de Dierkunde, xvi. (1888) pp. 146–226 (3 pls.).

stomach varies in character; in *Machilis* (and *Lepisma* ?) there are depressed spots which are centres of regeneration. In *Campodea* and *Macrotoma plumbea* [*um*] these spots are wanting. The Thysanura have salivary glands, but it is not yet certain that these organs are generally present in the Collembola. Malpighian vessels are found in *Machilis*, *Lepisma*, and *Nicoletia*, but wanting in *Japyx* and the Collembola; *Campodea* is in this respect an intermediate form, for it has diverticula. So far as is known the Thysanura have nine pairs of ostia in the dorsal vessel; such representatives of the Collembola as were examined have only five pairs; the blood is always coloured yellow, and contains blood-corpuscles. In both groups tracheæ are found, but they may be wanting in the Collembola, and, where present, are always feebly developed. In some of the Thysanura the tracheæ do not form anastomoses; the stigmata of these forms are thoracic and abdominal in position; in the Collembola they are found on the head.

The generative organs of the two groups show some differences. The female gonads of *Machilis*, *Lepisma*, and *Nicoletia* agree in most points; there are two oviducts, and with each a varying number of ovarian tubes are connected; they have an ovipositor which always belongs to the eighth and ninth segments of the abdomen. Both male and female gonads in *Campodea* exhibit considerable resemblance to those of the Collembola; in the latter these organs are always two simple tubes.

The author thinks that neither group can be placed in any of the orders of Insects, for the complete absence of wings and of any sign of metamorphosis forbid it. He agrees with P. Mayer and F. Brauer in speaking of them as Apterygogenea as opposed to the other Insects, which are Pterygogenea. He regards the Thysanura as a distinct family from the Collembola; the former are divided into the Lepismidæ and the Campodeidæ, and for the latter he accepts Tullberg's divisions of Sminthurinæ, Templetoniinæ, and Lipurinæ. He concludes with a tabular statement of the various points of difference.

β. Myriopoda.

Classification of Myriopoda.*—Mr. C. S. Kingsley doubts the homogeneity of the group of Myriopoda, and considers that the features common to the Chilopoda and Chilognatha are possessed by all other air-breathing Arthropods. The best definition for the whole group will probably run as follows:—The Myriopods are air-breathing Arthropods with elongate bodies and more than three pairs of legs.

The Chilognatha or Millipedes have a head which bears, besides antennæ, only two pairs of appendages; all but the more anterior segments of the body carry two pairs of appendages; and the bases of these legs are placed close to one another. The Chilopoda have three pairs of gnathites, each segment has but a single pair of legs, and these are widely separated at their base. The stigmata of Chilopods are placed at the sides of the body, above and outside the line of the legs; in the Chilognaths they are placed beneath or even in the coxal joints of the legs. The most marked points of difference are to be found in the generative organs. Chilopods are very closely allied to Insects; the Chilognaths seem to stand alone, *Peripatus* being nearer the annelid than the hexapod stock.

* Amer. Natural., xxii. (1888) pp. 1119–21.

γ. Prototracheata.

Development of Peripatus Novæ-Zealandiæ.*—Miss L. Sheldon has a further account† of her observations on the development of *Peripatus Novæ-Zealandiæ*. The central nuclei of the segments of the yolk which lie just beneath the periphery multiply much more rapidly than those over the rest of the ovum. They thus come to form a special area, which finally extends along about the middle third of the ovum, and consists of a loosely reticulate mass of protoplasm which contains a large number of nuclei. This area is triangular in form, and becomes more compact, and flattens itself out to form the blastoderm. It grows round the ovum till it covers about one-half of its surface, and the epibolic growth continues until the blastoderm covers all but a very small space in the middle of the ventral face of the ovum. Behind the uncovered area, and in the middle line, there is a proliferation of nuclei, which, in transverse section, gives rise to a keel-shaped mass of nuclei which extends along the posterior half of the ovum; round this space the protoplasm becomes inflected, or forms a blastopore. This last increases in length considerably, and becomes more open. The primitive streak also becomes wider and deeper, and the primitive groove appears along its centre. A small cavity, apparently homologous with the polar area of *P. capensis*, appears and then disappears. Up to this stage there are no signs of any cell-outlines, but the protoplasm forms a syncytium in which nuclei are irregularly scattered. Want of material causes a large gap in the observations at this point. After the appendages are formed, the history of development is very similar to that of *P. capensis*, but it is interesting to note that the duct of the first somite opens to the exterior.

The study of this new set of specimens has made the difference between the developmental history of this species and that of *P. capensis* less marked than it had previously been supposed to be. In fact, it is rather strange that the almost total loss of yolk by the Cape species should have apparently been accompanied by so few modifications in its development. The material in hand does not allow of any statement as to the mode or time of origin of the ectodermal yolk in *P. Novæ-Zealandiæ*, but as it appears in both species after the gastrula stage, it is probably an ancestral feature in the development.

The ova probably pass from the ovary into the uterus in December, and the young are born in July; to this, however, there are some exceptions, as some January specimens contained embryos ready for birth, and the embryos in one female vary somewhat in age.

δ. Arachnida.

Coxal Glands of Arachnida.‡—Dr. J. C. C. Loman has examined the coxal glands of six Arachnids, among which are *Scorpio*, *Epeira*, and *Phalangium*; on the whole he corroborates the results of those who have preceded him in these investigations; the organ in *Phalangium* is described at somewhat greater length than those of the other types. He cannot think there is any doubt about our having here the homologue of a segmental organ, but he is not so certain that the coxal gland is the

* Quart. Journ. Micr. Sci., xxix. (1888) pp. 283–93 (2 pls.).
† See this Journal, 1888, p. 33.
‡ Bijdragen tot de Dierkunde, xiv. (1887) pp. 89–96 (4 figs.).

homologue of the shell-gland of the Entomostraca. The poison-gland of *Galeodes* is an allied and perhaps a homodynamous organ.

Brain of Araneida.*—M. G. Saint-Rémy has been investigating the brain of dipneumonous Araneida. It is on the same plan as that of the Phalangida and Scorpionida; it is most complicated in the Citigrada, the appearances in *Lycosa narbonensis* and *Cardosa sacrata* being described. The greatest modifications are seen in the inferior lobule; this portion undergoes considerable reduction in the Orbitelaria, and more so in *Epeira diadema* than in *E. sericea.* In the Tubitelaria the inferior medullary masses have disappeared, and the fibrillar layers are directly attached to the lateral lobes. In *Tegenaria* the medullary layer is formed of three layers of nerve-tubes; in *Drassus* it is formed of a compact mass of tubes; in *Segestria* it is less distinct, and the commissure of the masses is a mere thread. In the Retitelaria (*Pholcus*) the inferior and superior lobules are separated, and the medullary layers are simple dotted masses, with a reticular structure. In the Saltigrada (*Eresus*) the inferior lobules are large and separate.

Anatomy of Pseudoscorpions.†—Herr A. Croneberg gives an account of his investigations into the structure of the so-called Pseudoscorpions. The characters of *Chernes* and *Chelifer* show that they have no close relationship to the Scorpions. The respiration by means of tracheæ, the concentration of the nervous system, and the position of the generative orifices remove the Chernetidæ from the Scorpions; the peculiarities of their development point to the great age of this group, some of the characters of which, such as the complete segmentation of the body, the relative development of the rostrum, and the transverse musculature of the abdomen, may have been retained to the present day. The Pseudoscorpions may be more nearly allied to the simpler forms of Opilionida, such as the Sironoids, but are separated from them by the important relation of the first two pairs of legs to the mouth. *Gibbocellum*, as Thorell has rightly insisted, must be separated from the Sironoids and placed with the Pseudoscorpions; for it has only a superficial resemblance to the former. Much remains to be done before the affinities of the various groups of Arachnids can be satisfactorily determined.

Marine Acarina of Wimereux.‡—M. E. L. Trouessart gives an account of a small collection of marine Acarina made at Wimereux by Prof. Giard. He has found a number of the species described from the English coast by Gosse and Hodge and Brady, as well as several new forms. There is a perfectly typical *Gamasus* which he calls *G. Giardi; Eupalus sanguineus* sp. n. was found with *E. Giardi* on *Balanus balanoides*, on which also lives *Rhyncolophus rubipes* sp. n. Six species of Halacaridæ were found, and of these there are two new genera. *Copidognathus* (*C. glyptoderma*) has the cheliceræ swollen and free from their base, and there is no trace of the unpaired eye; *Leptosalis longipes* g. et sp. n. was found in Mussels; its palpi have the last joint bifid, and so form a small cheliform forceps, the lower lip is prolonged into the form of a spatula, and so gives rise to a groove, in which the mandibles move; these last are intermediate in form between those of *Copidognathus* and those of *Halacarus*.

* Comptes Rendus, cvii. (1888) pp. 926–9.
† Bull. Soc. Imp. Nat. Moscou, 1888, pp. 416–61 (3 pls.).
‡ Comptes Rendus, cvii. (1888) pp. 753–5.

Structure and Development of the Visual Area in the Trilobites.* —Mr. J. M. Clarke has made an interesting addition to our knowledge of the eyes of Arthropoda by an account of those of the common fossil *Phacops rana*. In many cases both cornea and scleron are normally preserved; in others one alone is retained; in others both may be removed, leaving pillars of the matrix with cup-shaped surfaces, each bearing a little ball at the centre; an external film may be removed from the entire visual area, destroying the cornea, or, lastly, silica may be deposited as a thin film upon or replace a thin film of the external and internal surfaces of the test, and all the rest of the substance of the test and matrix may be removed.

Mr. Clarke thinks that the schizochroal eyes of the Trilobites are aggregated, and not properly compound eyes. The visual organs of *Harpes* may prove to be of similar character. The scleral portion of the visual surface is of the same structure as the test, and is a direct continuation of it. There is no evidence of any continuous corneal layer covering the entire surface. The corneal lenses are wholly discrete from the epidermis, but are of epidermal origin. In the addition of new lenses to the visual surface, they appear to arise from a thinning of both surfaces of the integument. The corneal lenses were hollow or were filled with some matter not homogeneous with the cornea itself. The corneal lenses, and, therefore, the ommatidia were added to the visual surface with advancing age until the mature growth of the individual was attained; thereafter they diminished in number with increasing senility. The addition of corneal lenses occurred regularly at the extremities of the diagonal rows. No evidence is preserved of crystalline cones in the ommatidial cavities, but they may have been removed in the decomposition of the soft parts of the eye.

With regard to the suggestion of Dr. J. S. Kingsley, in his paper on the eye of *Crangon*, that the mere fact of invagination indicates an ancestral condition, Mr. Clarke states that in *Mesothyra oceani*, one of the largest known representatives of the Phyllocarida, the eye consists of a simple deep pit at the summit of the optic node. There is no evidence that this pit contained a series of lenses, but it may serve as the ancestral condition of the Decapod eye.

Migrations of Pentastomum denticulatum in Cattle.†—Dr. V. Babes had in the summer of 1888 the opportunity of examining some thirty-five cattle which had died of epidemic hæmoglobinuria. In all but one instance he was able to verify the existence of the *Pentastomum denticulatum*. He found numerous specimens of the parasite in the mesenteric glands and between the two peritoneal layers of the mesentery; while in the convexity of the intestinal coils he met with roundish nodules about 5 mm. broad, and often arranged at regular distances. These nodules contained a living Pentastomum larva. As the parasite advances in development, so it proceeds towards the lumen of the intestine, the perforation of the mucosa being accompanied by hæmorrhage. In one case hundreds of parasites were found free in the intestinal canal.

It sometimes happened that living examples were not discovered either in the glands or in the intestinal walls, but the glands were found

* Journal of Morphology, ii. (1888) pp. 253–70 (1 pl.).
† Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 1–5.

in various stages of degeneration, and scar-like points were seen in the intestinal coats.

The author is of opinion that the migration path of these parasites is outwards, that is, towards the lumen of the gut, but he does not neglect to notice that the animals may burrow back into the mucosa for a short distance.

The connection between this parasite and the hæmoglobinuria, said to be endemic in Roumania, is very interesting.

ε. Crustacea.

Monstrosity in a Crayfish.*—M. G. Stamati remarks that accessory pieces have not yet been noticed except on the legs of Crustacea. He describes a specimen in which the exopodite or squama of the left antenna had a bifurcated appendage so placed that the free point of the scale appeared to be trifurcate. This supernumerary growth appears to arise from the left half of the scale, and there is no reason to suppose that it is, as Rösel von Rosenhof would have suggested, the result of any lesion, nor with Herklots, to regard it as a simple excrescence. It seems to the author more reasonable to regard the appendage as a dependent of the external half of the scale which is regularly developed; it is only because of the growth of its two halves that the two points have been directed forwards. The investigation of the development of supernumerary growths on the appendages of Crustacea can only be investigated on young specimens and after ecdysis.

Nebaliidæ and Leptostraca.†—Prof. C. Claus publishes a monographic account of the Nebaliidæ, on the structure of which he gave a preliminary report more than ten years ago. The present memoir discusses the history, general morphology, general physiology, reproduction, and distribution of the family. The systematic portion includes diagnoses of *Nebalia*, *Paranebalia*, *Nebaliopsis*, and discusses the general relations of the Leptostraca.

The following forms have to be distinguished:—(*a*) Mature males, characterized by the lank body, long furcal joints, bushy setæ on the anterior antennæ, and much elongated setæ on second pair of antennæ; (*b*) pregnant females with fans of bristles on the terminal joint of each thoracic appendage; (*c*) mature females and younger females of variable size with a short equipment of bristles on the terminal joint of the thoracic limbs; (*d*) young males of variable size, characterized by the short-ringed setose joints of the second antennæ; (*e*) larvæ with three-jointed antennary setæ, and a still simple fourth pair of pleopods.

The northern *N. bipes* O. Fabr. is a large variety of the Adriatic, Mediterranean, and Atlantic *N. geoffroyi*. The form found on the east coast of North America, those from Chili and Japan, and probably the *N. longicornis* of New Zealand, are to be regarded as mere varieties of the same species.

The so-called rostral plate represents a third portion of the shell, which forms a movable head-valve. It covers two rostral processes of the head, and is so connected with them that raising the head elevates the head-valve. The two last segments of the abdomen with the

* Bull. Soc. Zool. France, xiii. (1888) pp. 199–201.
† Arbeit. Zool. Inst. Wien (Claus), viii. (1888) pp. 1–148 (11 pls.).

branchipodiform furca represent the telson of Malacostraca. The anus is also ventral.

The brain is much more highly differentiated than that of Phyllopods, and approaches that of Malacostracans. The mid-brain with the olfactory centres agrees in the presence of "olfactory glomeruli" with the olfactory lobes of Isopoda and Podophthalmata. The hind-brain (ganglia of the second antennæ) lies on the œsophageal commissure, and has a slightly developed sub-œsophageal transverse commissure in front of that of the mandibular ganglia. The mandibular and maxillary ganglia are quite distinct, as in *Apseudes* and *Sphæroma*. So too are the thoracic ganglia. Behind the six abdominal ganglia, there is in embryo and larva the rudiment of a seventh (as in *Sphæroma*). This degenerates. On the median surface of the stalked eye, between two protuberances, there is a special sense-organ of unknown import (frontal organ?). The histological characters of eye and optic ganglion most closely resemble those of the Mysidæ.

The masticatory apparatus in the stomach is complex, as in Malacostraca. Two cardiac teeth, a bristle-bearing ridge on the right side, two pairs of pyloric sieves, and a funnel-groove extending far into the intestine, are demonstrable.

The liver consists of two anterior sacs entering the head, and three pairs extending posteriorly to the last abdominal segments. Mid-gut and posterior liver-sacs are inclosed in a perivisceral connective-tissue which also surrounds the reproductive glands. The cells thereof are filled with fat-spherules of nutritive import in the fasting period. Pregnant females and mature males gradually use this material, and as it disappears the perienteric cellular strand shrivels, and the vascular space enlarges in proportion. At the end of the mid-gut there opens a cæcum, which lies above the rectum. The high cylindrical cells of this structure are continued far forward on the dorsal wall of the gut.

Besides the antennary gland there is a much reduced shell-gland, and eight pairs of limb-glands.

The heart extends from the maxillary region to the fourth abdominal segment; it has seven pairs of ostia, of which four to six are small and dorsal, the others lateral. Besides an anterior and posterior aorta, there are branched arteries in both pairs of antennæ and in the abdomen.

The reproductive ducts are as in Malacostraca. The females carry eggs and young in a sort of basket formed between the lamellar thoracic limbs and their bristle-fans. Even the hatched and moulting larvæ are sheltered therein.

The Leptostraca form the first main division of the Malacostraca. The fossil Archæostraca (Ceratiocaridæ, &c.) belong to the same series as the Leptostraca, as the mobile head-valve shows. They cannot, however, be included in the same order. The general structure, the form of the mouth-parts and appendages, the numbers of the segments, may have been very different. The memoir is copiously and beautifully illustrated.

Marine Ostracoda.*—Prof. C. Claus makes a brief communication in reference to a recent work by G. O. Sars on Mediterranean Ostracods. In this work Sars has entirely overlooked three important memoirs by Prof. Claus on Cypridinæ, Halocyprinidæ, and the general genealogy of

* Arbeit. Zool. Inst. Wien (Claus), viii. (1888) pp. 149–54.

Crustacea, as well as some contributions by other investigators. The author refers to some of the results of his papers which it would have been well that Sars had known of.

Cladocera of Hungary.*—Dr. E. D. de Deés has produced a monograph of the Crustacea Cladocera of Hungary, of which, unfortunately, the diagnoses of the genera and species are alone in Latin. About a hundred species are described, a few of which are new, but there are no new genera; the comparative tables of distribution will be the part of the work most accessible to the majority of English readers.

Calanida of Finland.†—Herr O. Nordquist, who has been working at the Copepoda of Finland, has published a monograph on the Calanida. Nearly all the forms are represented in the North Sea, and the Baltic specimens are more or less reduced in size somewhat in proportion to the diminution of the amount of salt in the water. Twelve species in all are described, among which *Temosella affinis* has two new varieties—*hirundoides* and *hispida*. The only Finland species not found in the North Sea is *Linnocalanus macrurus;* this must be assumed to have been produced in the Baltic or in the lakes, or to be a remnant of an Arctic fauna. The former view is negatived by the fact that this species is also found in the lakes of North America. The ova of this species are not carried about by the female, but sink to the bottom after extrusion, and we may, therefore, safely regard it as a relic.

Morphology of Cyclops ‡—Prof. M. M. Hartog gives a full anatomical description of *Cyclops*. The Copepoda may be regarded as very primitive forms among the Crustacea on account of (1) the plasticity of the eye, derivable from the triune inverted eye of the *Nauplius*, and of the absence of eyes of the paired compound type which may be termed the phyllopod eye; (2) the condition of the appendages, the antennules being always uniramous or retaining the primitive larval condition, the mandibles being sometimes biramous, and the first pair of maxillæ being most plastic; (3) the pleura are feebly developed, and never encircle the body; (4) the absence of gills, and the respiratory function of the anus; (5) the plasticity of the forepart of the alimentary canal; (6) the circulation and (7) the general form of the body. After making some critical and general remarks on these characters, the author gives a phylogenetic table in which the Copepoda Natantia occupy the lowest place. If in any Crustacean we are to seek a common relative to the Tracheata, and especially to the Arachnida, it must be among the Copepoda that we have to look.

Vermes.

a. Annelida.

Pericardial Gland of Annelids.§—Prof. C. Grobben gives a more detailed account of his views on the pericardial gland of Chætopods, along with some notes on the perienteric fluid. The general tenor of his conclusions has already been reported.‖ The pericardial gland

* 'Crustacea Cladocera Faunæ Hungaricæ,' 4to, Budapest, 1888, 128 pp. (4 pls.).

† 'Die Calaniden Finlands,' 8vo [2 plates stated to be 4to] 1888. See Ann. and Mag. Nat. Hist., iii. (1889) pp. 62–4.

‡ Trans. Linn. Soc. Lond., v. (1888) pp. 1–46 (4 pls.).

§ SB. Akad. Wiss. Wien, xcvii. (1888) pp. 250–63.

‖ See this Journal, 1887, p. 939.

arises on the epithelium of the secondary body-cavity, and thus the author associates the branchial heart appendage of Cephalopods, the pericardial glands in Lamellibranchs, Prosobranchs, and Opisthobranchs, the appendages of the dorsal vessel in Lumbriculidæ, and other structures in Chætopods. The body-cavity fluid is for the most part and perhaps originally of excretory import, but also takes on the respiratory and nutritive functions of lymph or hæmolymph—an example of great adaptability.

Anatomy of Megascolides australis.*—Prof. W. B. Spencer has a memoir on the anatomy of the giant earthworm of Gippsland, where it appears to be not uncommon, though its area of distribution is limited. The best sign of the worm's presence is a very distinct gurgling sound made by the animal retreating in its burrow when the ground is stamped upon by the foot. It has a curious odour, resembling somewhat that of creosote. When held in the hand the worm, on contracting its body, throws out jets of a milky fluid; an important, if not primary, function of this fluid is that of making the burrow walls smooth, moist, and slippery, and thus of enabling the animal to glide along with ease and speed. Its setæ appear to be of but little use to it in locomotion. Its cocoons are 1½ to 2 inches in length, vary in colour according to age, and contain only one embryo each.

The largest living specimen found was 6 feet long, and the average length is from 44 to 48 in., with a breadth of 3/4 in.; there are from 300 to 500, or perhaps even more, segments in a sexually mature worm. The setæ project only slightly beyond the surface of the body, and none are specially modified in connection with the male genital aperture. The dorsal pores are very evident oval openings in the mid-dorsal line. No nephriodiopores are visible.

The anterior septa are enormously developed, the first fourteen forming deep cups, with their concavities facing forward; their septa are connected with each other and with the body-wall by strong muscular slips. It is curious to note that the insertions of the septa do not correspond with the grooves separating the segments. The structure of the body-wall in the non-clitellar region is that which is characteristic of most earthworms, though in minor points it shows variations from that of *Lumbricus*. In the clitellar region the skin is, as usual, much modified, but differs in structure from that of *Lumbricus* or *Microchæta*. The narrow elongated cells containing granules similar to those of the goblet cells are absent, but there is a great development of glandular cells with long ducts leading towards the exterior; some have branched bases. The glandular portion is very rich in blood-vessels, which usually form distinct coils.

Salivary glands, which are obviously modified nephridia, are described, but there is no trace whatever of œsophageal glands, or of a typhlosole; the only modification of the intestine occurs in segments 12–18, where the walls are highly vascular and devoid of strong muscles.

The vascular system is comparatively simply developed, consisting of a dorsal and a ventral trunk, and transverse and dorsal vessels; there is no subneural trunk. The blood is red, owing to the presence of hæmoglobin, and contains very numerous nucleated corpuscles oval or rounded in shape, with a diameter of about 0·0016 mm., and few more

* Trans. R. Soc. Victoria, i. (1888) pp. 1–60 (6 pls.).

irregularly shaped nucleated corpuscles, from which few or many stiff pseudopodia-like processes may be extended. The cœlomic fluid is of a milky white colour and opaque, and its numerous corpuscles resemble the latter of the two forms found in the blood.

The nervous system has, in the main, the form usual in earthworms, and its minute structure is very similar. The giant-fibres, which can in no way be called neural canals, are remarkable for the very definite central rod of homogeneous gelatinous material, and for the equally definite inclosing sheath of connective tissue. Prof. Spencer thinks that the most appropriate name for these organs is Vejdovsky's term neurochord.

The characters of the nephridia are dealt with at some length; the main features of the system are the presence of numerous nephridia in each segment, the modification of the nephridia in various parts of the body, and the connection of the ducts of the various nephridia. Two distinct kinds are present; there are numerous small nephridia, which lie so close to one another that the shape of each separate one cannot be distinguished; each of these consists of a small, somewhat straight tube, and a larger coiled part; these are present in every segment after the fourth, and are most largely developed in the clitellar region, where they form an almost complete investment for the body-wall, and where each segment has certainly more than one hundred. The second kind of nephridia are much larger, are only present in the posterior region of the body, and occur in the same segments with the smaller kind; these latter have internal openings, and there is only one pair of them in each segment. The series of gradations which Prof. Spencer was able to make out lead him to the generalization that the specialization of nephridia appears to commence at the posterior end, and to pass gradually forward, the anterior being in a much more primitive condition than the posterior end of the body. The structure of the nephridia is described in detail, and it is especially pointed out that in no part of the body is there any relationship between the nephridiopores and the setæ, even when the nephridia become more localized.

The general characters of the nephridia of Chætopods are discussed at some length, and many interesting questions considered. In dealing with their homologues, Prof. Spencer thinks that it is important to remember that in Chætopods there is a very clear distinction of the nephridial ducts into two parts—one intracellular, and one intercellular; the latter leads to the exterior, and has the vesicular part connected with it. It is possible that the former is always mesoblastic in origin, and the latter epiblastic. It is suggested that the various stages in the development of the nephridia of Chætopods may be somewhat as follows:—

(1) A stage (in some Platyhelminth-like ancestor) in which in an unsegmented body a continuous network of nephridial tubules, with flame- or internally ciliated cells, the former uniting to form longitudinal canals leading to the exterior.

(2) A modification (as seen in *Dinophilus gyrociliatus*) in which the excretory organs are still in the form of a network with flame cells, but with secondary external openings in each segment, irregularly arranged as in some Planarians, or regularly arranged, as in *Dinophilus*.

(3) A further modification, resulting in the formation of numerous irregularly arranged outgrowths from the nephridial network, having the nature of coiled tubules which are directly continuous, and identical in structure with the network. These form the nephridia of the more

highly developed worms, and their development is to be regarded as intimately associated with that of the segmentally arranged cœlomic chambers, such as are at any rate but feebly represented in the Hirudinea.

(4) In connection with these numerous nephridial tubes many external openings leading into the still persisting network are formed (e. g. *Perichæta aspergillum*).

(5) The small nephridia become aggregated into groups, the aggregation commencing in the posterior region of the body (as in *Acanthoporus multiporus* and *Megascolides australis*). As the aggregation proceeds the external openings diminish in number, and the network lessens in extent.

(6) The formation of large nephridia, either out of an aggregate of small nephridia, or by the special growth of one of an aggregation of small nephridia. Each large nephridium acquires secondarily an internal opening into the cœlom. These openings, which have a very definite relationship to the cœlomic chambers, must be supposed to be new formations within the group.

(7) The final disappearance of all trace of the small nephridia, and with them of the network and longitudinal duct. Then there remains in each segment, as in most adult earthworms, a limited number—usually one pair—of large nephridia, with internal and external openings.

When it is considered that the character of a nephridium is that in some part of the funnel-shaped structure the duct is not intercellular, but the funnel bends back into an intracellular duct, always of considerable length and complication, and never absent, while the whole of the genital duct is intercellular, we see that there is little reason for supposing that the latter is a modified nephridium. The testes can, apparently, be found at any time of the year, and closely resemble the ovaries—of which there is one pair—externally. Spermatozoa undergo their development in the vesiculæ seminales, which are broken up into a great series of capsular chambers.

Structure of Urochæta and Dichogaster, and Nephridia of Earthworms.*—Mr. F. E. Beddard has some notes on the structure of Urochæta in supplement to and criticism of Prof. Perrier's memoir on this earthworm. Mr. Beddard cannot believe that there are in it any pores which put the hæmal system into communication with the surrounding medium. The mucous glands described by Perrier may be shown to be nephridial in character by the presence of cœlomic funnels which agree in their structure with the funnels of the nephridia in the other segments of the body; from the typical nephridium the gland differs by its branched character and the presence of several cœlomic funnels; the author concludes that the mucous gland is a branched nephridium, of which the greater number of branches end blindly, while a few open into the cœlom by ciliated funnels. In *Dichogaster* g. n. (*D. Damonis* sp. n. from Fiji) the mucous gland has no cœlomic funnel, and the duct opens, not on the exterior of the body, as in *Urochæta*, but into the buccal cavity, and, lastly, it appears to be formed by a simple much coiled tube. Mr. Beddard thinks there is evidence that the specialization of this part of the nephridial system ultimately led to the concentration of the numerous excretory pores into one long duct; in other

* Quart. Journ. Micr. Sci., xxix. (1888) pp. 235–82 (2 pls.).

words, the branched mucous gland of *Urochæta* is traceable to the specialized nephridial mass of the anterior segments of *Perichæta*, the numerous external pores of the latter being replaced by the single aperture of *Urochæta*. The ova are of larger size, and, like those of *Allurus*, differ from those of most earthworms and agree with those of the "Limicolæ" in this point.

The alimentary canal of *Dichogaster Damonis* has two gizzards, each of which occupies two segments, and in the characters of its nephridia it approaches the "Limicolæ."

The latter part of the present memoir is taken up with further remarks on the nephridia of earthworms. It seems possible to separate into two groups the genera in which there is a greater or less development of a network with numerous external pores in each segment, and of these there appears to be a parallel series of differentiations.

A. Nephridia forming a network, consisting of excessively fine canals, continuous from segment to segment.

(1) ?

(2) Nephridial network of posterior segments partly composed of tubules of greater calibre. Numerous cœlomic funnels—*Perichæta aspergillum*.

(3) Larger nephridial tubules increased in size and forming a nephridium nearly independent of the finer tubes, and opening by a single cœlomic funnel.—*Perichæta armata*, *Megascolides*.

B. Nephridia forming a network consisting of wider canals, discontinuous at the septa.

(1) No further specialization.—*Deinodrilus*.

(2) Nephridial network partly composed of tubes of greater calibre. Numerous cœlomic funnels.—*Acanthodrilus multiporus*.

(3) Nephridial network of posterior segments chiefly composed of larger tubules opening by a simple cœlomic funnel.—*Dichogaster*.

In treating of the evolution of the nephridia the author states that, in his opinion, the nearest approach to the primitive condition in the Oligochæta is to be seen in *Perichæta aspergillum;* in the anterior segments the resemblance to the Platyhelminth excretory system is closest, for there is a continuous network of tubules with numerous external pores. The network is not interrupted by the septa, and the external pores are not in any way related to the segmentation of the body. In the posterior segments the network of tubules are beginning to break up into more or less isolated tufts, but this has no discernible relation to the segmentation. From this point the modification of the excretory system appears to have gone along one of two paths, but in both cases the same goal—the reduction of the nephridial system to a pair of isolated nephridia in each segment—has been reached. Mr. Beddard agrees with Prof. W. B. Spencer that the single pairs of nephridia of certain earthworms (e.g. *Perichæta Novæ-Zealandiæ* and *Perionyx*) have arisen by a gradual increase in calibre of a part of the nephridial network in each segment to form a pair of nephridia, and by the gradual reduction of the rest. In certain other forms (e.g. *Acanthodrilus Novæ-Zealandiæ*) the nephridia have been derived through the gradual increase in calibre of the tubules forming the primitive network and have become isolated into metamerically disposed tufts of tubules, corresponding more or less to the setæ; these separate nephridia have become ultimately reduced to a pair in each segment.

New Earthworm.*—Mr. H. Garman describes a new American earthworm under the name of *Diplocardia communis.* It belongs to the family of the Acanthodrilidæ, but is distinguished by the absence of a subneural vessel, and the existence of a double dorsal vessel, the two halves of which are separate throughout their length, except where they pass through the septa between the somites. Sixteen species of American earthworms have been named, and there is an undetermined species of *Perichæta.*

New Genus of Eudrilidæ.†—Dr. D. Rosa describes a new genus of the family Eudrilidæ—*Teleudrilus ragazzii*, from Africa (Scioa), which he regards as throwing some light on the characters of *Eudrilus.* The new genus is certainly very nearly allied to it, and from its examination the author concludes that it is probable that some of the more divergent characters ascribed to *Eudrilus* cannot be really sustained. It is certain that all these aberrant characters are not demonstrable in *Teleudrilus.* He discusses the aberrant features noted by Beddard, and would not separate either *Eudrilus* or *Teleudrilus* from the other members of the family, for which he gives a somewhat modified diagnosis. He also describes a new species of Acanthodrilus (*A. scioanus*).

Indian Perichætidæ.‡—Dr. D. Rosa describes certain Indian Perichætidæ found by Sig. L. Fea, viz. *Perionyx excavatus* Perr. from Irawaddy and Tenasserim; *Megascolex armatus* Bedd. from Mandalay; *Perichæta feæ* sp. n., from Tenasserim; and *Perichæta birmanica* sp. n., from Irawaddy. He divides the Perichætidæ into two sets: (*a*) with the orifices of the male ducts and of the spermathecæ contiguous—gen. *Perionyx;* (*b*) with the orifices of the male ducts and of the spermathecæ distant—gen. *Megascolex* and *Perichæta.* The last two genera are thus distinguished: in the former the setæ are in interrupted rings, and there are no intestinal cæca; in the latter the setæ are in continuous rings, and intestinal cæca are present. The characters of all the four species are given at length.

β. Nemathelminthes.

Fertilization and Segmentation in Ascaris megalocephala.§—Dr. Th. Boveri, continuing his "Cell-Studies," describes in great detail the phenomena of fertilization and segmentation in the ovum of *Ascaris megalocephala.* On this subject at least eight important investigations have been made since Schneider's memoir in 1883, and, in spite of manifold contradictions, it would be vain to assert that there has not been great progress towards certainty and clearness. To this end the present memoir contributes much. Dr. Boveri discusses the various stages and aspects in eight chapters, extending over nearly 200 pages, and illustrates them in five most beautifully executed plates which well deserve to be ranked among the masterpieces of microscopic draughtsmanship.

* Amer. Natural., xix. (1888) pp. 1030–1.
† Ann. Mus. Nat. Genova, vi. (1888) pp. 571–92 (1 pl.).
‡ Ibid., pp. 155–66 (1 pl.).
§ Jenaische Zeitschr. f. Naturwiss., xxii. (1888) pp. 685–882 (5 pls.).

(1) *Method.*—No pathological condition occurs, as the result of any mode of preservation, in ova which have passed beyond the stage with vesicular pronuclei. Boveri's principal methods of fixing were (*a*) by alcohol of various degrees of concentration, with 1 per cent. acetic acid, or (*b*) by picro-acetic acid.

(2) *The spermatozoon from its entrance to the extrusion of the second polar globule.*—There is no special "bouchon d'impregnation" nor micropyle of Meissner. Polyspermy is exceedingly rare, and due to a weakness in the ovum, which prevents it excluding other spermatozoa after one has been received. It is in the highest degree probable that the nucleus of the sperm in all stages consists of two independent chromatin elements (Carnoy's type), except in those males which correspond to the females with eggs including only one chromatin element (van Beneden's type). These two varieties have to be distinguished. Carnoy's type of ovum (with two elements) is always fertilized by a sperm with two elements, and so with the other variety.

(3) *Nuclei of ovum and sperm till the formation of the first spindle of division.*—After the extrusion of the second polar body, the male and female nuclei present very close resemblance. From the second polar figure the female pronucleus receives the two chromatin elements (Carnoy's type is followed) of the internal daughter-plate. These become surrounded by homogeneous nuclear sap, from which the protoplasm is separated by a delicate membrane. Into these vacuoles, towards the membrane, the chromatin-rods give off processes, which grow, and grow together, till a framework is formed, in which the rod is lost. For a while the results of the modification of each rod are separable, later on this cannot be demonstrated. Minute nuclear bodies appear and are distributed throughout the nucleus. The movements associated with the making of the above reticulum are extremely Rhizopod-like. The differences between the above account of the differentiation of the nucleus and that given by van Beneden depend upon the preservation of the ova.

In the sperm-nucleus also, a growing vacuole forms round the chromatin elements, into this the elements give off anastomosing processes, nucleolus-like bodies appear, the solid chromatin masses are gradually transformed into framework, which is gradually drawn towards the nuclear membrane. The chromatin elements, however, which form the female pronucleus are very simple and regular, both in form and disposition; the opposite is true of the elements of the sperm; and this causes certain differences.

The position of the nuclei within the ovum is then discussed; van Beneden's results as to the protoplasmic mantle of the sperm-nucleus are corroborated and extended; the "germ-dualism" theory of Zacharias, involving the conclusion that the pronuclei of van Beneden are not pronuclei, but already conjugated nuclei, is unfavourably criticized. Boveri maintains the generally accepted view, which van Beneden now also allows, that the two vesicular pronuclei really fuse into a uniform segmentation nucleus. Details of this are given. Against van Beneden and Zacharias the author contends that the nuclear filaments are not necklace-like, but parallel in contour, homogeneous, and uniformly chromatic. Nor has he ever seen the continuous coil they describe.

(4) *The changes in the cell-substance during this period.*—Beyond their four essential chromatin loops, the two nuclei furnish nothing for

the karyokinetic figure. The entire achromatic division figure is due to the cell-substance. Parallel with the phases of the nuclei there are phases of the protoplasm, which finally lead to the well-known appearance of the achromatic nuclear spindle with the two polar suns. It was Boveri's merit in 1887 to point this out for the first time; van Beneden and Neyt have since followed him. The cell-substance, according to Boveri, consists of a homogeneous matrix and a fine network, between the meshes of which lie yolk-corpuscles, irregular granules, and a specific granular or filamentar substance. This last alone has an active *rôle* in the process of division. For it, Boveri proposes the new title of *archoplasma*. It is demonstrable by a certain action of picro-acetic acid, of which the author does not give the details, but which leaves the nucleus and the archoplasma alone distinct. It is unfortunately difficult, within the limits of a report, to relate how Boveri has followed the modifications of the archoplasma in relation, for instance, to the "central corpuscle" or "centrosoma" of van Beneden and Neyt, or other phenomena of division. "The centrosoma exercises upon the archoplasma contained in the cell an attraction of this sort, that round itself as centre it contracts the above substance into a dense granular sphere." The division of the originally single mass of archoplasma into two spheres is the result of the presence and opposition of two equally strong centrosomata. It is probable that the sperm brings with it a centrosoma which divides. When the two are adjacent, their attractions only modify the archoplasma slightly from the spherical form. As they go apart, the more marked does the constriction of the archoplasma become. Dr. Boveri draws a sharp contrast between the polar and the segmentation spindles, which turn out to be extremely different so far as their achromatin constituents are concerned.

(5) *The origin and division of the first segmentation spindle.*—In the first part of this chapter the relations between the archoplasmic spheres and the nuclear elements are followed from their beginning to their perfected result.

The spindle-formation begins with the radiate metamorphosis of the two archoplasmic spheres. Radiating fibrils, growing at the expense of the central granular portion, meet and attach themselves to the chromatin elements. Is this by chance or by attraction, is a question hard to answer, but probabilities are in favour of the former. All the threads which connect one sphere with a chromatin element attach themselves exclusively to the one narrow surface; all those from the other sphere likewise attach themselves to the other narrow surface. Each daughter-element within a mother-element admits of the attachment of the threads from one pole only. The fibrils thus attached to a chromatic loop seek to contract, and this contraction may go so far that the length of the threads approaches the radius of the original sphere. The contraction brings about a corresponding approximation between the centrosoma and the point of the loop with which the fibrils are associated. These archoplasmic threads are genuinely like muscle-fibrils. "The movement of the elements is solely and wholly the result of the contraction of the attached fibrils, and the final arrangement of the above into an 'equatorial plate' is the result of the equal action of the two archoplasmic spheres exerted through the said fibrils."

In a later portion of the chapter the author enters into detail in regard to the stage with the equatorial plate. The stage has very definite limits. It is a condition of rest *par excellence* in the life of the cell. It is interrupted by the action of a new factor—the longitudinal splitting of the chromatin elements. The author seeks to justify his regarding this as "an independent expression of life, a reproductive act in the chromatin elements."

(6) *The nuclei of the two first segmentation spheres* are discussed in the next chapter. The reconstructive processes and the individuality of the nuclear elements are especially treated. "The general agreement in the number and disposition of the chromatin elements before and after the resting stage of the nucleus, makes it probable that each element of the daughter-plate is identical with an element again produced from the nuclear framework. This is confirmed by the demonstration that (1) each new *end* of a chromatin loop is identical with an end of the loops forming the nucleus, and (2) each two ends, united before the reconstruction in one element, are after the retraction of the framework again united in one loop." The only question is about the middle portion uniting the two ends. If the hypothesis is correct, then of the four chromatin loops, observed in the division figure of a segmentation cell, two are derived from the male and two from the female. The importance of this in regard to heredity, is emphasized by the author.

(7) *Archoplasma and Centrosomata in the two primary segmentation spheres* are discussed in the next chapter. The presence of the centrosoma (in itself an important fact), its division, the modification and disposition of the archoplasma, are discussed. The last chapter (8) on abnormal and pathological phenomena is rich in suggestions as to the physiology of the cell-division. An appendix unfavourably criticizing Kultschitzky's results concludes this valuable memoir.

Maturation and Fertilization of Ova in Ascaris marginata.*—Dr. N. Kultschitzky follows up his recent investigation of the phenomena of maturation and fertilization in *Ascaris megalocephala* by a similar study of *Ascaris marginata*. His general results are thus summed up:—

(1) In the first stages of development, he shows that the chromatin of the germinal vesicle, and the (paler on staining) substance of the nucleolus arise from the same source. This confirms an opinion long since expressed by Flemming.

(2) The mature ovum has the following characteristics:—(*a*) the chromatin of the germinal vesicle becomes a group of rods, variable in size and number; (*b*) the other constituents entirely disappear; (*c*) an egg-envelope may be developed, but only fully after fertilization, never perfectly in unfertilized ova.

(3) The achromatin substance forming the spindles in polar globule extrusion arises from the protoplasm of the ovum, as in every other division of the egg-cell.

(4) The extrusion of polar globules is a genuine typical process of indirect ("karyomitotic") division, and the extruded elements are to be regarded as cells.

(5) The structure of the pronuclei deviates considerably from the general type of nucleus. Its framework is formed of achromatin substance, which with the membrane determines the form. In other nuclei

* Arch. f. Mikr. Anat., xxxii. (1888) pp. 671–82 (2 pls.).

the framework is supposed to consist of chromatin. Whether this is a real difference or not remains to be seen.

(6) "The study of the origin of the pronuclei has an extraordinary importance in this way, that it, as it appears to me, presents the only possibility of following the developmental history of the nucleus."

"In regard to the formation of the pronuclei, apart from all the incompleteness of my observations, I consider it possible to demonstrate that the pronuclei arise quite independently of one another, and that the female pronucleus contains only the chromatin of the ovum, and the male pronucleus only that of the spermatozoon."

Anatomy and Ontogeny of Nematodes.*—Herr N. A. Cobb commences with an account of *Ascaris Kükenthalii* sp. n., from the stomach of *Beluga leucas.* The male is from 7–9, and the female 8–10 cm. long; there are about one hundred caudal papillæ, arranged in two irregular rows. Behind the œsophagus there are two delicate organs which consist of several hundred tubular elements, connected with one another by fine fibres of connective tissue. The walls of the separate tubes are formed by a layer of epithelial cells, and the tubes contain one to five large vesicular cells, and have an efferent duct; the several ducts are, at various points, collected into common tubes. Nematodes that live in the stomach of their hosts rarely want these glands, which are absent in such forms as live in the small intestine and the body-cavity; they may, therefore, be regarded as digestive glands. The ova make their first appearance as nuclei, but soon become surrounded with protoplasm, and finally with a cell-membrane. There are generally three to six masses of chromatin. At a distance of 3 mm. from the blind end of the ovarian tube the ova group themselves round the rachis, and then gradually increase in size. Fertilization and maturation are effected in the seminal pouches, and the upper end of the uterus. Segmentation of the ova, as far as the progastrula stage, is effected in the uterus. As in all Nematodes yet examined, the first change is equatorial, but in the worm under consideration the two products of division were unequal, the first ectoblastomere being very much smaller than the first endoblastomere. The author's results agree pretty closely with those of Götte and Hallez.

Seven distinct layers could be made out in the integument; the cuticle is distinguished by the large quantity of hæmatoxylin which it can take up; the subcuticula is very like the cuticle; then follow three so-called fibrous layers, each of which appears to consist of parallel fibres united by a connecting membrane. There is a very thin limiting membrane which separates them from the so-called subcutaneous layer, with which the muscle-cells are directly connected. Two kinds of ganglion-cells are distinguished in the central nervous system; some are large, have a large vesicular nucleus, and give off two or three processes; others are much smaller and spindle-shaped, and have two processes; the ganglia formed by them are set close to the nerve-ring, and are connected therewith by nerve-fibres.

The other new species are *Ascaris bulbosa* from the stomach of *Phoca barbata, Strongylus arcticus* from the auditory organ of *Beluga leucas;* the anatomy of these new forms is described in some detail. In *Oxyuris*

* Jenaische Zeitschr. f. Naturwiss., xxiii. (1888) pp. 21–76 (3 pls.).

vermicularis the author has found a structure which he takes to be a salivary gland.

Of the free worms on which there are notes *Dorylamius Langii* is a new species, found at Jena, of which the male is alone known. *Tylenchus gracilis* is a new species from Jena, whence, also, comes *Spilophora impatiens* sp. n.; this last is closely allied to *Chromadora Leuckarti*, but differs from it in the structure of the cuticle, the rings of the skin consisting of elongated corpuscles, the nature of which it is hard to explain.

Cellular Epidermis of Nematodes.*—M. A. Michel, doubting the truth of the statement that the hypodermis of Nematodes is formed of a continuous protoplasm with scattered nuclei, has made an examination of the integument of *Gordius*. In the greater part of the body the subcuticular layer has a single layer of flat cells, with sinuous contours, which are arranged like the endothelial elements of the lymphatic capillaries of Vertebrates. Near the extremities of the animal the cells become cylindrical. The cuticle of Nematodes does not, then, consist of an epidermis and dermis, but of a membrane external to the elements of the cellular layer, and this membrane is of more than ordinary thickness. The subcuticular cellular layer is not a hypodermis, but an epidermis, and the dermis, as in most Invertebrates, becomes part of the muscular layer. There is no reason to suppose that there is any peripheral nervous system in this epidermis.

Red Colouring Matter of Eustrongylus gigas.†—Dr. V. Aducco has made an elaborate physiological study of the nature of the red colouring substance in the hæmolymph and body-wall of *Eustrongylus gigas*. Specific gravity, coagulability, result of boiling, effects of reagents, pressure, &c., spectroscopic characters and the like were studied in great detail.

The general conclusion of the author is as follows:—The animal "has in its hæmolymph and in its cuticle a red colouring substance, which is very similar to the oxyhæmoglobin of the blood of vertebrates, but differs from it in the temperature at which it coagulates, and in its greater resistance to reagents and in a special way to pressure, acetic acid, and reducing agents."

New Species of Gordius.‡—Dr. L. Camerano describes a new species of Gordius (*G. feæ*), found in Irawaddy by Sig. L. Fea. The species is easily distinguished by the structure of the cuticle which presents irregularly scattered areolæ, and by the co-existence of a post-cloacal lamina and the areolæ.

γ. Platyhelminthes.

Tapeworms with Perforated Joints.§—Dr. H. Blanc has investigated the nature and origin of the perforated joints which are occasionally exhibited by Tænia and Bothriocephalus. His cases are of *T. saginata* and *B. latus*, the latter from a set of ninety which were voided at one time! The anomaly affects isolated proglottides, or a group, or a long series; the form of the perforation is broad in *Tænia*, long in *Bothriocephalus*;

* Comptes Rendus, cvii. (1888) pp. 1175–7.
† Atti R. Accad. Lincei—(Rend.), iv. (1888) pp. 187–94, 213–20.
‡ Ann. Mus. Nat. Genova, vi. (2) (1888) pp. 168–70 (2 figs.).
§ Bull. Soc. Vaud. Sci. Nat., xxiv. (1888) pp. 9–16 (1 pl.).

the perforations are usually central, but not always. The histological features are described, and the various opinions on the subject are noted. The author regards the anomaly as primarily an integumentary variation,—"an irregular, abnormal development of the cuticle of some of the rings, resulting in a kind of pathological condition, completed by an external digestive action."

Intermediate Host of Tænia cucumerina.*—Professor B. Grassi communicates a preliminary note in regard to the intermediate host of *Tænia cucumerina*. This is usually supposed to be the louse *Trichodectes latus*, as has indeed been demonstrated, but Grassi was led to doubt this on account of the rarity of the "louse" compared with the abundance of the tapeworm. His experiments inclined him in fact to suppose that the development might be direct as in *T. murina*. Now, however, he has been led to regard it as more probable that the ordinary intermediate host is no other than the flea (*Pulex serraticeps*).

Structure of Bipalium.†—Dr. J. C. C. Loman has a memoir on the genus *Bipalium*, twenty-one species of which have already been more or less completely described. Kuhl and v. Hasselt examined forms which are now to be called *B. vittatum* and *B. marginatum*, and the author describes as new *B. moseleyi* from Borneo, *B. sumatrense* from Sumatra, and *B. javanum* from Java.

In dealing with the integument the author raises objections to Moseley's explanation of the disappearance of cilia in certain parts being due to the expulsion of large numbers of rod-like bodies, and contends that these are tegumentary cells which are not ciliated; in fact he declares that the cilia of the surface are confined to what he calls the ambulacral bands. The rod-cells are regarded as mesenchymatous structures which wander through the surrounding connective tissue, while their contents become converted into filamentar rods. Mucous glands are especially numerous, and are found over the whole body; their efferent ducts do not appear to have special walls, and the granulated mucous filament is found lying in simple lacunæ of the connective tissue.

The number of layers in the dermomuscular tube appears to vary somewhat in Planarians; in *Bipalium* dorsoventral and transverse fibres are present in addition to oblique (with a few circular), external and internal longitudinal fibres. There is really a kind of muscular foot such as is not known even in other Land Planarians. The majority of the muscles are homogeneous, and do not even exhibit a differentiation into cortex and medulla. *B. javanum* is strongly pigmented, and the colour is due to small black granules which are collected in the connective tissue cells and their fine processes; the pigment is not confined to the surface of the body, whereas it is in *B. sumatrense* very rare in any other than the superficial parts.

The investigation of the nervous system is a matter of some difficulty, as the cells and fibres are not easy to distinguish from the larger mesenchym cells, but the nuclei of the connective tissue are always smaller than those of the ganglion cells, and are always much more intensely coloured by hæmatoxylin and borax-carmine. Professor Moseley's account of the histology of the eyes is stated to be correct. The

* Bull. Soc. Entom. Ital., xx. (1888) pp. 66.
† Bijdragen tot de Dierkunde, xiv. (1887) pp. 63–88 (2 pls.).

author thinks there is evidence, though of a negative character, that the nervous system has a mesodermal origin.

The species examined were found to be protandric; in *B. javanum* there are on either side a number of testes lying behind one another, and a vas deferens which lies internally to them; after forming a seminal vesicle it opens into a penis, which consists of a sheath, an antrum, and an external genital orifice. The ovaries lie just behind the head, the oviduct is long, and passes into the so-called uterus; from the uterus the ova pass into the same antrum as that in which the male duct opens. Numerous yolk-glands are scattered in the mesenchym. The antrum is a spacious cavity, and its epithelium consists of low cells carrying short cilia. The ova of *B. javanum* are said to be laid in a cocoon, which is probably formed in the antrum; the shell appears to be a secretion of the penial sheath, and the high glandular epithelium of that organ supports this supposition.

δ. Incertæ Sedis.

New Rotifer.*—Mr. C. Rousselet describes, under the name of *Limnias cornuella*, a new Rotifer which he found attached to the rootlets of a plant ("*Trianœ Bogotensis*") in one of the hot-house tanks in the gardens of the Botanical Society in Regent's Park. Its tube looks very much like a little horn, and is only about half the size of that of the two other species of the genus; it is not ringed quite as distinctly as that of *L. annulatus*. Its most striking character is the possession of two long ventral antennæ, which are surmounted by tufts of long setæ.

Echinodermata.

Ludwig's Echinodermata.†—Prof. H. Ludwig has commenced a second edition of the Echinodermata of Bronn's 'Klassen,' &c. The author commences, without any preface, with the Holothurians, of which there is a bibliography and a short introductory account. The description of the skin is begun, but the account of the spicules is not yet completed.

Comatulids of Kara Sea.‡—In his report on the few species of Comatulidæ collected in the Kara Sea, Dr. P. H. Carpenter makes some remarks on pentacrinoid larvæ collected during the expedition, but, brought up, unfortunately without any adult specimens accompanying them. With the exception of the Pentacrinoids dredged by the 'Challenger' near Ascension, those now under discussion are the largest and most robust that the author has seen, and they are much more developed than the 'Challenger' specimens. It is possible, though not probable, that we have here the larval forms of *Antedon dentata*, but Dr. Carpenter is inclined to think that they are the young of *A. eschrichti*. The larger larva had a length of 35 mm., which was about equally divided between the head and stem; the latter, which is singularly like that of *Rhizocrinus*, has twenty-nine joints. Its centrodorsal bears fifteen cirri, the longest of which has a length of 5 mm. The adult specimens were examples of *Antedon eschrichti*, *A. quadrata*, and *A. prolixa*.

* Journ. Quek. Micr. Club, iii. (1888) pp. 337–8 (1 pl.).
† Bronn's Klassen u. Ordnungen, ii. 3, bearbeitet von Dr. H. Ludwig, 1. Lief., 8vo, Leipzig and Heidelberg, 1889, pp. 1–48.
‡ Bijdragen tot de Dierkunde, xiv. (1887) pp. 41–9 (1 pl.).

Ventral Structure of Taxocrinus and Haplocrinus.*—Messrs. C. Wachsmuth and F. Springer have made certain discoveries in the ventral structure of *Taxocrinus* and *Haplocrinus* which lead to modifications in the classification of the Crinoidea. They have found that the whole ventral surface of *Haplocrinus* is covered by five large plates which meet in the centre as in *Allagecrinus*, and that the "central plate" is a myth; what had been taken for it was a more or less tongue-like prolongation of the posterior plate, and a fracture in their original specimen had been taken for a suture on the posterior side. They give reasons for now thinking that the apparently central plate of many Platycrinidæ and Actinocrinidæ is the posterior oral, pushed inward to a central position by anal structures. It would then appear that the five orals of Neocrinoids were represented in the Palæocrinoids by the central plate and four large proximals; and this view does much to reconcile the conflicting views of our authors and of Dr. H. Carpenter; "the orals being found at last to consist of a portion of the proximals which he has claimed, with the addition of the central plate which we have contended for. This rational result, as often happens in such cases, adopts what was sound, and rejects the errors in the views of both parties."

A well-preserved specimen of *Taxocrinus intermedius* has demonstrated that it had an external mouth, surrounded by five parted oral plates, with the ambulacra converging to it and passing in between the orals. The authors have now very little doubt that the structure here discovered is substantially that of the Ichthyocrinidæ in general, and that the ventral side of the calyx in this family is morphologically in the condition of *Thaumatocrinus*, and similar to that of *Hyocrinus* and *Rhizocrinus*. After discussing this matter in some detail and considering the alleged points of difference between the Palæocrinoidea and Neocrinoidea, Messrs. Wachsmuth and Springer come to the conclusion that this division is not natural. They now think that four well-defined groups can be distinguished as independent primary divisions of the Crinoidea:—1. Camarata; 2. Inadunata; 3. Articulata, including the Ichthyocrinidæ; and 4. Canaliculata; the last includes most of the mesozoic and recent Crinoids. They are inclined to put *Holopus*, *Bathycrinus*, and *Hyocrinus* under the group Larviforma of the Inadunata, for they are all monocyclic, and retain throughout life large oral plates. *Thaumatocrinus* may be referred to the Articulata. With these alterations the Canaliculata would form a well-defined group, containing only dicyclic Crinoids, in which the underbasals are anchylosed to the top-stem-joint, with which they form the centrodorsal. A revised diagnosis of the Icthyocrinidæ is given.

Crotalocrinus.†—Messrs. C. Wachsmuth and F. Springer give a detailed account of the structure of this remarkable palæozoic Crinoid. Its net-formed radial appendages, resembling rather the fronds of a Bryozoan than the arms of a Crinoid, have long made it a puzzle to naturalists. It is only lately that they have had the opportunity of observing actual specimens, and they find that the views as to its structure and relationships which they published in their revision of the Palæocrinoids were completely erroneous. They now come to the conclusion that a family of the suborder to be called Crotalocrinidæ must be

* Proc. Acad. Nat. Sci. Philad., 1888, pp. 337-63 (1 pl.).
† Ibid., pp. 364-90 (2 pls.).

made for *Crotalocrinus* and its ally *Enallocrinus*, and suitable diagnoses are given; this family is allied to the other Camarata through *Marsupiocrinus*.

Cœlenterata.

Structure and Development of Colony of Pennatula phosphorea.*— Herr H. F. E. Jungersen has had the opportunity of examining a series of young stages of *Pennatula phosphorea*, of which he gives an account. To this he prefixes some notes on the anatomy of the adult form, dealing with neglected or unobserved points in its structure. Attention is drawn to the fact that a transverse section through one of the leaves shows that all the polyps of one leaf are arranged in the same direction. Below the pharynx the eight septa are continued into the axis through the gastric cavity; the two dorsal septa are lower than the rest and are of ectodermal origin, while the other six, which are much thicker, more coiled and shorter, are of endodermal origin. Gonads are never developed on the two dorsal septa; their filaments take no part in the work of digestion, but are of use, thanks to their rich supply of cilia, in the circulation of water. In the opinion of the author the dorsal and ventral primary canals of the axis have a different morphological value to the two lateral; the latter do not appear to be in direct connection with the animals, but communicate by small orifices with the median canals. So little is known regarding the developmental history of the Pennatulidæ that Herr Jungersen's observations, though incomplete, are of considerable interest. The youngest specimen, which was 7 mm. long, consisted of a single well-developed individual, the stem-polyp or the first individual formed from the larva; it may be called the axial individual or terminal polyp. Above, it forms an open cup, at the edge of which are eight processes formed by long calcareous needles; this cup contains a retracted animal with seizing arms. Below the cup the body is prolonged in the form of a stalk, and below the lowest bud passes into a somewhat enlarged peduncle, which appears to be colourless and was clearly fixed in the bottom of the sea; an internal calcareous axis is already developed. There are five buds, four of which are lateral, while one lies in the median plane of the axial individual; the last has no tentacles, undergoes no further development, and may be called the axial or terminal zooid. It can be easily traced in later stages, and it was found that the surface of the axis on which it is placed is that which is generally known as the ventral surface. What has been called the ventral surface of the whole colony must be called the dorsal, and the dorsal the ventral. The uppermost leaf is always found on the right side of the terminal polyps. When four or five well-developed leaves have been developed on either side of the axis the first lateral zooids begin to be formed; these increase in number as development goes on, but no regular arrangement could be detected in them. In all cases it happens that there is no terminal polyp in the adult colonies of *Pennatula phosphorea*, though the young stages always have one. This terminal polyp remains a purely vegetative individual, the individualized part of which either disappears or becomes converted into a zooid, while the rest of its body persists as the axis of the colony.

A comparison of the young stages of *Renilla* and *Pennatula* points

* Vidsenskab. Meddelelser, Copenhagen, 1888, p. 154; translated in Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 620–49 (1 pl.).

to the conclusion that in the still unknown larva of the latter there is, as in the former, developed a transverse wall—the septum of the stalk; in this two longitudinal spaces and a supporting hard structure are later developed. It follows that the dorsal and ventral canals are parts of the primitive gastric cavity of the axial polyp, while the lateral canals are cavities in the walls that separate them, and are probably enlarged nutrient canals. This generalization may, perhaps, be safely extended to all other genera of Pennatulidæ.

New Cornulariæ.*—Mr. J. A. Grieg describes two new species of Cornulariæ from the coast of Norway. *Rhizoxenia alba* has a creeping stolon which is adherent to submarine objects; from this lateral branches are given off at right angles to the parent stem, which they connect with those adjacent; the polyp is elongated and smooth, the septa are non-calcareous, and the attenuated points of the tentacles are furnished with pinnules. The stolon, cell, and polyp are closely covered with spicules. *Sympodium margaritaceum* has a creeping basal part which adheres to shells and other marine objects; the polyps, which are ordinarily solitary, are small and project but little; the cell is firm, very finely granulated, and of the same Havannah-brown colour as the lower part; it has eight costæ. The polyp-body is of a fine pale rose-red colour, cylindrical, and with eight tentacles. The oral disc is smooth; the mouth oblong and slightly protuberant; the pinnules and gullet are non-calcareous; the spicules of the polyp and tentacles are colourless; they extend as far as the points of the latter.

North-Atlantic Actinida.†—Dr. D. C. Danielssen describes two very remarkable genera, the exact systematic position of which is very hard to define; he places them provisionally with the Actinida, but makes for them a new tribe, that of the Ægireæ, which he describes thus:—Actinida with a perfect body-cavity (cœlom) and a developed digestive apparatus, consisting of œsophagus, intestine, and anus. The family Ægiridæ contains Ægireæ, whose body is cylindrical and vermiform; there are twelve single septa, and the cœlom is divided into twelve longitudinal chambers. The genus *Fenja* has an elongate body, furnished with twelve longitudinal grooves, between which are twelve longitudinal areas covered with suckers. There is a series of a few retractile tentacles. Twelve longitudinal muscles have prominent transverse muscles between them. There are twelve genital pores round the anus, outside the rectum. The circular muscles are mesodermal, and the sexes are united. The species is called *F. mirabilis*. The genus Ægir (*Æ. frigidus*) has a mucous sheath, and small suckers are scattered between the twelve longitudinal ribs. There is one cycle of a few tentacles. Immediately above the anus there are twelve slender fissures which communicate directly with the intestinal passage. The other characters are very similar to those of *Fenja*.

The anatomy of these interesting forms is described with great care and in some detail. As observed alive *Fenja* was regarded as a *Halcampa*, and *Ægir* as one of the Ceranthidæ. The integument with its epithelium, nematocysts, mucous glands, and connective tissue; the form of the tentacles, septa, gonads, and nervous system are all of the Cœlenterate type; but the chief characteristic of the Cœlenterata—the gastrovascular

* Bergen's Museum Aarsberetning for 1887 (1888), No. 2, 18 pp. (2 pls.).
† T.c., No. 1, 24 pp. (3 pls.).

cavity—is transformed into a fully developed intestinal canal which, in *Fenja*, does not communicate directly with the body-cavity. The fissures found in *Ægir* do remind us somewhat of the anatomy of the Ctenophora.

If the cœlom is to be regarded as the decisive feature these two genera must be removed from the Cœlenterata; further research may show that too much stress has been laid on this character, or we may have here only the final stage of a process of development already begun in other Actinida.

Natural History of Fungia.*—Mr. J. J. Lister has a preliminary notice of his observations on the life-history of *Fungia*. The young stock has vertical thecal walls; after a time the upper part begins to widen out, and, after forming a shallow cup, gives rise to a disc, depressed in the centre, with the thecal walls facing directly downwards. After the disc is distinctly formed absorption of the calcareous skeleton takes place in a plane at right angles to the axis of the attaching stalk. When the disc becomes free it has a round scar in the middle of the under surface which corresponds to a similar scar at the summit of the stalk. This scar ultimately disappears. The free end of the stalk throws up delicate fluted laminæ which project above the level of the other structures of the scar; a mouth is formed in the centre, a thecal wall becomes developed round the thecal laminæ, and a new cup is formed; this is not a bud, but a product of the growth of the structures already existing in the base of its predecessors. A new disc having been formed its stalk undergoes absorption; in due course a third disc is formed, the stalk growing in height as the process is repeated.

Development of Manicina areolata.†—Dr. H. V. Wilson gives a full account of his observations on the development of *Manicina areolata*, the preliminary notice of which was referred to at the time of its appearance.‡ With regard to the origin of the Anthozoa the author considers that Götte's objection to the hydroid polyp ancestry of the group is no longer valid. The question whether or no the Anthozoa are descended from hydroid polyps must be argued out on the ground of some more primitive anthozoan development, such as that of *Manicina*. Here it is at once seen that, contrary to Götte's idea, the invagination of the œsophagus does not necessitate the formation of endodermal sacs. The surface ectoderm and the œsophagus become apposed along the lines of the first and second mesenteries; this process, though seen in the Scyphomedusæ as well as the Zoantharia, was probably acquired secondarily, and was not a peculiarity of the primitive Anthozoa; this belief is supported by the entire absence of the process in the Alcyonaria. The explanation of the process is probably connected with the early development of the first pair of filaments.

Origin of Female Generative Cells in Podocoryne Sars.§—Mr. C. Ishikawa has studied the history of the development of the female generative cells of *Podocoryne carnea*. Weismann was unable to observe the wandering of the ectodermal cells into the endoderm, but his pupil now brings forward evidence to show that the primordial female germ-cells arise in the ectoderm of the young medusa-bud, and thence wander

* Quart. Journ. Micr. Sci., xxix. (1888) pp. 359–63.
† Journal of Morphology, ii. (1888) pp. 191–252 (7 pls.).
‡ See this Journal, 1888, p. 434.
§ Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 621–5.

very early into the endoderm, where they become differentiated into germ-cells as Weismann had supposed.

Cunoctantha and Gastrodes.*—Prof. A. Korotneff has notes on these two difficult forms; Gastrodes is new; of *Cunoctantha* he has studied two quite young stages which he found in the stomach of *very young Geryoniæ*, where they appeared as small white dots. A transverse section through the gastric wall of a young *Geryonia* revealed an elongated oval larva completely imbedded in an endoderm formed of large cells. Its ectoderm consists of long delicate cells, which only form one row, and contain a considerable number of nematocysts. These ectodermal elements are, obviously, in a state of active division, at the free pole of the body, and the appearance was that of a somewhat coarsely granular plasmodium, in which separate nuclei were imbedded. At the free pole the ectoderm and entoderm pass into one another; the larva under observation was just forming its endoderm, and only two nuclei were apparent in that layer. In a later stage the ectoderm was found to contain a considerably larger number of nematocysts, and the endoderm, though still plasmodial in character, had many more nuclei, which were much smaller than those of the ectoderm. One nucleus of the ingrowing ectoderm has become very large, and is placed at the upper, oral end of the larva; this is, no doubt, the peculiar colossal nucleus of the larva. The nematocysts, which are wanting in the adult *Cunoctanthæ*, are present in numbers in free-swimming larvæ. The loss of these organs may be due to the acquirement of a parasitic habit.

The name of *Gastrodes parasiticum* is given to a form which appears to have some affinities to *Cunoctantha;* it was found in the gelatinous coat of *Salpa fusiformis* in the winter of 1886; in 1887 the author failed to find it. When slightly magnified it has the form of a round cake with a flat base and a curved upper surface. From the base a process projects into the interior; looked at from above this invagination is seen to carry a central oral opening. It is a scarcely altered gastrula, for it is a saccular organism in which only two layers can be made out, which has no true cœlom, and takes in nourishment by means of a primitive mouth. This mouth is not at the end of the body, but at the tip of a proboscis-like prolongation which is invaginated into the interior. It calls to mind the stomach of an Actinian, and leads into a cavity which has, however, no septa. The ectoderm and endoderm are separated by a supporting lamella. The ectoderm is of the simplest construction on its curved surface, for there is there a single layer formed of low cells, and only in places multilaminate; this layer owes the simplicity of its structure to the parasitic habit of *Gastrodes;* there are no nematocysts or muscular fibres. On the lower surface and on the oral tube there are large distinct ovarian cells, in which may be seen a large germinal vesicle and a fine reticulum; they form an unbroken series round the margin of the animal; the complete development of these eggs may be studied in one and the same individual. The gelatinous layer is a thin lamella which is only well developed at the margin, where it forms a ring. The endoderm consists of two sets of elements; some are low, cubical cells like those of the ectoderm, others, which are large, form the lateral walls of the gastric cavity; the latter also form a plasmatic network. There are no special gland-cells in the endoderm of *Gastrodes.*

* Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 650-7 (1 pl.).

In a younger stage the gelatinous ring was found to be wanting; in its place there was a large cell which appears to be quite identical with an endodermal cell, as it has a plasmatic plexus, and a large network; as to the fate of this cell nothing is yet known. This younger form had only a single row of large endodermal cells, and these form a circular lining to the gastric cavity; each of the large cells assimilates the neighbouring small cells. The resemblance between *Cunoctantha* and *Gastrodes* is unmistakable; the endodermal dimorphism of *Gastrodes* differs only from that of *Cunoctantha* in that the small cells of the latter are at first completely covered by the giant cells. Morphological differentiation is more markedly exhibited in *Gastrodes* than in *Cunoctantha*; instead of one large cell there is a complete generation of such cells, which have, however, lost their power of movement (formation of pseudopodia) and only function as gastric digestive cells.

Porifera.

Stelospongus flabelliformis.*—Mr. A. Dendy gives an account of the anatomy and histology of this South Australian sponge, the characteristics of which were briefly diagnosed by Mr. H. J. Carter in 1885. A specimen was fortunately found containing a large number of enormous spherical embryos, each as large as a small pea. The entire surface of the sponge is thickly incrusted with sand-particles, which give a very hard, impenetrable character to the sponge, and must form an admirable protection against the attacks of the numerous parasites to which sponges are very subject, and it functionally replaces the special dermal skeleton of spicules which is found in very many siliceous sponges.

The skeleton is thoroughly typical in structure and arrangement, and is essentially the same as that of the bath-sponge, only much coarser. A reticulate skeleton may be regarded as derived from the radiate by a development of secondary fibres connecting the primaries; the majority, at any rate, of the so-called horny sponges are descended, probably along several lines, from the Halichondrina, by the gradual loss of the spicules and the greater development of spongin in a reticulate skeleton. In the species under discussion the skeleton fibres may sometimes be seen projecting freely from the surface of the sponge; this is a character often observed in siliceous forms.

The canal system, which is carefully described, is seen to differ little from the ordinary lacunar type so characteristic of the Halichondrina. The outermost portion of the ectosome is formed by an extremely thin and delicate epidermis; cystenchyme cells are present, and the stellate mesodermal cells appear to be thoroughly typical. The structure of the choanosome is considered under the heads of (1) the walls of the inhalant and exhalant canals, (2) the walls of the embryo-containing cavities, (3) the walls of the flagellated chambers, (4) the general mass of mesoderm in which the chambers and canals are imbedded, and (5) the spongoblasts and other mesodermal cells surrounding the skeleton fibres.

The ovum of *S. flabelliformis* lies in a fibrous capsule, and has a longer diameter of 0·076 mm., while that of the nucleus, which lies at one pole, is 0·024 mm. All the embryos, except one or two of the smaller ones, were solid. The surface, under a pocket-lens, exhibits a

* Quart. Journ. Micr. Sci., xxix. (1888) pp. 325–58 (4 pls.).

minutely punctate appearance, due to the presence of an immense number of shallow pits; each of these is the imprint of one of the large epithelial cells of the embryo-capsule. The outer layer of the embryo consists of rather large, closely-packed cells, inclosing a mass of clear, transparent, jelly-like substance, in which immense numbers of amœboid wandering cells are imbedded. The ectoderm consists of a single layer of large sac- or flask-shaped cells, the neck of which is on the outer side of the embryo; the swollen portion projects inwards into the gelatinous intercellular substance, and from its inner extremity frequently sends out a few very short, slender, pseudopodial processes.

The unusual length of time during which the embryo remains within the mother sponge, and the great size to which it attains, necessitate some special arrangement whereby it may be nourished; Mr. Dendy believes that the investing epithelium has the function of nourishing the embryo, absorption of nutriment being effected through the elongated necks of some of the ectodermal cells.

Within the ectodermal layer the embryo consists of a clear, jelly-like matrix, in which there are numerous large amœboid cells. These appear to be simply ectodermal cells which have wandered into the central jelly; many of them become rounded, and so arranged as to give rise to hollow chambers, lined by small spherical cells; these cavities the author regards as young flagellated chambers. Coincidently with the formation of these a slit-like invagination appears on the surface of the sponge, and it is around this that the chambers are formed. The invagination is probably the commencement of a communication between the chambers and the exterior; but, unfortunately, it has not yet been possible to trace the development further.

It is not yet known how the embryos of *Stelospongus* escape from the parent; they may, as they increase in size, rupture the walls of the oscular tubes near which they lie, when they would be forcibly ejected with the outgoing stream of water; or the sponge may die down in the winter, and the embryos be released by the decay of the maternal tissues.

Protozoa.

Bütschli's 'Protozoa.'*—Prof. Bütschli continues his general account of the organization of the ciliate Infusoria, and devotes a large portion of the lately published parts to a history of the nuclei; the membranous investments are also described, and the processes of reproduction are begun, though not disposed of.

Infusorian Fauna of the Bay of Kiel.†—Prof. K. Möbius commences his account of the Infusoria of the Bay of Kiel with a description of *Euplotes harpa*; various corrections are made in Stein's account of this species. In addition to reproduction by transverse fission, a special mode of gemmation after encystation was observed. In the latter mode the creature rolls itself up, the cilia cease to beat, and the body becomes surrounded by a delicate cyst; granules appear in the ectoplasm which refract the light strongly. The contractile vacuole grows considerably and divides into smaller vacuoles; these continually alter in form and size and make their way into the protoplasm. Opposite the pectinellæ

* Bronn's Klassen u. Ordnungen, i. Protozoa (1888) pp. 1489–1584 (pls. lxxii.–v.).

† Arch. f. Naturgesch., liv. (1888) pp. 81–116 (7 pls.).

there appears a wart-like elevation which contains vacuoles; this increases in size, becomes constricted off from the mother-body, pushes out delicate cilia, elongates and takes on the form of its parent. While these changes have been going on the nucleus undergoes considerable changes; it elongates, becomes bowed, then constricted, and finally breaks up into several pieces. The difference between the behaviour of the nucleus in fission and gemmation is explained thus: in fission all the developed external organula take part; but they merely distribute themselves into the two halves, and in each there is a kind of regeneration which affects the nucleus; in gemmation, on the other hand, the whole body of the bud is newly formed from the substance of the parent, and a closer relative connection between the nuclear substance and the body-plasma becomes necessary.

A more accurate account and figures than any yet published are given of the red spots of *Oxytricha rubra;* they are not sharply bounded spheres, but merely consist of spherical aggregations of yellowish-red granules. Three new species of *Stichotricha*, *S. gracilis*, *S. saginata*, and *S. horrida*, are described.

Of the Heterotricha *Porpostoma* (*P. notatum*) is a new genus which is distinguished from *Spirostoma* by the lip-like thickenings near the mouth. In dealing with the Peritricha a somewhat detailed account is given of *Zoothamnium Cienkowskii;* among the Holotricha *Uronema marinum* is fully described, as is *Hoplitophrya fastigata* sp. n. *Trichonema gracile* is a new cilio-flagellate; *Salpingœca procera* and *Monosiga sinuosa* new choanoflagellates; while *Urceolus ovatus*, *Anisonema multicostatum*, and *Diplomastix Dahlii* are new flagellates.

New or Little-known Infusoria.*—M. J. Kunstler has found an infusorian about 60 μ long in the terminal part of the intestine of *Limulus*. Its general appearance recalls that of *Lophomonas blattarum*, but the present species, which is not named, is not identical with it. In the intestine of a Tipulid larva a number of Flagellata allied to *Bodo* were found; some of the creatures are from 8 to 10 μ long, and the anterior flagella are remarkable for their length; others, which appear to belong to a different species, have an elongated body and execute spiral movements. The intestine of *Hydrophilus* contains a small *Monocercomonas;* its form changes, and while some of these changes do not alter the general configuration of the body, others are true amœboid movements which are localized at the hinder part of the body; at the anterior extremity there are four equal flagella, three of which are connected at their base. Encystation has been observed. The same insect has a small *Amœba* as a guest. The vagina of the cow contains a *Trichomonas*, as does the intestine of the pig, and the mouth of a man in ill-health. A very remarkable new ciliated infusorian has been observed in the intestine of *Periplaneta orientalis*.

New Infusorian.†—Prof. A. Giard gives the name of *Pebrilla* (*P. paguri*) to a new genus of Infusorians found living on the hermit-crab. It forms small colonies which are placed either in the vicinity of the foot or at the posterior extremity of the abdomen, and which are visible to the naked eye as black patches which retain their colour,

* Comptes Rendus, cvii. (1888) pp. 953–5.
† Bull. Sci. de la France et de la Belg., 1888, p. 316 (2 figs.). Ann. and Mag. Nat. Hist., iii. (1889) p. 69.

even after having been long preserved in spirit. Its capsule is of an oblong-ovate form with a projecting tubercle at the hinder extremity, within which the actual body of the infusorian is attached; it is strongly constricted in the middle, and the aperture is surrounded by a nearly erect or slightly everted collar. It forms an interesting addition to the long list of commensals found on *Eupagurus Bernhardus*.

Luminosity of Noctiluca miliaris.*—Dr. L. Plate has lately made a thorough investigation of *Noctiluca miliaris*. He describes the nucleus as a vesicle bounded by a distinct membrane, the limpid contents of which are sometimes perfectly homogeneous, but which, as a rule, have several nucleoli which are true globules and not threads, as described by Cienkowski. He accepts Bütschli's explanation of the so-called bacillar organ, according to which its ridges are produced merely by a particularly close attachment of the plasma to the body membrane. The formation of swarmers is more frequent than reproduction by simple division.

All observers are agreed that the luminosity of *Noctiluca* may be called forth by any strong irritation, so long as air is not excluded; as the light is extinguished in nitrogen it seems to follow that the luminosity is an oxidation process. Further observations may be adduced in favour of this proposition; the luminosity occurs only in the peripheral plasma of the body, and regenerating forms, which accumulate at the bottom of a vessel of water, are made to phosphorize with much more difficulty than normal individuals swimming at the surface, and under the influence of the atmospheric air. When pure oxygen was passed over specimens for some minutes a dull light was produced which was visible for about ten minutes after the evolution of the gas.

If *Noctilucæ* be laid upon moist blotting-paper and examined under a high power, the light may be found to belong to one of four categories:—

(1) Lightning-like; intense luminosity of the whole outer layer, immediately followed by darkness.

(2) The same, but with a faint after-luminosity persisting for one or two minutes.

(3) Dull luminosity of the outer zones of plasma, or of some considerable portions of it, with simultaneous strong sparkling of small points.

(4) A large portion of the surface is entirely or partially luminous, the luminosity being composed of numerous small points.

This luminosity appears to be involuntary, and induced by external irritation. As to the lighting-up of the sea, it would appear that the wind and the strength of the waves alone exert any appreciable influence; the light is not so fine when the waves break strongly, as then the *Noctilucæ* are drawn down too far beneath the surface of the water.

Red Organisms of the Red Sea.†—Herr K. Möbius criticizes the theory of Krukenberg that the red colour of the Red Sea is due to specimens of *Noctiluca miliaris;* this red colour (hæmatochrome) is stated to disappear rapidly in alcohol. As the *Noctilucæ* of the North Sea are always colourless, Möbius suggests that the colour was due to the infusoria having recently eaten *Trichodesmium erythræum*, or that specimens of that Oscillarian had got into the bottle with the *Noctilucæ*. We still require to know what substances, if any, of the animal are

* Zool. Jahrb., iii. (1888) pp. 174–80. Ann. and Mag. Nat. Hist., iii. (1889) pp. 22–8.

† SB. Gesell. Naturf. Freunde, 1888, pp. 3-4, 17–18.

reddish, or whether it was food, or other red organisms that produced the colour.

Rhizopods of Gulf of Genoa.*—Prof. A. Gruber, who described in 1884 some Protozoa from Genoa, gives here some notes on new and little-known Rhizopods.

Protomyxa pallida sp. n. is seen at once to differ from Haeckel's *P. aurantiaca* by its colourless protoplasm. It never takes on a Heliozoon stage, but tends to extend itself; the streaming in the processes is very lively, and the pseudopodia form such wide branches as to sometimes extend over a space of 4–8 mm. The nuclear substance is scattered in numerous small constituents through the protoplasm; the granules are so small that, with high powers, they are merely fine dots coloured dark-red by picrocarmine; in life they cannot be distinguished from the other granulations in the protoplasm. It will be remembered that Haeckel's species was said to have no nucleus, but that is only to be expected when the condition of microscopical *technique* at the time of its discovery is considered.

Under the head of various *Amœbæ* Prof. Gruber remarks that, on several occasions, he has attempted to show that definite specific diagnoses can be drawn up of these variable forms; the amount of difficulty in doing so varies, and with regard to the marine species, he has not yet been very successful. He has, however, recognized the species which he has called *Amœba fluida*. Another one, which always contains yellow drops or spheres, he now calls *A. globifera*, and a third, on account of its yellowish colour, is called *A. flavescens*. In the last no nucleus can be made out during life, but after staining, several vesicular nuclei may be seen; it is the first true multinuclear *Amœba* which the author has found in the sea.

The name of *Schultzia diffluens* is now applied to the species which the author first called *Lieberkühnia diffluens;* its whole sarcode is filled with extremely small nucleoli, which become evident on treatment with picrocarmine. A real member of the genus *Lieberkühnia* is a new species which is called *L. Bütschlii;* it agrees in many points with *L. Wagneri*, as described by Maupas, but differs by its much larger size, and by the characters of its nuclei.

The protoplasm of *Polymastix sol* sends out processes which, though they look like pseudopodial rays, are capable of flagellar movements, and the question arises whether we have here a Heliozoon with flagellate pseudopodia, or a Fagellate with radiate flagella; the organism named by Cienkowski *Multicilia marina* appears to be identical with this *Polymastix.*

Pseudopodia and Cilia.†—Prof. O. Zacharias refers to a statement by Prof. A. Gruber in regard to *Polymastix sol*, in which he says, "of pseudopodia which behave like cilia, nothing is hitherto known." Zacharias recalls his experiments ‡ with the spermatozoa of *Polyphemus pediculus* which, in 3 per cent. salt solution, developed very active pseudopodia. Reference might also be made to the facts noted by Geddes in his 'Restatement of the Cell-Theory.' §

* Ber. Naturf. Gesell. Freiburg, ii. (1888) pp. 33–44 (1 pl.).
† Biolog. Centralbl., viii. (1888) pp. 548–9.
‡ Zeitschr. f. Wiss. Zool., xli. (1884) pp. 252–8 (1 pl.).
§ Proc. Roy. Soc. Edin., xlii. (1883–4) pp. 266–92 (1 pl.).

Structure of Pylomata of Protista.*—Herr F. Dreyer gives us a comparative and developmental history of the structure of the pylomata of the Radiolarians and of the Protista in general, to which he adds a system and description of new and known pylomatic Spumellaria. The work is mainly based on 'Challenger' material, and may be considered as a continuation of that done by Haeckel on the Radiolaria. The term "pylom" is used instead of "osculum," which was the name used by Haeckel for the oral orifice of some Spumellaria; the change of designation recommends itself as preventing any misunderstanding which might arise from the central capsule having an "osculum."

In the chapter on the system and special description of the pylomatic Spumellaria a number of new forms are described, which we must be content to enumerate. The Sphæropylida is a new family of the Sphæroidea; it has two subfamilies, the Monostomida, with the genus *Sphæropyle*, in which there are seven new species, and *Prunopyle*, in which there are eleven; and the Amphistomida has a single new genus *Stomatosphæra*, with two species. Of the Phacodiscida, the Phacopylida, with *Phacopyle stomatopora* g. et sp. n., is a new family; of the Porodiscida there are eight new species; the Spongopylida is a new family of the Spongodiscida, with a single genus *Spongopyle* and eight species. The Larcopylida is a new family of the Larcoidea for *Larcopyle Bütschlii* g. et sp. n.

The third chapter deals with the comparative anatomy and development of the pylomata of Radiolarians in general. These structures may be primary or secondary; the former are pylomata which were already present when a connected skeleton began to be formed, the latter have appeared after the skeleton was complete, and, in many cases, when it was already highly developed. The characters of these are considered in detail.

The influence of the pyloma on the form of the whole shell in the Protista in general is next discussed; it appears to have a tendency to draw out the shell in the direction of its primary axis. In this direction the radial skeletal parts become disposed. The various modifications which obtain are dealt with in considerable detail.

The fifth chapter treats of the constancy of the pylom in species and its ontogenetic development in the Radiolaria. It would appear that the pylom is not constant, being sometimes present and sometimes absent, whence we may conclude that the process of pylom formation is still in a fluid condition. It does not, of course, follow that all pylomata are inconstant, and in many cases it is not so.

The author gives ample evidence of the extraordinary "labyrinth of forms" which is to be seen among Rhizopods, and hopes that this and succeeding memoirs will do something to make us understand the complex morphological relations of the Rhizopoda and the causes that have brought them about.

* Jenaische Zeitschr. f. Naturwiss., xxiii. (1888) pp. 77–214 (6 pls.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.*

(1) Cell-structure and Protoplasm.

Nuclear Origin of Protoplasm.†—M. C. Degagny discusses further some points which were only briefly treated in his former communication on this subject. The history of the cell-nucleus is by no means finished. New facts are continually being added which at first appear contradictory to those already known. Observers who have studied the cell-nucleus have noticed the peculiar phenomena which accompany the different movements and evolutions of the chromatic bodies. These movements are in part the result of intermittent contractions and dilatations, of which these bodies are the seat. From observing the nucleus of the mother-cell of the embryo-sac of the fritillary, the author shows that there exists an immediate antagonism between the freshly formed protoplasm which condenses at the base of the nucleus and the chromatic bodies.

The hyaloplasm is secreted in quantity by the hypertrophied nucleus of the mother-cell of the sac; but hyaloplasm is not only produced in the nucleus, but is expelled by incompatibility with the chromatic bodies. Among the processes which belong especially to matters derived from nuclear activity is one by means of which these bodies are able to take upon themselves well-determined geometrical forms.

Intercellular Protoplasm.‡—M. C. Sauvageau describes an instance of this structure in the roots which proceed from the nodes of the stem of *Naias major* and *minor*. These have a very small central vascular cylinder and a large cortex; the cortical parenchyme consists of several rows of cells with intercellular passages, which increase in size from the tip to the older part of the root; in the adult region these become aeriferous canals, with cuticular coatings.§ Towards the tip of the root there is no intercellular protoplasm; it begins to be observed, however, in the aeriferous canals 1–2 cm. from the tip.

The origin of this intercellular protoplasm is from hernioid protuberances which project from the adjacent cells into the canals; sometimes a cell will put out protuberances into two contiguous canals. They can become so large as to fill up the whole of the canal; they frequently contain starch-grains, and very rarely the cell-nucleus is to be found in them. The protrusion may be either closed or ruptured at the extremity. They are especially well shown on longitudinal section, and are then seen usually to proceed from the lower extremity of a cell. Their formation takes place at a very early period.

(2) Other Cell-contents (including Secretions).

Hydroleucites and Grains of Aleurone.‖—M. P. Van Tieghem calls attention to the researches of Wakker and Went ¶ by which the so-called

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents (including Secretions); (3) Structure of Tissues; and (4) Structure of Organs.

† Bull. Soc. Bot. France, xxxv. (1888) pp. 348–57. Cf. this Journal, 1888, p. 440.

‡ Morot's Journ. de Bot., ii. (1888) pp. 396–403 (4 figs.).

§ Cf. this Journal, 1886, p. 471. ‖ Morot's Journ. de Bot., ii. (1888) pp. 429–32.

¶ Cf. this Journal, 1888, pp. 443 and 981.

aleurone-grains have been proved to be vacuoles containing albuminoid substances which have undergone desiccation. He proposes to limit in future the use of the term vacuole to actual cavities in the protoplasm, and to call the structures hitherto termed vacuoles which make up the cell-sap *hydroleucites*, corresponding to amyloleucites, chromoleucites, chloroleucites, elaioleucites, oxalileucites, &c. These hydroleucites may be tanniferous, oxaliferous, coloured, albuminiferous, &c., the last corresponding to the structures ordinarily known as aleurone-grains. They have been rendered for the time passive and inert by desiccation, and pass again into the active state during the germination of the seed. They may be distinguished as passive or reserve-leucites in contradistinction to the active leucites.

Xanthophyllidrine.*—Prof. L. Macchiati gives a short note on this substance, which he believes to be entirely new and quite distinct from xanthophyll, or from the yellow colouring matter of petals, being especially distinguished by its property of crystallizing, and by its insolubility in ether and alcohol. It is an invariable accompaniment of chlorophyll, at least in all flowering plants examined, and probably exercises an important function in connection with it, which will be the subjects of future investigation.

New Principle from Ergot of Rye, Ergosterin.†—M. C. Tauret describes the preparation, composition, and chemical and physical properties of ergosterin, a new crystallizable substance obtained from ergot of rye. Ergosterin gives the same colour reactions as cholesterin, except in the case of sulphuric acid and chloroform.

Colouring Matter of Drosera Whittakeri.‡—Prof. E. H. Rennie has examined the tubers which grow at the end of the underground stem of this species, found in the neighbourhood of Adelaide, and finds them to contain a red colouring matter with the formula $C_{11}H_8O_4$, probably a methyl-trihydroxy-napthaquinone.

Mineral Substances in Leaves.§—Sig. G. Briosi has examined the amount of ash in the leaves of a large number of trees and shrubs, both evergreen and deciduous, belonging to a great variety of natural orders, and gives the following as his general conclusions.

Except in a few cases, the amount of mineral substances in evergreen leaves increases with age, while the proportion of organic substances not only does not increase, but even tends to diminish. The proportion of mineral substance is less in the petiole than in the lamina; and in the petiole the amount both of mineral and of organic substances increases with age. In *Eucalyptus globulus* the horizontal are richer in mineral matter than the vertical leaves.

In trees with deciduous leaves the quantity of inorganic substances increases, during the first months of life, from spring to autumn (except in *Cerasus avium*); in the annual leaves of herbaceous plants the quantity of ash does not increase with age, but decreases regularly from spring to autumn. In the wood and bark the proportion of inorganic

* Nuov. Giorn. Bot. Ital., xx. (1888) pp. 474–6.
† Comptes Rendus, cviii. (1889) pp. 98–100.
‡ Trans. Roy. Soc. S. Australia, x. (1888) pp. 72–3.
§ Ist. Bot. R. Univ. Pavia, 1888, 63 pp. See Bull. Soc. Bot. France, xxxv. (1888), Rev. Bibl., p. 177.

substances is much less than in the leaves. Generally speaking, the leaves of evergreen trees one year old contain a greater quantity of ash than those of herbaceous plants.

(3) Structure of Tissues.

Secretion-reservoirs.*—M. F. Jadin has examined the location of the reservoirs of secretions in plants belonging to a large number of different families. The Aroideæ have canals, pockets, and cells, all of which play the part of secreting organs. The arrangement in Dicotyledons may be grouped under the following heads, viz.:—(1) Cortical canals in the root and the stem (some Clusiaceæ); (2) endodermal canals in the root and the stem (Compositæ); (3) pericyclic canals in the root and the stem (Umbelliferæ, Araliaceæ, Pittosporeæ, Hypericaceæ); (4) liber-canals in the root and the stem (Terebinthaceæ); (5) liber-canals in the root only (Liquidambaraceæ); (6) ligneous canals in the root and the stem (Dipterocarpeæ); (7) ligneous canals in the stem only (some Simarubeæ and Liquidambaraceæ); (8) medullary canals in the stem only (Bixaceæ). The part of the plant in which secreting organs are least often found is the root.

Reservoirs of Gum in Rhamnaceæ.†—MM. L. Guignard and Colin have observed in certain Rhamnaceæ reservoirs of gum or mucilage, analogous to those found in Malvaceæ and Tiliaceæ. They are to be met with in *Rhamnus*, *Hovenia*, *Ceanothus*, *Palinurus*, *Zizyphus*, *Gouania*, &c., while they have not been observed in *Berchemia*, *Sarcomphalus*, *Alphitonia*, *Colubrina*, &c. In every case the reservoirs, whatever their size, can be easily studied with the aid of alcoholic hæmatoxylin, which colours the contents. The reservoirs are to be met with either in the stem, leaf, or petiole, or in the pericarp of the fruit; they, however, appear to be absent from the primary and secondary roots.

Palisade-parenchyme.‡—Herr O. Eberdt has investigated the structure and origin of the palisade-parenchyme in the leaves of a number of species of plants. He dissents from the view of Stahl that this particular form of cell can be called into existence directly by the action of light, regarding it, on the contrary, as in general a hereditary property. Most plants, or especially their leaves, display from the first a disposition to form at least one layer of palisade-cells without the influence of any external agency. This is shown by the existence of this one layer even in leaves found in the deepest shade or in the dark. The lengthening of the palisade-cells and the increase in the number of layers are brought about by the concurrent action of assimilation and transpiration, the length of the cells or the number of layers being in proportion to the extent to which these two forces co-operate. If the amount of transpiration be very small, then, notwithstanding active assimilation, a dissolution of the palisade-parenchyme may take place by the formation of intercellular spaces, and the consequent loosening of the tissue.

* 'Les organes sécréteurs des végétaux et la matière médicale,' 83 pp. and 3 pls., Montpellier, 1888. See Bull. Bot. Soc. France, xxxvi. (1888) Rev. Bibl., p. 178.

† Bull. Soc. Bot. France, xxxv. (1888) pp. 325–7.

‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 360–74. Cf. this Journal, *ante*, p. 82.

Sclerenchymatous Cells in the Flesh of the Pear.*—According to Herr H. Potonié, the sclerenchymatous cells which, in the cultivated pear, are scattered through the flesh, lie, in the wild forms, in a closed very hard zone surrounding the core; and he regards them as the remains of a shell which, in the ancestors of the present species, inclosed the seeds, as is now the case with the medlar and with many species of *Cratægus*. The same applies also to the quince and to some Oleaceæ.

Development of Cork-wings.†—Miss E. L. Gregory now describes the development of cork-wings in certain species of the genus *Euonymus*. The first important consideration on taking up the study of the wing in this genus is, that we have no longer to do with large trees, but with small trees and shrubs. Of the thirteen species of *Euonymus* examined, five may be said to be winged, and of these *E. alatus*, formerly described as *Celastrus alatus* Thb., presents the most marked and striking example. In this species there are four sharp thin wings extending along the internodes, not at the corners, but as nearly as may be exactly between them. The formation of the wing takes place ordinarily after the internode has reached its full length. The first indication of it externally is a little line of brown flecks at equal distances from the ridges at the corners. The author concludes by stating that the periderm does not originate from the epidermal cells, if by periderm is meant the corky growth covering older stems, but from certain layers of cells at a greater or less distance below the epiderm. The cells which are cut off from the epidermal layer form an additional support to the outer collenchymatous cylinder which at first is only two layers in thickness. By means of these additional cells from the epiderm the number of layers is often increased to six or seven.

Bordered Pits of Conifers.‡—Dr. Wille gives particulars of the size and distribution of the bordered pits in Conifers, especially in *Pinus sylvestris*, *P. Larix*, and *P. Abies*. He finds that in each section (zone) of the stem the outer and the inner border of the pits do not attain their full size for about ten years, the size remaining after this nearly constant. The border of the pits in the autumn-cells is nearly of the same size in all the annual rings. No rule can be laid down with regard to the relative size of the pits at different heights in the stem.

Accumulation of Reserve-substances in Trees.§—Dr. R. Hartig has determined, as the result of a number of experiments, that the purpose of the accumulation of reserve-materials in the trunks of trees is to supply the material for the production of seeds; and that the periodicity in the occurrence of good fruit-years depends on the gradual collection of food-supplies, which are then used up in the abundant production of seeds.

Fibrovascular Bundles in the Petiole of Nierenbergia rivularia.‖—M. Lamounette states that the petiole of *Nierenbergia rivularia* is slightly winged on the two sides. If a transverse section be made of an

* Naturwiss. Wochenschr., iii. (1888) pp. 19–21 (1 pl.). See Bot. Centralbl., xxxvi. (1888) p. 266.

† Bot. Gazette, xiii. (1888) pp. 312–6. Cf. this Journal, *ante*, p. 84.

‡ Ber. Naturf. Gesell. Halle, (1887) 1888, pp. 1–39.

§ Bot. Ztg., xlvi. (1888) pp. 837–42.

‖ Bull. Soc. d'Hist. Nat. Toulouse, xxiv. (1888) pp. xviii.–xxi.

adult petiole, a central fibrovascular arc will be found, and between the extremities of this arc and the wing, both to right and to left, will be seen three or four fibrovascular bundles. By a most cursory observation it will be seen that these lateral fibrovascular bundles are exactly parallel to the foliar bundle, and longitudinal sections will show that there is no communication between the different bundles of the petiole. Finally it will be seen that each of these lateral bundles possesses a simple and complete pericyclic layer. The author then traces the formation of these lateral bundles which he states are formed at the expense of the parenchyme of the wings of the petiole.

Vascular Bundles in the Rhizome of Monocotyledons.*—Herr W. Laux gives the following as the general results of his investigations on this subject. The concentric or perixylematic bundles of the rhizome are not distinguished from the collateral bundles of the leaf and stem by the nature of their elementary constituents, but only by the relative position of the xylem and phloem. The passage from a collateral to a concentric bundle usually takes place by the xylem enveloping the phloem in one and the same bundle; and the transition from one to the other is usually very gradual. One and the same collateral bundle may be first transformed into the concentric and then back into the collateral type; this has been observed in the nodes of Juncaceæ. In one and the same transverse section all stages of transition may be seen from the collateral to the concentric type; the collateral bundles belonging to older, the concentric to the younger leaves.

As regards the arrangement of the bundles in the rhizome, this is nearly uniform in the genus *Juncus*, while in *Carex* it displays the greatest variation, arranged under as many as nine different types, if the structure of the cortex is taken into account. A connection in general terms was observed between the arrangement under these different types and the nature of the habitat of the species. Those species which exhibit large lacunæ in the fundamental tissue, especially in the cortical parenchyme, inhabit moist localities; whilst those which grow in dry situations, as on grass-plots, have their fundamental tissue more solid. Both collateral and concentric bundles occur in the same genus.

Bacillar Tumour on Pinus halepensis.†—M. P. Vuillemin describes the structure of a bacterian gall found on *Pinus halepensis*. In the cavity which was found on making a section was an accumulation of immotile bacilli which were feebly stained by anilin. In the hypertrophied parenchyme were woody irregular nuclei having circular or sinuous outlines. A more complete dissection, combined with the examination of young material, showed that these hard corpuscles were connected with each other, and that they were expansions of a ligneous mass dependent on the normal wood of the stem.

Mechanical Structure of Floating-Organs.‡—Dr. H. Dingler describes the various mechanical contrivances by means of which fruits and seeds are enabled to float in the air, classifying them under twelve heads. Excessively slow deposition in the air is secured in some cases by the

* Verhandl. Bot. Ver. Prov. Brandenburg, xxix. (1888) pp. 65–111 (2 pls. and 1 fig.).

† Comptes Rendus, cvii. (1888) pp. 874–6.

‡ SB. Bot. Vereins München, April 23, 1888. See Bot. Centralbl., xxxvi. (1888) p. 386.

organs being enveloped in a vesicle of air. The torsion which a large number of fruits exhibit in falling to the ground is due to the centre of gravity not corresponding to the mechanical centre.

Development of the Endocarp in the Elder.*—Mr. J. B. Farmer states that if sections of the ovary of *Sambucus nigra* be made while the bud is still very young, it will be readily seen that the two innermost cell-layers which surround the 2–4 cavities containing the ovules are perfectly distinct both from each other and from those cells which lie immediately outside them; subsequently, however, a third layer is formed immediately outside these two layers. The cells which compose this third layer are much larger in transverse section than those lying internally to it. The first change which takes place consists in a slight radial extension of the cells, and at the same time the nucleus becomes spindle-shaped. Very soon after flowering, thickening of the cell-walls of each of the three layers commences. Transverse sections taken at a later period show the endocarp, which is very hard and lignified, to be apparently inclosed in a sheath of tangentially flattened cells.

(4) Structure of Organs.

Epiderm of the Seeds of Capsicum.†—Herr T. F. Hanausek states that the ordinary description of the seeds of *Capsicum* is incorrect in one point. Instead of a thick colourless cuticularized outer membrane, he finds, in three species examined, that the outer wall is not cuticularized, but consists of pure cellulose, a true cuticle being wanting or very feebly developed. All the other spots of the membrane of the epidermal cells are very strongly lignified, and the passage from these lignified portions to the lamella of cellulose is a very abrupt one.

Embryo of Umbelliferæ.‡—Herr C. Mez describes the specialities in the structure of the embryo in a very large number of genera and species of Umbelliferæ. Its position is perfectly uniform throughout the family. Where the form of the seed allows of it, the plane of symmetry of the entire fruit, vertical to the commissure-surface of the mericarp, cuts the plane of the surfaces of contact of the cotyledons at a more or less acute angle. The root-cap of the primary root is always well developed; the plumule is never formed before germination. The size of the embryo varies very greatly in relation to that of the seed. The two cotyledons are usually of the same length, but in *Scandix* one is normally longer than the other.

Winged Stems and Decurrent Leaves.§—Herr K. Reiche distinguishes from true wings—on morphological, not on anatomical grounds—the elevated lines and ridges on opposite sides of stems with decussate leaves, which can be compared with the lines of hairs on such stems as those of *Veronica Chamædrys* and *Stellaria media*. Of true wings he distinguishes three kinds, viz.:—(1) where the leaves are continued from their base into two descending wings in immediate contact with the edge of the leaf (*Onopordon*, *Cirsium*, *Carduus*, *Symphytum officinale*, &c.); (2) where the leaves are distinctly detached from the wings

* Ann. of Bot., ii. (1888) pp. 389–92 (3 figs.).
† Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 329–32 (1 pl.).
‡ Verhandl. Bot. Ver. Prov. Brandenburg, xxix. (1888) pp. 31–6.
§ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 323–9.

(*Genista sagittalis*); (3) where the leaves are suppressed (*Acacia alata*). The object of ridges and wings on the stems is to assist in assimilation, that of those on fruits and seeds to aid in dissemination.

Bud of the Tulip-tree.*—M. H. Emery criticizes Sir J. Lubbock's explanation † of the singular truncation presented by the extremities of certain leaves of *Liriodendron tulipifera*, viz. that the extremities of the leaves are hindered in their development by the formation of stipules, and cannot elongate as is usually the case. This the author doubts on two grounds; firstly, because the obstacle does not exist in the bud, and secondly, if it did exist, only the growth of the lamina would be affected. The author then traces the development of the bud, which he states grows for three years.

Foliar Organs of a new species of Utricularia.‡—Mr. H. N. Ridley describes certain spathulate leaf-like bodies belonging to a small epiphytic species of *Utricularia*, from St. Thomas's Island, West Africa. They were narrow and filiform at the base, broadening into a lamina about 1/16 in. in diameter, and apparently had been green in colour, with three veins. Further examination showed that every stage occurred between the filiform process, frequently branched and bearing numerous utricles, and the flattened leaf-like lamina. A similar modification was figured by Oliver in *Utricularia Jamesoniana*, a small epiphytic species from the Andes, and apparently allied to the one described here. The author concludes by giving a technical description of this new species, to which he has given the name of *U. bryophila*, and by stating that in the epiphytic species of *Utricularia*, at least, these leaf-like bodies are dilated phylloclades.

Polymorphism of the Leaves of Abietineæ.§—M. A. Daguillon points out that in many species of pines two forms of leaves occur: the primordial form, succeeded by a more defined form. The primordial form of leaf immediately succeeds the cotyledons, and remains for the first year or two, while the adult leaves are fascicled, and occur in bundles of two, three, or five, according to the species. The author's conclusions are that in the Abietineæ the existence of primordial leaves is tolerably constant. The passage from the primordial leaves to those of the adult is made either suddenly, in the genus *Pinus*, or by insensible gradations, in *Abies*. This passage is characterized by the progressive development of hypoderm and sclerenchyme next to the fibro-vascular system, and in certain genera by the formation of the central vein in two bundles, with a common endoderm.

Leaves of Begonia.‖—Herr G. Haberlandt describes the peculiar emergences on the leaves of *Begonia smaragdina* (*B. imperialis* Lem. *β smaragdina*). On the upper side of the lamina are a number of hollow conical projections, each of which is prolonged at the apex into a curved hair; and corresponding to each of these there is on the under side a funnel-shaped depression. The veins and leaf-stalk are furnished with similar hairs. The epiderm of the leaf is continuous with that of the elevation and of the hair, the extremity of which is frequently occupied by strongly refringent cells containing tannin. These hairs

* Bull. Soc. Bot. France, xxxv. (1888) pp. 327–9.
† Cf. this Journal, 1887, p. 112. ‡ Ann. of Bot., ii. (1888) pp. 305–7 (1 pl.).
§ Comptes Rendus, cviii. (1889) pp. 108–10.
‖ MT. Nat. Verein. Steiermark, (1887) 1888, pp. 117–26 (1 pl.)

are distinguished from those of other species of *Begonia* by almost invariably containing a mechanical element in the form of one or more rows of sclerotized bast-cells running through their whole length. A few of the weakest of the hairs are destitute of this mechanical element. They are true emergences, being of hypodermal origin, and always springing from a single meristem- or periblem-cell. The peculiarity of these structures lies in their being emergences in which the sclerotized element is not the epiderm but an internal skeleton.

The leaves of the same species of *Begonia* contain also mechanical elements imbedded in the assimilating-tissue in the form of sclerotized branched bast-cells, resembling those of other thick-leaved plants such as *Camellia* and *Olea*. Similar stereides also accompany the vascular bundles of the veins and leaf-stalk.

The author believes these peculiarities of structure to be connected with the habit of the species, which is probably a native of dry sunny localities.

Scars on the Stem of Dammara robusta.*—Mr. S. G. Shattock states that in *Dammara robusta* C. Moore, the base of the branch presents a marked enlargement due almost solely to an increase of the cortical parenchyme; this excess serves to aid the wood in this situation in supporting the branch; the cortical parenchyme generally and the medulla as well contain a considerable proportion of branching sclerenchymatous idioblasts. In *Dammara robusta* the process of disarticulation is like that by which a leaf or other organ is shed; that is, the parenchymatous cells across the whole zone of articulation multiply by transverse division, a layer of cork resulting from the formation of this secondary meristem, and through the distal limits of this the solution of continuity occurs. It thus happens that the whole of the parenchymatous system of the stem is closed by cork before the branch is actually shed. The branch-scar, when examined immediately after disarticulation, is ovoid, concave, and has a finely granular surface; the narrow circular zone of the fractured wood projects slightly at the bottom of the cicatrical fossa, and in the cortical parenchyme are imbedded the ruptured ends of the bast-fibres.

Root-tubercles of Leguminosæ.†—Dr. A. Prazmowski reviews the various theories with regard to the nature of these structures and of the organisms contained in them, and appends the results of observations and experiments of his own.

In order to test whether the tubercles are normal or pathological productions, he grew plants of *Pisum sativum* and *Phaseolus vulgaris* in sterilized soil watered with distilled water and protected from all possible access of microbes, side by side with others grown in normal conditions or in sterilized soil and watered with ordinary water in which soil had been soaked. In all of a large number of experiments abundance of tubercles were found on the root in the latter cases, while not a single one could be seen on those from which the possibility of infection had been excluded. Under normal conditions the tubercles appear to be formed about the time of the appearance of the root-hairs.

* Journ. Linn. Soc. Lond., xxiv. (1888) pp. 441–50 (1 pl.).

† Bot. Centralbl., xxxvi. (1888) pp. 215–9, 248–55, 280–5. Cf. this Journal, 1888, p. 608.

The filiform bodies found in the tubercles are, according to Prazmowski, true hyphæ-filaments, as Ward has already proved; * he does not, however, think with Ward that they enter the root only through the root-hairs, but also through the young epiderm. The tubercles he finds invariably to be formed only where the fungus-hyphæ penetrate the tissue of the root. They branch copiously in the epidermal cells. As soon as the hyphæ reach the lower layers of the bark, the transference of formative materials into them commences. The first substance produced in them is starch; subsequently in the inner part of the tuber is formed the so-called "bacteroid-tissue," in which are found the peculiar bodies regarded by some observers as of the nature of bacteria, or detached portions of the fungus-hyphæ, by others as simply unorganized food-materials. The author does not agree altogether with either of these views; he regards them as internal protoplasmic structures found within the fungus-hyphæ before the development of the "bacteroid-tissue." Their form varies in different species; in *Phaseolus* and *Lupinus* they maintain during their whole existence the form of bacterium-like rods; in *Pisum*, *Medicago*, and *Vicia* they branch; in *Trifolium* they are usually pear-shaped.

With regard to the nature of the fungus, the author regards it as belonging properly neither to the Hyphomycetes nor to the Myxomycetes, but presenting in some respects the closest analogy to *Plasmodiophora Brassicæ*, differing from this chiefly in having, in an early stage of its existence, a filiform state, and in the peculiar "bacteroids" contained within its hyphæ. It is possible that these, although not true spores, may have a reproductive function, and may possibly, under certain conditions, develope into plasmodes. With respect to the function of these tubercles, the author is disposed on the whole to agree most with Hellriegel's view that the connection between the plant and the fungus is a symbiotic one, and that the fungus enables the host in some way to avail itself, in its nutrition, of the free nitrogen of the atmosphere.

The observations were made chiefly on the species above-mentioned, but the following agree also in the general facts:—*Vicia sativa*, *V. Faba*, *Lupinus angustifolius*, *L. luteus*, *L. perennis*, *Trifolium pratense*, *T. hybridum*, *Medicago sativa*, and *M. lupulina*; the phenomena differing only in unimportant points in the different species.

Tubercles of Leguminosæ.†—M. P. Vuillemin describes, in the root-tubers of *Medicago disciformis* and *Galega officinalis*, the occurrence of a *Cladochytrium*, which produces its sporanges and uniciliated zoospores at the end of the winter when the tubercles are quite mature. The "bacterioids" he regards, with Brunchorst, as simply fragments of the protoplasmic network. The anatomical structure of the tubercles themselves he compares to that of the aggregated buds of *Petasites*, resulting from the isolation of the fibrovascular bundles.

Formation of Subterranean Swellings in Eranthis hyemalis.‡—M. P. A. Dangeard states that the first subterranean swelling of the winter aconite includes the upper part of the principal root, the hypocotyledonary axis, and the region of insertion of the cotyledonary

* Cf. this Journal, 1887, p. 788.

† Ann. Sci. Agron., i. (1888) 96 pp. and 2 pls. See Morot's Journ. de Bot., ii. (1888) Rev. Bibl., p. 153.

‡ Bull. Soc. Bot. France, xxxv. (1888) pp. 366–8.

bundles; it is produced by a division of the internal layers of the cortex and cells of the pericycle and the pith; it forms immediately a meristematic zone outside the primary formations, and new swellings are formed by a lateral extension of this zone with production of a new bud. In the case studied by the author the structure of the cotyledons was peculiar; the axis was arrested at the summit of the tubercle, the cylinder which supported the cotyledons with its two bundles only represented a sort of sheath, the axis being replaced by a central lacuna.

Morphology of the Mistletoe.*—Dr. S. Schönland has observed a large number of abnormalities in the structure and arrangement of the organs of the mistletoe, many of which have been noticed before, while others are apparently new. The present paper deals with the morphology of the flowering shoots, including both the arrangement and general structure of the flowers. The mistletoe is diœcious. The plants of the two sexes have on the whole the same structure. The inflorescences are usually found between the two foliage-leaves, and normally consist of two lateral flowers at right angles to these leaves, and a terminal flower. The terminal flower of the male inflorescence is, as a rule, not preceded by scale-leaves. But Hofmeister has stated that they are present here, as in the female. This is really often the case, although not observed by Eichler; but still the structure of the inflorescences in which it occurs is not the same as that of the female inflorescences, and this apparent abnormality can be observed in inflorescences developed from dormant buds. In the female flowers the perianth usually consists of two dimerous alternating whorls of scale-leaves, which cohere more or less at the base. An increase in the number of parts composing the male terminal flowers is not rare. Eichler only knew of pentamerous and hexamerous flowers besides the normal ones; the author, however, has observed one heptamerous and one decamerous flower.

Structure of Marcgraviaceæ.†—Herr H. O. Juel gives details of various points of structure in the plants belonging to this tropical natural order, especially of *Marcgravia polyantha* and *Norantea brasiliensis*, both from Brazil.

The outer bark contains a close tissue, supported by stereïdes; in the inner bark there are no mechanical elements. There are no tracheides in the wood; the wood-fibres are septate, and have narrow fissure-like slightly bordered or larger elliptical pits. In the nectaries the secreting tissue is formed from the fundamental tissue, and is covered by a thin epiderm without stomates. The gamopetalous corolla is composed of four leaves alternating with the sepals. The outer integument of the ovule is shorter than the inner one, and the embryo-sac is near to the micropyle. When the seed is ripe the end of the inner integument projects beyond the testa, the outer integument forming the single hard layer of the testa. The embryo is surrounded by a layer of cells, the outermost endosperm-layer; and in *Norantea* there are also the remains of a starchy endosperm. In *Marcgravia* some of the seeds are sterile, without embryo.

* Ann. of Bot., ii. (1888) pp. 283–90 (1 pl.).
† Bih. K. Svensk. Vet.-Akad. Handl., xii. (1887) No. 5, 28 pp. and 3 pls. Cf. this Journal, 1888, p. 449.

β. Physiology.*

(1) Reproduction and Germination.

Distribution of the Sexual Organs in the Vine.†—Prof. E. Rathay records a number of observations which support his statement that there is a certain amount of differentiation of the sexes in the cultivated vine. Many of the flowers are functionally female; they contain stamens, but the pollen-grains have no power of putting out pollen-tubes; and these female flowers differ somewhat in form and appearance from the hermaphrodite flowers. He finds, moreover, that those individuals which bear female never bear hermaphrodite or male flowers. The male individuals also never bear female, but not unfrequently hermaphrodite flowers. The hermaphrodite individuals may bear male but never female flowers. Dr. Rathay suggests that the wild ancestor of the cultivated grape-vine must have been diœcious.

Constancy of Insects in visiting Flowers.‡—Observations made by Dr. M. Kronfeld on *Apis mellifica* and *Bombus hortorum* tend to show that these insects will, on the same flight, confine their visits to the same species of flower, even when a number of others are equally accessible which would just as well afford them a supply of nectar and pollen.

Fertilization of Lonicera japonica.§—Mr. T. Meehan describes, in relation to their mode of fertilization, three different forms of this species grown in American gardens. He states that, notwithstanding the length of the corolla-tube, it is, after the dehiscence of the anthers, so completely filled with nectar that bees and other short-tongued insects have no difficulty whatever in obtaining it. These visit the honeysuckle in large numbers, and, from the position of the stamens and stigmas, can in no possible way aid in fertilization. Mr. Meehan sees in this evidence of design for the benefit of the insect rather than of natural selection for the benefit of the flower alone.

Fertilization in the Nyctagineæ.‖—Dr. A. Heimerl describes the mode of pollination in several species belonging to this order. In *Oxybaphus viscosus*, the styles and filaments undergo several changes in direction, from nearly straight to strongly curved, ultimately bringing the stigma and anthers in close proximity to one another. The showy scented perianth appears to point to the visits of insects, and cross-pollination is not excluded; but, on the other hand, the structure seems contrived to ensure the possibility of self-pollination. The main facts are the same in *Mirabilis Jalappa*, and in the night-flowering *M. longiflora*. In other genera of the order, *Boerhavia, Acleisanthes, Pentacophrys,* and *Selinocarpus,* there is a gradual transition from the ordinary open to cleistogamous flowers which are, of course, exclusively self-fertilized. In the suborder Pisonieæ, on the other hand, consisting of tropical and subtropical trees and shrubs, cross-pollination is insured by diclinism, or the suppression of the pistil and the stamens respectively in the male and female flowers.

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

† SB. K.K. Zool.-Bot. Gesell., xxxviii. (1888) pp. 87–92.

‡ Abh. K.K. Zool.-Bot. Gesell., xxxviii. (1888) pp. 785–6.

§ Proc. Acad. Nat. Sci. Philad., 1888, pp. 279–83.

‖ Abh. K.K. Zool.-Bot. Gesell., xxxviii. (1888) pp. 769–74.

Cross-fertilization in Hydrangea.*—Mr. T. Meehan shows, by some studies in *Hydrangea*, that the variations in the species are of the most contradictory character taken from the standpoint of benefits in the struggle for life; while they are entirely consistent with the author's view of variation for variety's sake. *Hydrangea hortensis* from Japan has the ray-florets sterile, or rather it is the lateral florets of the compound cyme that give the enlarged sepals and fail to perfect the gynœceum. The terminal florets are fertile. In *H. quercifolia* all the lateral florets are fertile, and it is only the terminal one that has petaloid sepals and is barren. Will any one assert that these exactly opposite conditions can have any bearing whatever as aids in a struggle for life? It is broadly asserted that we owe to the existence of insects the various forms and colours of flowers. In the genus *Hydrangea*, however, we have illustrations of the most dissimilar and contradictory variations. The facts are absolutely inexplicable on any theory of the survival of the fittest in the struggle for life; but on the author's view of the absolute necessity of variation for its own sake, the explanation seems to him simple enough.

Life-history of Yucca.†—Mr. T. Meehan continues his contributions to the life-histories of plants. This year (1888) *Yucca filamentosa* commenced to bloom about the end of June. During the first week or ten days of the flowering period, an enormous amount of moisture exudes from every part of the flower. The moths become very active just after sunset, travelling rapidly up and down over the moistened stigma, apparently feeding on the moisture. When, however, half the blossoms on the panicle have matured, the production of moisture ceases, and on the evening of the 8th of July no trace of exudation of moisture could be found, nor was there any during the whole remainder of the flowering period.

Flowering of Euryale ferox.‡—Further examination of the mode of flowering of this plant leads Prof. G. Arcangeli to the conclusion that it possesses both chasmogamous and cleistogamous flowers, and that the former exhibit all the peculiarities of flowers which depend on the visits of insects for their fertilization; their number is small compared to that of the cleistogamous flowers. The author, however, agrees now with Darwin's view that this plant is abundantly fertile when self-pollinated.

Germination of the Seeds of Euryale ferox.§—Prof. G. Arcangeli describes the structure of the seed of this water-lily, which is covered by a large thick aril, the bubbles of air in the cells of which assist in the floating and consequent dissemination of the seeds. The aril is composed of two parts, an outer larger pulpy, and an inner smaller corrugated cartilaginous portion. Within the aril the seed is inclosed in a double integument. The nucleus is composed, as in *Nymphæa*, *Nuphar*, and *Victoria*, of three portions—embryo, albumen (endosperm), and perisperm. The endosperm consists of a single layer of cells, while the perisperm, derived from the tissue of the nucellus, occupies the

* Proc. Acad. Nat. Sci. Philadelphia, 1888, pp. 277–9.
† T. c., pp. 274–7. Cf. this Journal, 1887, p. 116.
‡ Atti Soc. Tosc. Sci. Nat., ix. (1888) pp. 369–83. Cf. this Journal, 1888, p. 83.
§ Nuov. Giorn. Bot. Ital., xx. (1888) pp. 467–73.

larger portion of the seed. The embryo is small, and is situated near the micropylar region.

The process of germination itself is characterized by the small development of the radicle, of the hypocotyledonary axis, and of the cotyledons. The absorption into the growing embryo of the nutrient substances contained in the perisperm appears to be assisted by a ring of small protuberances in the neighbourhood of the collar, corresponding apparently to the appendages described by Briosi in the seeds of *Eucalyptus*.

Germination of the Hazel.*—Herr A. Winkler describes the rarely observed germination of the hazel-nut. The seed appears to retain its germinating power only for about a year; it is very liable to destruction by frost and by animals. The oily fleshy cotyledons never emerge from the shell, and in the first autumn after germination in the spring have scarcely changed their appearance, but have lost their oil. The two cotyledons resemble those of *Æsculus* in being closely adpressed to one another, but are not actually united, as in *Castanea*. In the second spring the growing point emerges from the shell, and a strong tap-root is developed, but the root is never pushed above the surface of the soil. During the first year four leaves are formed with almost perfect regularity, and the subsequent development is very slow.

(2) Nutrition and Growth (including Movements of Fluids).

Relation between the formation of Tubercles and the presence of nitrogen in the soil.†—Dr. S. H. Vines gives the details of a series of experiments which tend to confirm his previous conclusion that the development of tubercles on the root of *Vicia Faba* and of other Leguminosæ is directly related to the absence of assimilable nitrogen in the surrounding medium. The experiments do not conclusively prove that the tubercular disease is not infectious, but they do prove the influence of nitrate in the soil in diminishing the development of tubercles.

Conduction of Water through Wood.‡—Herr A. Wieler replies to the criticisms of Hartig § on his previous communications on this subject, and maintains his assertion that any considerable occupation of the transpiring surfaces with water is only possible in the newest of the annual rings. He further states that the formation of alburnum can have no connection with the conduction of water, since this proceeds more rapidly in the higher than in the lower regions of the tree.

(3) Irritability.

Spontaneous Movements of Stamens and Styles.‖—Herr H. Beyer gives a *resumé* of all that is known respecting these interesting phenomena and their connection with fertilization.

He first deals with those actinomorphic flowers which are adapted for "under-pollination" by insects. He regards flowers with a single whorl of stamens as a later derivation from polyandrous flowers, and commences with those of the latter in which the stamens are arranged spirally.

* Verhandl. Bot. Ver. Prov. Brandenburg, xxix. (1888) pp. 41–3 (1 pl.).
† Ann. of Bot., ii. (1888) pp. 386–9. Cf. this Journal, 1887, p. 788.
‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 406–35. § Cf. this Journal, *ante*, p. 90.
‖ 'Die spontanen Bewegungen d. Staubgefässe u. Stempel,' 1888, 56 pp. See Bot. Centralbl., xxxvi. (1888) p. 262.

Of these he describes mainly the phenomena in question in Ranunculaceæ (*Ranunculus auricomus*, *Batrachium aquatile*, *Clematis recta*, *Thalictrum aquilegifolium*, *Adonis vernalis*, and *Aquilegia*), Malvaceæ (*Alcea rosea*, *Malva sylvestris*), and Rosaceæ (*Sorbus*, *Rosa*, *Chimonanthus*, *Spiræa*, *Prunus*, *Potentilla*). In the Ranunculaceæ the stamens bend from a joint-like zone at the foot of the filament; in the Malvaceæ this zone lies in the middle of the filament; while in the Rosaceæ there is a nearly uniform bending of the entire filament. This spontaneous movement is a frequent phenomenon in polyandrous actinomorphic flowers; its purpose being either to place the anthers with their fissures round the nectary, or, at the end of the period of flowering, in contact with the stigma.

Next follows a discussion of actinomorphic flowers with two rows of stamens, including *Allium* (especially *A. ursinum*), Caryophyllaceæ (*Stellaria* and its allies, *Dianthus deltoides*, *Silene*), *Geranium* (*sylvaticum*, *pyrenaicum*, *molle*, *pusillum*), *Erodium*, *Sedum*, *Sempervivum*, Saxifragaceæ, Rutaceæ (*Ruta graveolens*), *Epilobium*, *Philotheca australis*, and *Asarum europæum*; and then those with a single row:—*Lilium*, *Eremurus spectabilis*, *Methomia superba*, *Trientalis europæa*, *Cobæa penduliflora*, *C. scandens*, *Sabattia angularis*, *Valeriana officinalis*, *Linum*, *Boronia pinnata*, *Paliurus aculeatus*, Umbelliferæ, *Parnassia palustris*, *Teesdalia nudicaulis*, *Faramea*, *Polygonum*, *Fagopyrum*, *Ceratophyllum demersum*, and *Eschscholtzia*.

The few cases in which actinomorphic flowers show contrivances for "over-pollination" by insects are also described, viz.:—*Nigella*, *Passiflora*, and *Veratrum album*; and for lateral pollination:—*Jasione montana*, *Picris hieracioides*, *Leontodon autumnalis*, and *Solanum rostratum*.

Of zygomorphic flowers those only are referred to which display spontaneous motions and which are adapted for under-pollination:—*Delphinium*, *Aconitum*, *Reseda*, *Tropæolum*, *Dictamnus*, *Polemonium*, *Æsculus*.

These spontaneous movements are a very constant character of families, and, being usually derived from the earliest periods, do not disappear with the most complete changes in the parts of the flower.

Irritability of Mimosa.*—Mr. D. D. Cunningham records the result of a series of experiments on the phenomena of propagation of movement in *Mimosa pudica*. He favours the view that it is due to mechanical causes connected with the transference of water, together with peculiarities in the structure of different masses of tissue, rather than to the contractility of the protoplasm. The following are some of the results on which this conclusion is founded.

The intensity in the propagation of the movement is proportional to the ease with which variations in the tensions of the tissues spread themselves. The direction in which the movement advances is, in many cases, that in which variations in the tensions of the tissues can be determined; while they cannot be explained as a result of protoplasmic conduction. The order of succession of the excitations in cases of advancing irritation is often inexplicable on the theory of a continuous conduction of protoplasmic irritation, while it can easily be explained as the result of variations of pressure in masses of tissue differing in their anatomical structure.

* Scient. Mem. by medical officers of the army of India, iii. (1888) pp. 83-138.

Cause of violent Torsion.*—From observation of an extreme case of violent torsion (Zwangsdrehung) in the case of *Galium Mollugo*, Herr H. Klebahn has come to the conclusion that the cause is to be found in an alteration in the growing points, which shows itself in a change from the decussate arrangement of the leaves to a 2/5 phyllotaxis, and in a coalescence of the bases of the successive leaves, resulting in a union of the vascular bundle of each leaf with that of the next.

(4) Chemical Changes (including Respiration and Fermentation).

Products of the Decomposition of Albuminoids in the absence of free oxygen.†—In continuation of previous researches,‡ Herr W. Palladin gives the following as the most important results of a fresh series of observations.

When albuminoids decompose in the absence of free oxygen, nitrogenous substances are formed in different proportions to what occurs in the open air. Asparagin is, under these circumstances, formed in very small quantities, while the principal products are tyrosin and leucin. Asparagin is formed during the first day when there is no free oxygen present, but disappears on the death of the plant, passing over into ammonium succinate. In wheat, when albuminoids decompose in the presence of atmospheric oxygen, asparagin is almost the only nitrogenous product. The formation of a large quantity of asparagin as the result of the decomposition of albuminoids in plants, can only take place when atmospheric oxygen is being assimilated, and is therefore, a consequence of the oxidation of the albuminoids, not of their dissociation.

Panic Fermentation.§—Prof. G. Arcangeli maintains, in opposition to the assertion of Chiaudard, that alcohol is one of the products of the fermentation of bread. This can be proved, both by the slight alcoholic odour and by the production of iodoform on the addition, with proper precautions, of potassium carbonate and iodine to the distilled liquid. This alcoholic fermentation is due, he believes, not to the bacilli which may always be found in the paste, but to the presence of small quantities of *Saccharomyces minor*. These microbes assist also in the transformation which does take place of a portion of the albuminoids of the gluten into soluble albuminoids, and then into peptones.

γ. General.

New Myrmecophilous Plant.‖—Herr C. Mez points out an instance of myrmecophily in *Pleurothyrium*, a South American genus of Lauraceæ. The habitation of the ants is in hollows excavated in the pith of the woody portion of the branches.

Scent of Flowers.¶—Prof. A. Kerner v. Marilaun discusses the various odours of flowers, which may be either for the purpose of attracting or of keeping off insects. The mutual adaptations of the scented flower and of the olfactory faculty of animals are described at length.

* Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 346–53 (1 pl.).
† Ibid., pp. 296–304.
‡ See this Journal, 1887, p. 437.
§ Atti Soc. Tosc. Sci. Nat., ix (1888) pp. 140–211. Cf. this Journal, 1888, p. 633.
‖ Verhandl. Bot. Ver. Prov. Brandenburg, xxix. (1888) p. xxiv.
¶ SB. K.K. Zool.-Bot. Gesell., xxxviii. (1888) p. 87.

From the point of view of their chemical composition, the author classifies the odours of flowers under the following four heads, viz.:—(1) indoloids (*Stapelia*, *Rafflesia*, *Aristolochia*, Aroideæ); (2) aminoids (*Cratægus*, *Pyrus*, *Pachysandra*, *Sanguinaria*, *Ailanthus*, *Castanea*); (3) terpenoids (*Lavandula*, *Dictamnus*); (4) benzoids (*Caryophyllus*, *Dianthus*, *Hyacinthus*, *Asperula*, *Syringa*, *Robinia*, *Viola*, Orchideæ).

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Doubling of the Endosperm in Vascular Cryptogams.*—According to M. P. Van Tieghem polystelic stems or leaves, with double endoderm, exhibit, according to the diameter of the vascular bundles, sometimes a pericycle in all of them, as in the single bundle in the stems of *Hymenophyllum* and the stolons of *Nephrolepis*, sometimes an absence of pericycle in all of them, as in the single bundle of the stem of *Azolla*, sometimes both arrangements. The doubling of the endoderm occurs in many species of *Polypodium*; and the bundles may be surrounded by a pericycle, or this may be entirely wanting; and these two forms may occur in the same stem, the large bundles being provided with a pericycle, whilst the smaller ones are without one.

Systematic Position of the Rhizocarpeæ.†—From an investigation of the structure of the prothallium in *Marsilea* and *Pilularia*, Dr. D. H. Campbell has come to the conclusion that the family of Rhizocarpeæ, as now constituted, consists of two groups, which represent the last terms of two distinct series of forms. Of these the Marsileaceæ are in all probability derived from forms closely allied to living Polypodiaceæ. The exact position of the Salviniaceæ must remain for the present in doubt, but they certainly should be removed from their present close proximity to the Marsileaceæ.

Germination of Marsilia ægyptiaca.‡—Dr. D. H. Campbell has followed out the germination of both microspores and megaspores of this species. The microspore divides first of all into a larger and a smaller cell, the latter of which is the vegetative portion of the prothallium, and undergoes no further division. As in *Pilularia* and the Polypodiaceæ, the former is the mother-cell of the antherid, and divides further into the mother-cells of the antherozoids. The antherozoids themselves resemble those of other species of the genus. In the development of the archegone in the female prothallium there is no production of "primordial cells"; septa are formed at all stages of the division. Only a single canal-cell could be detected with certainty, and that was very short.

Development of Pilularia.§—Dr. D. H. Campbell has very carefully examined the structure and development of the male and female prothallium and of the embryo of *Pilularia globulifera*. He has employed, and strongly recommends for similar investigations, the process of paraffin-imbedding and cutting with a microtome.

In the microspore the vegetative portion is more considerable than

* Morot's Journ. de Bot., ii. (1888) pp. 404–6.
† Bull. Torrey Bot. Club, xv. (1888) pp. 258–62.
‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 340–5 (1 pl. and 1 fig.).
§ Ann. of Bot., ii. (1888) pp. 233–64 (3 pls.).

has been stated by previous observers. The very thin endospore exhibits the reactions of cellulose, the three layers of the exospore those of cuticularized membrane; the very thin nearly transparent epispore is apparently derived from the epiplasm, not from the protoplasm of the mother-cell. The first wall in the germinating microspore is at right-angles to the shorter axis of the spore, and divides it into a small basal cell, which again frequently divides into two cells of very unequal size which represent the vegetative part of the prothallium, and a much larger upper cell, the mother-cell of the antherid. The further divisions in the latter closely resemble those in Polypodiaceæ; the normal number of antherozoids is thirty-two, formed by repeated divisions in the central cell of the antherid, not by free-cell-formation. The vegetative part of the prothallium is separated from the mother-cells of the antherozoids by a strong wall, the basal cell of the antherid intervening between them. Eventually the wall of the microspore is ruptured by the absorption of water by the internal walls; owing to its strong turgescence the cap-cell is very conspicuous just before the rupture. The gradual development was followed out of the nuclei of the mother-cells into the antherozoids, which are furnished with a large number of cilia, as in other Vascular Cryptogams. The attached vesicle is large, and is surrounded by a very delicate membrane; occasionally the swarming antherozoid frees itself entirely from the vesicle.

The structure of the megaspore and the succession of its early divisions are much as has been described by previous observers. The mother-cell of the archegone is distinguished from the other cells by its central position and by its more densely granular protoplasm. The ventral canal-cell appears to be formed not by further division of the central cell, but by division of the primary canal-cell. Fecundation takes place very soon after the archegone opens, and the oosphere becomes almost at once surrounded by a membrane which prevents the further penetration of antherozoids; as soon as the latter enters the oosphere it appears to undergo similar changes, only in reverse order, as those which it underwent in transforming itself from a nucleus of a mother-cell to an antherozoid.

The first divisions of the embryo are into two primary cells, and then into four quadrant-cells, which Dr. Campbell regards as of equal morphological importance. The development is described in detail, from the four quadrants respectively, of the first leaf, the first root, the stem, and the foot. In the leaf the apical growth ceases early; the apical cell of the root is from the first very conspicuous, and immediately recognizable as such. The apical cell of the stem is formed indifferently from either of the two octants of the stem-quadrant. The first leaves show scarcely a trace of the circinate vernation of the later ones.

From the very great resemblance in the structure of the antherid, the author derives a conclusion favourable to the very close relationship of the Marsileaceæ to true ferns.

"Bulblets" of Lycopodium lucidulum.*—Mr. E. E. Sterns describes the bulblets of *Lycopodium lucidulum* Michx., which are borne on the end of the 6-bracted stipes. These stipes are short thickish subterete ascending branches, not axillary in any sense, but occupying, side by side, the exact position of leaves. The bulblet resembles the

* Bull. Torrey Bot. Club, xv. (1888) pp. 317–9, and xvi. (1889) pp. 21–2 (3 figs.).

ovary of an apetalous pistillate flower, and looks like a small plump dust-pan. The body of the "pan," which is horizontal inclining to cernuous in position, is formed of two broad oblong scales, subconcave at base, and placed close side by side. Here then, we have a stipe, six bracts, five scales, and a germ, in all thirteen separate elements, completely differentiated, regularly combined, and adapted to each other in the most systematic fashion.

Apospory in Pteris aquilina.*—Prof. W. G. Farlow describes an instance of apospory in the common brake. On pinnæ which presented a peculiar curled appearance, some of the sporanges had developed at an early period into abnormal structures, while others were altogether replaced by such. Some of these abnormal structures presented most resemblance to the protoneme of a moss, others to the prothallus of a fern. On none of them had antherids and archegones been formed.

Xerotropism in Ferns.†—By the term *xerotropism* Prof. A. Borzì designates the tendency of plants, or of parts of plants, to alter their position in order to protect themselves from desiccation. The property is but rarely exhibited among Phanerogams, much more frequently among Cryptogams,‡ especially in the vascular section. Among Thallophytes, however, we find it displayed by many Oscillariaceæ, and by species of *Ulothrix* and *Schizogonium*. Among Vascular Cryptogams, striking examples are afforded by many species of *Selaginella*, and by ferns growing in dry or stony situations, such as *Asplenium Trichomanes*, and several species of *Ceterach* and *Notochlæna*. The structure adapting the fern to this end is especially described in the case of *Ceterach officinarum*.

Under prolonged desiccation the leaves of this fern become completely rigid, the lamina recurving itself on the upper surface, and exposing the under surface covered with brown scales. A few hours of rain are sufficient to cause the leaves to resume their normal position and appearance. The xerotropic movement is more vigorous in young than in adult leaves; each pinna has a movement independent of that of the others.

The anatomical structure which gives rise to these movements is as follows. The upper epiderm is composed of large cells with wavy sinuous walls somewhat thickened and collenchymatous. When dry they contract considerably in the transverse direction, and this is accompanied by a corresponding enlargement of the subjacent tissue, the lower mesophyll having very thin cell-walls, and being abundantly supplied with intercellular passages. The palisade-parenchyme takes no active part in the movements, but its cells are affected by the contraction of the epiderm, and their chlorophyll-grains are transferred from their radial walls to the lower portion of their cell-cavity.

Similar structures are described in *Notochlæna vellea*, *Asplenium Trichomanes*, and several species of *Cheilanthes*.

Structure of the Commissure of the Leaf-sheath of Equisetum.§—Dr. C. Müller enters in great detail into the mathematical questions connected with the arrangement of the sheath-teeth of *Equisetum* and of

* Ann. of Bot., ii. (1888) pp. 383–5 (4 figs.). Cf. this Journal, 1887, p. 996.
† Nuov. Giorn. Bot. Ital., xx. (1888) pp. 477–82.
‡ Cf. this Journal, 1888 p. 1001.
§ Jahrb. f. Wiss. Bot.—(Pringsheim) xix. (1888) pp. 497–579 (5 pls. and 5 figs.).

their divergence. He regards the sheath as intended for the protection of the young growing point, and therefore as corresponding in function to the bud-scales of dicotyledons. The points of resemblance and difference between the leaf-sheath of *Equisetum* and of *Casuarina* are also dwelt upon. In the Equisetaceæ the firmness of the commissure is chiefly dependent on the silicification of the epidermal layer of cells; in *Casuarina*, on the other hand, to the lignification of internal cells.

Muscineæ.

Peristome of Mosses.*—M. Philibert continues his observations on the peristome of mosses. In the first place he discusses the difference between the Nematodonteæ and the Arthrodonteæ, and then points out certain transitions between these two groups. One of the Polytrichaceæ, *Polytrichum juniperinum*, is then described in detail. If a transverse section be made of one of the teeth of this moss, it will be found to be of the form of an isosceles triangle; cell-cavities may be distinguished which are oval towards the middle of the tooth but lunar at the edges. The author in conclusion states that the structure of the peristome in the Polytrichaceæ does not resemble either in plan or origin that of any other family of mosses. Besides *Dawsonia*, which is evidently allied to this family, it is only approached to a very slight extent by the Tetraphideæ (Georgiaceæ Lind.).

Shining of Schistostega osmundacea.†—Dr. F. Noll describes the peculiar optical phenomena belonging to this moss, but only to its protonemal condition, it which it often clothes dark clefts in rocks. The protoneme consists not of cylindrical cells, but of a single layer of cells of very peculiar form lying at right angles to the direction of the incident light. Each cell is of elliptical form, with the longer diameter at right angles to the incident light, and with a projection on the side furthest removed from the light. In this protuberance lie a small number of chlorophyll-grains and the nucleus, the rest of the cell being occupied by a colourless highly concentrated cell-sap. Dr. Noll points out that the effect of this peculiar structure is, on optical principles, to concentrate the rays of light on the portion of the cell occupied by the chlorophyll-grains, and thus to counteract the influence of the small amount of natural illumination. The effect is to cause an apparent radiation of light from patches of the protoneme as it grows on the wall of the dark rock.

New Hepaticæ.‡—Among the plants collected by Sintenis in the West Indies in 1885–1887, Herr F. Stephani describes the following unpublished species of Hepaticæ. From Porto Rico:—*Aneura digitiloba*, *A. virgata*, *A. Zollingeri*, *A. Schwaneckii*, *Kantia portoricensis*, *Taxilejeunea antillana*, *T. Eggersiana*, *Odontolejeunea Berteroana*, *O. Breutelii*, *Microlejeunea ovifolia*, *Cololejeunea stylosa*, *Pycnolejeunea Schwaneckii*, *C. Sintenisii*, *Lepidozia commutata*, *Micropterygium portoricense*, *M. Martianum*, *Radula portoricensis*, *R. tectiloba*. From S. Domingo and Dominica, collected by Eggers:—*Bazzania Krugiana*, *Eulejeunea Urbani*, *Raddia Eggersiana*.

* Rev. Bryol., xv. (1888) pp. 90–3. Cf. this Journal, 1888, p. 1000.
† Arbeit. Bot. Inst. Würzburg, iii. (1888) pp. 477–88 (5 figs.). Cf. this Journal, 1888, p. 774.
‡ Hedwigia, xxvii. (1888) pp. 276–302 (4 pls.).

Algæ.

Phycoerythrin.*—Herr F. Schütt has found, by a combination of Reinke's spectrophore with Zeiss's microspectroscope, that the intense orange-yellow fluorescence of phycoerythrin belongs only to a light with the wave-length between $\lambda = 590–560$, and that only rays between $\lambda = 600–486$ can produce a powerful fluorescence, a smaller degree being caused by rays between $\lambda = 490–470$. The maximum of absorption and of the power of producing fluorescence concur.

Besides the normal blue-red α phycoerythrin, which can be obtained from algæ directly by extraction with water, Herr Schütt has obtained two derivatives which he calls β phycoerythrin and γ phycoerythrin. The former is pure red instead of blue-red, and is obtained by the action on α phycoerythrin of such neutral substances as alcohol, barium chloride, &c.; the latter is violet-blue, and is obtained by precipitation by acids from the normal pigment.

The author regards phycoerythrin as a chromatophore-pigment quite distinct from chlorophyll and its derivatives.

Reproduction of Sphærococcus.†—Mr. T. Johnson describes the hitherto unknown procarp of *Sphærococcus coronopifolius*. The main stem produces irregularly placed branches, from which very numerous short flat branchlets spring in an upward direction; and these branchlets have their two edges beset with small cylindrical filaments. Running through the middle of each filament is a central axis consisting of a uniseriate row of large tubular cells. In these cylindrical filaments or procarp-branches are formed the procarps which are very numerous. Any primary lateral branch of the central axis may develope a procarp. The carpogenous branch consists of three cells, the apical cell of which is the carpogone and developes the trichogyne, which is exceedingly long and reaches the surface of the thallus after curving in all directions. The procarp is completed by the formation of a number of small secondary lateral branches, the carpogenous cells. Contact of the "spermatia" (pollinoids) with the trichogyne was not actually observed.

The course of development of the cystocarp is as follows:—After fertilization the carpogone fuses with the hypogynous cell, and this apparently with the basal cell of the carpogenous branch. Further fusion then takes place with cells of the lateral branch and of the central axis in succession, and a large conjugation-cell is thus formed, from the greater part of the surface of which ooblastema-filaments arise even before the process of fusion is completed. These filaments are short, and composed of but few cells, the terminal one or two of which become carpospores. The carpogenous cells also become connected directly with the large conjugation-cell, and produce carpospores at their apices. As the cystocarp developes, its presence is manifested by a spherical swelling in the frond, and the carpospores ultimately escape through an irregular slit in the pericarp, not through a definite pore. Each cystocarp is the product of one procarp only. All the cells which fuse with the carpogone to produce the central cell of the cystocarp are auxiliary cells.

If *Gracilaria* and *Nitophyllum* are united with *Sphærococcus* to form

* Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 305-23.
† Ann. of Bot., ii. (1888) pp. 293-304 (1 pl.).

the family Sphærococcaceæ, then this family includes genera which give examples of three of the four main types of thallus-structure exhibited in the Florideæ; i.e. of all except the simplest, which occurs in the Helminthocladiaceæ. This fact illustrates the difficulty of determining the systematic position of a genus of Florideæ from a consideration of the structure of the thallus alone.

Entocladia.*—A fresh-water species of this hitherto exclusively marine genus is described under the name *Entocladia gracilis* by Dr. A. Hansgirg. It was found growing both endophytically and epiphytically on a species of *Cladophora*, germinating in the former case within the cells of the host. It is reproduced either by the direct germination of larger zoospores or by the conjugation of smaller zoogametes. The filaments may either remain distinct or may be associated into a pseudo-parenchymatous mass.

The genus *Entocladia* Reinke was recently assigned by Hansgirg † to a systematic position among the Chætophoraceæ; the mode of escape of the zoospores through an orifice in the cell-wall, and the absence of Chætophora-like bristles, now incline him to place it rather among the Trentepohliaceæ, or to refer it to an independent family, the *Entocladiaceæ*, intermediate between this order and the Chætophoraceæ. Kützing's imperfectly described *Periplegmatium* may possibly be identical with *Entocladia;* and *Endoclonium* Szym., *Chætonema* Nowak., and *Bolbocoleon* Prings. may belong to the same family. *Chætopeltis* he now places among the Chætophoraceæ rather than the Coleochætaceæ.

Binuclearia.‡—Prof. V. B. Wittrock gives the following diagnosis of this new genus of Confervaceæ:—Planta serie simplici cellularum formata. Incrementum plantarum bipartitione cellularum intercalare. Cellulæ cylindricæ binucleatæ; nuclei bini cellularum vegetantium inæquales, unus major, alter minor. Chlorophori in unaquaque cellula singuli, parietales fasciæformes, semiannuliformes. Dissepimenta cellularum crassitudine inæquali. Zoosporæ adhuc ignotæ. Propagatio fit cellulis vegetativis in cellulis perdurantibus, membrana incrassata, transformatis.

The only species, *B. tatrana*, was found in the Csorber-See in Hungary. The filaments are not enveloped in mucilage; the vegetative cells are from 6 to 9 μ in diameter, and from the same length to eight times longer.

Chætopeltis.§—Herr M. Möbius finds, attached to *Myriophyllum*, a new species of *Chætopeltis*, differing from Berthold's *C. orbicularis* both in its smaller size and also in its mode of reproduction, by means of biciliated zoogametes, which conjugate into a zygosperm which is at first 4-ciliate, instead of by non-sexual 4-ciliate zoospores. He proposes for the species the name *C. minor;* and regards the resemblance of *Chætopeltis* to *Coleochæte* as only superficial, constituting in reality, along with *Phycopeltis*, *Mycoidea*, and *Phyllactidium*,|| a group nearly allied to the Chætophoraceæ.

* Flora, lxxi. (1888) pp. 499–507 (1 pl.). Cf. this Journal, 1880, p. 1023.
† Cf. this Journal, 1888, p. 776.
‡ Bih. K. Svensk. Vet.-Akad. Handl., xii. (1887) No. 1, 11 pp. (1 pl.). Cf. this Journal, 1887, p. 441.
§ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 242–8 (1 pl.). || Cf. *ante*, p. 97.

Struvea.*—Messrs. G. Murray and L. A. Boodle give a monograph of this genus of Siphonocladaceæ, of which they make five species:—*S. plumosa* Sond., *S. macrophylla* Harv., *S. ramosa* Dick., *S. delicatula* Kütz., and *S. pulcherrima* nob. (*Phyllodictyon pulcherrimum* Gray), excluding *S. scoparia* Kütz., which appears to be identical with *Apjohnia lætevirens* Harv.

The organs described are the stalk, the root, and the frond. The stalk consists of a single cell from its earliest stages to the time of formation of the frond, when a transverse wall is formed a short distance below the base of the frond. The calcareous incrustation described by some authors is due to the presence of an epiphytic calcareous alga, generally a *Melobesia*. In *S. ramosa* the pinnæ of the frond consist of a series of segments separated by transverse walls. The pinnæ are again divided into pinnules. When a pinnule has, in its growth, brought its tip into contact with another part of the frond, it forms at its apex a special organ of attachment, called by the authors a *tenaculum*, consisting of a ring of radiating branched rhizoids, which, however, appear to be entirely superficial, never penetrating the cell-wall to which they are attached. Similar organs occur in other species, as well as in some allied genera. Although filaments become attached to one another by means of these tenacula, there is no true anastomosis, as described by Harvey and Dickie.

No reproductive organs were detected in any species of *Struvea*; but in *S. ramosa*, singular structures at the base of some of the filaments of the frond, resembling in shape the sporanges of *Botrydium*. Until the organs of reproduction are known the position of the genus is somewhat uncertain; but it appears to connect *Valonia* on the one hand with *Cladophora* and *Spongocladia* on the other hand.

Sexuality among the Lower Algæ.†—M. P. A. Dangeard believes that a sexual mode of reproduction will eventually be found to occur in many of the lower algæ where it is at present unknown, and that it is in particular incited by defective nutrition, progressive desiccation, the action of injurious substances, and other similar causes.

He describes its occurrence in *Phacotus angulosus*, an organism first described by Carter under the name *Cryptoglena angulosa*, and usually placed among the Protozoa. Under cultivation the non-sexual mode of propagation was found to be almost suppressed. On the other hand individuals, after losing their cilia, formed four or eight small biciliated zoogametes by successive bipartitions. These swarmed for a time within the parent-cell, then escaped, and finally conjugated with very great rapidity, losing their cilia, into a spherical oosperm. These zoogametes differed from all others previously observed in having the chlorophyll located at the anterior extremity. The author believes that the bodies previously described as resting-cells in this genus are in reality oosperms. No sexual differentiation was observed in the zoogametes. *Phacotus* forms, therefore, sexually produced oosperms in the same way as *Chlorogonium*,‡ *Cercidium*, and *Chlamydomonas*; and these genera must be regarded as belonging to the same family.

A new marine species of *Chlamydomonas* is described, *C. minima*.

* Ann. of Bot., ii. (1888) pp. 265–82 (1 pl.).
† Morot's Journ. de Bot., ii. (1888) pp. 350–3, 415–7 (2 figs.).
‡ See this Journal, 1888, p. 1003.

The resting-cells divide into zoogametes 8 μ long by 5 μ broad, which move about with great velocity, and are provided with four cilia, distinguishing them from the other species of the genus.

Oosperms resulting from the fusion of zoogametes, the author states, differ in no essential point from those produced by oospheres and antherozoids; indeed, *Eudorina* may, under exceptional circumstances, produce its oosperms in the former way instead of the latter.

The author reaffirms his previous conclusion that the Chlamydomonadineæ and Eugleneæ must be regarded as families of Algæ rather than of Protozoa, and expresses an opinion that normal chlorophyll is to be found only in organisms belonging to the vegetable kingdom.

Fungi (including Lichenes).

Physiological Significance of Mycorhiza.*—In opposition to the views of Hartig † and Grosglik, Herr B. Frank reaffirms the view that the phenomena of mycorhiza are of the nature of mutual symbiosis, and that the fungus is in no true sense a parasite on the root of the tree which it attacks.

The mycorhiza depends for its existence and subsistence, not on the root of the tree, but on the presence in the soil of undecayed vegetable matter. The fungus behaves like a haustorium or absorbing organ, the hyphæ radiating on all sides like root-hairs; they may be isolated or united in fascicles, giving to the root the appearance of a bottle-brush.

Trees, the roots of which are infested with mycorhiza, resemble such saprophytes as *Neottia nidus-avis* in not exhibiting a trace of nitrates; while trees which are not attacked by it contain nitrates, at least in their absorbing roots. It is most probable that the mycorhiza removes nitrogen from ammonia and organic nitrogenous substance, and thus enables the tree to obtain nitrogen in the same way that saprophytic fungi do; and the fungus on the other hand receives equal benefit from the mutual symbiosis.

Hibernation of Peronosporeæ.‡—Herr P. Magnus states that the hibernation of the mycele when oosperms fail to be formed, which, in *Phytophthora infestans* takes place in the tuber of the potato, is effected in *Peronospora effusa* in the rosettes of young leaves of the spinach on which it is parasitic, and in *P. Alsinearum* in the stem and leaves of the autumn shoots of *Stellaria media*.

Entomophthoreæ and their use in the destruction of noxious Insects.§—M. C. Brongniart states that the Entomophthoreæ are very widely spread in nature, and that they cause certain and rapid destruction to a great number of noxious insects. All locusts are rapidly attacked by these fungi, death resulting in about twenty-four hours after the first indication of the attack. On these insects *Entomophthora* is found under two forms which were formerly considered as two distinct genera, *Empusa* and *Tarichium*. *Empusa* fructifies in the interior of the body, and produces conidial spores, while *Tarichium* consists of the oosperms which are formed also in the interior of the body. The author considers

* Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 248–69 (1 pl.). Cf. this Journal, 1888, p. 268.

† Cf. this Journal, 1886, p. 662.

‡ Verhandl. Bot. Ver. Prov. Brandenburg, xxix. (1888) pp. 13–5.

§ Comptes Rendus, cvii. (1888) pp. 872–4.

that the Entomophthoreæ might very well be used in the destruction of noxious insects.

Olpidiella, a new genus of Chytridiaceæ.*—Herr G. Lagerheim describes a new Chytridiacea found on the uredospores of a *Uredo* parasitic on the glumes of *Aira cæspitosa*, which he regards as the type of a new genus, *Olpidiella*, nearly allied to *Olpidium*, with the specific name *O. Uredinis*. The wall of the zoosporange is covered with minute elevations, and opens by a pore to allow of the emission of the evacuating canal by which the zoospores escape, and the escape of the zoospores is very easy to follow under the Microscope. The normal zoospores are uniciliated, the cilium being fixed to the posterior extremity; no conjugation of zoospores was observed. There are in addition larger multiciliated zoospores. In the same genus Herr Lagerheim proposes to include *Olpidium endogena* A. Br., *Chytridium decipiens* A. Br., and *Chytridium luxurians* Toni (*Olpidium Diplochytrium* Schrœt.).

The author gives the following diagnoses of the genera which make up the family Olpidiaceæ:—(1) *Sphærita* Dang.; zoospores with a single anterior greatly curved cilium; the wall of the zoosporange opens to allow the escape of the zoospores, and subsequently deliquesces. (2) *Olpidium* A. Br.; zoospores with a single straight anterior cilium; zoosporanges opening by a pore or neck. (3) *Olpidiella* n. gen.; zoosporæ cilio singulo recto posteriore præditæ; zoosporangium orificio singulo. (4) *Plæotrachelus* Zopf; zoospores with a single posterior cilium, zoosporanges globular, opening by several necks. (5) *Ectrogella* Zopf; zoospores with a single straight cilium; zoosporanges vermiform, opening by several necks. (6) *Olpidiopsis* Fisch.; zoospores biciliated; zoosporanges opening by a neck.

Origin and Development of the Apotheces of Lichens.†—The general conclusions arrived at by Herr G. Lindau from observations of the development of the apothece in a large number of Fungi are that the ascogenous system and the enveloping system are distinct, and that the course of development of this organ corresponds in all cases closely to that in the Collemaceæ.

Taking *Anaptychia ciliaris* as a typical example, the apotheces are formed in the gonidial zone as club-shaped cells originating either laterally or terminally on hyphæ which are distinguished from the vegetative hyphæ by their strongly refractive contents which are coloured dark brown by chlor-zinc-iodide. These are very numerous, but only a few of them develope into ascogones. The ascogones are spirally or irregularly coiled hyphæ, surrounded by paraphyses, and by large numbers of gonids. Each ascogone terminates in a trichogyne which can only be distinguished from the cortical hyphæ by the colouring of its contents by chlor-zinc-iodide. The actual entrance of the pollinoids (spermatia) into the trichogyne was not observed. It is only after the dying off of the trichogyne that an "excipulum thallodes" is produced, and the asci are formed in the midst of the paraphyse-tissue.

The other species examined exhibited a general agreement in the phenomena with *Anaptychia*. In *Ramalina fraxinea* the apotheces are distinguished by the dense masses of gonids which surround them. The contents of the pollinoids appeared here to pass into the trichogyne.

* Morot's Journ. de Bot., ii. (1888) pp. 432–40 (1 pl.).
† Flora, lxxi. (1888) pp. 451–89 (1 pl.).

In *Placodium saxicolum* the ascogones are sometimes branched. In *Lecanora subfusca*, in addition to the normal yellow-green gonids, there are colonies of blue-green gonids (*Glœocapsa*) also surrounded by the fungus-hyphæ, and still other smaller gonids. The author was not able to determine the connection of these with the *Lecanora*-thallus. One ascogone occasionally bears two trichogynes; and the apotheces appear to be sometimes formed of several ascogones. Both in this species and in *Lecidella enteroleuca*, the hyphæ have apparently the property of dissolving cellulose, and using it for the nutrition of the plant. In this species, and in some others, especially *Usnea barbata* and *Cornicularia aculeata*, the cavities of the functionless antherids (spermogones) are filled by a weft of hyphæ.

Graphideæ.*—Dr. J. Müller describes in detail the Lichens belonging to the section Graphideæ, in the collection of M. Fée from Rio Janeiro. A large number of new species are described, and some new genera and sections proposed.

Germination of the Spores of Sphæropsideæ.†—Sig. C. Massalongo describes the mode of germination of the spores in several fungi belonging to this family, which closely resembles that of *Saccharomyces*. In consequence of this peculiarity he distinguishes three new species, *Phyllosticta Bizzozeriana* parasitic on the vine, *P. Aristolochiæ* on the leaves of *Aristolochia Clematitis*, and *Phoma Orobanches*, on the dry corolla of *Orobanche rubens*.

Helotium parasitic on Sphagnum.‡—Herr S. Nawaschin describes a parasitic fungus which he finds abundantly among the perigynial leaves of the female "flowers," and also among the archegones themselves, of *Sphagnum squarrosum*, and which was described by Schimper as paraphyses of the moss. They constitute, in fact, the mycele of a fungus, the peritheces and asci of which the author is now able to describe, and establishes it as a new species under the name *Helotium Schimperi*, nearly related to *H.* (*Peziza*) *phascoides*.

Pezizæ causing Cankers in Coniferæ.§—M. P. Vuillemin states that Willkomm in 1867 pointed to *Corticium amorphum* Fries as being the fungus causing the canker in pines. The disease has been attributed to several other fungi, and the author considers that the parasite of the pines ought to be left in the genus *Trichoscypha*, by the side of *T. chrysophthalma*, and he gives a definite diagnosis for *T. calycina*.

Sclerotiniæ of Vaccinium.‖—Dr. M. Woronin has followed out the life-history of the various species of *Sclerotinia* which are parasitic on different species of *Vaccinium*. In addition to the well-known *S. baccarum*, which attacks the berries of *V. Myrtillus*, causing them to turn white, three new species are described:—*S. Vaccinii* on *V. Vitis-Idæa*, *S. Oxycocci* on *V. Oxycoccus*, and *S. megalospora* on *V. uliginosum*. They all possess the character which he terms "lipoxeny," i. e. the faculty of leaving their host when the sclerote is mature in order to live on their accumulated food-material.

* Mém. Soc. Phys. et d'Hist. Nat. Genèv., xxix., Part ii. (1887) 80 pp.
† Nuov. Giorn. Bot. Ital., xx. (1888) pp. 437–40 (3 figs.).
‡ Hedwigia, xxvii. (1888) pp. 306–10 (1 pl.).
§ Bull. Soc. Bot. France, xxxv. (1888) Sess. Extraord., pp. lxiv.–lxxi.
‖ Mém. Acad. Imp. Sci. St. Pétersb., xxxvi. (1888) No. 6, 49 pp. and 10 pls.

The ascospore of *S. Vaccinii* produces, on germination, a filament which perforates an epidermal cell of the host, and forms in the cambium of the stem branched rows of toruloid conids, which separate from one another in a singular way. When the constrictions have become considerably developed there is formed in the dividing-wall between two adjacent partially formed conids what appears to be a pore, through which is pushed out of the protoplasmic contents of each cell a cone-shaped mass of cellulose; these meet in the middle, and unite into a body which M. Woronin terms a "disjunctor." Finally the conids remain joined to one another only by a very slender fusiform connection, a conical mass of cellulose remaining attached to each end of the conids and giving them a lemon-shaped form. The fruit appears in the spring, but is comparatively rare; the asci contain eight spores, of which four are slightly smaller than the other four; the lower part of the ascus contains epiplasm or glycogen.

Sclerotinia Oxycocci is distinguished by its smaller conids, and by four out of the eight ascospores being always much smaller and sterile; and the same is the case in *S. baccarum.* The conids of *S. megalospora* attack exclusively the leaves of *Vaccinium uliginosum*, and the sclerote is more simple in structure than in the other species. The eight ascospores are all of the same size and fertile. In these species the conids are also separated by "disjunctors," which are, however, smaller than in *S. Vaccinii.*

Similar sclerotes, the structure of which has not, however, been accurately examined, are found also on the fruit of the bird-cherry, and on that of species of *Alnus* and *Betula.*

Development of Corynites Curtissii.*—Mr. J. F. James describes the development of *Corynites Curtissii* B. The first figure shows the outer wall surrounding a mass of greyish glairy matter, in the centre of which is a white column, surmounted by a two-lobed mass of dark brown or blackish matter. A little later the stipe begins to be plainly manifest. Little pits represent what develope finally into openings; the second layer represents the inner wall of the peridium, while a dark mass of matter at the top, gradually diminishing in size, eventually forms the glebe and contains the spores. The mature fungus is bright pink, full of small holes, surmounted by the glebe, and springing from the ruptured sac which previously inclosed it.

New Parasitic Fungi.†—M. F. Cavara describes several new species of parasitic fungi which attack cultivated plants. *Dendrophoma Marconi* n. sp. belongs to the section *Eudendrophoma* of the genus *Dendrophoma*, and attacks the stems of the cultivated hemp. *Pseudo-peziza Trifolii* (Bern.) Fck. has been observed this year on *Medicago sativa;* while another new spheropsid, *Phleospora Trifolii*, has been found on the leaves of *Trifolium repens. Botrytis parasitica* n. sp. has been found on the culivated tulips in the Botanic Garden at Pavia, and the author describes a new genus *Basiaschum*, with a new species *B. Eriobothryæ*, which he has found attacking the leaves of *Eriobothrya japonica* Lind. *Plenodomus Oleæ* n. sp., belonging to the section *hyalosporæ* of *Plenodomus* Preus., has been found on the fruit of the olive, and *Pestalozzia Banksiana* n. sp. on the lower part of the leaves of *Banksia robur.*

* Bull. Torrey Bot. Club, xv. (1888) pp. 314–5 (1 pl.).
† Rev. Mycol., x. (1888) pp. 205–7.

Lily Disease.*—Prof. H. M. Ward discusses the cause of certain discolourations in the form of orange-brown and buff specks which appear on the stems, pedicels, leaves, and buds of the white lily (*Lilium candidum*). He traces the development and describes the structure of the fungus which causes them, and which he states belongs to the genus *Botrytis*, and the section known as *Polyactis*, and is probably a gonidial stage in the life-history of some *Peziza*; whether the alternative form is developed on some other plant, or whether it is lost, cannot be said. It is quite conceivable, however, that, in consequence of their pronounced parasitism, this fungus and *Phytophthora infestans* may have lost their alternative form. The fungus is characterized by some of its branches forming cross-connections which it is very difficult to distinguish from a true process of conjugation, and by some of the free branches developing into singular organs of attachment which glue themselves to solid bodies and display an irritability to contact.

Saccharomyces Allii, sp. n.†—A new species of blastomycete has been found by Prof. N. Sorokin on bulbs of *Allium cepa*, which were being destroyed and reduced to a gelatinous condition, accompanied by the development of a powerful odour. Microscopical examination of the diseased bulbs showed numerous bacteria and a ferment fungus, *Saccharomyces Allii*. Healthy bulbs inoculated from the diseased ones rapidly succumbed with the presence of the same micro-organisms, only one of which is seen at the commencement of the disease, *S. Allii*. The cells of this fungus are from 3–15 μ long and 3–4 μ broad; they contain one large or several small vacuoles, and one or two small nucleoli. The cells increase by budding, and are very variable in size and arrangement.

Polydesmus petalicolor, sp. n.‡—This micro-organism was found on certain asters by Prof. N. Sorokin, and causes a black broad streak on the corona. It consists of a colourless branched mycele, the filaments of which are composed of cells of various size and shape. The plasma is granular, and contains numerous oil-drops. The mycele is entirely epiphytic, and forms a rather thick layer, which is quite colourless. From the mycele rise brown hyphæ, which are for the most part unbranched. At the extremity of the brown hyphæ there are formed spores, which may or not be spherical. These spores are not necessarily of the same shape and size. The spores may also collect together in chains of 2–5 individuals. The only organism which at all resembles *Polydesmus petalicolor* is *P. exitiosus*. Of this there are two varieties, *luxuriosus* and *alternarioides*. The latter resembles the form described by the author, but is distinguishable from that fungus in that

(1) *P. exitiosus* is a true parasite, i. e. penetrates the tissue of the plant, while *P. petalicolor* is an epiphyte.

(2) *P. exitiosus* has smooth spores; those of *P. petalicolor* are covered with prominences.

(3) In *P. exitiosus* the spores are seated singly on the hyphæ, while in *P. petalicolor* two or three may be gathered together.

(4) Spores of *P. petalicolor* are never seated on such short hyphæ as those of *P. exitiosus*.

* Ann. of Bot., ii. (1888) pp. 319–82 (5 pls.).
† Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 641–4 (5 figs.).
‡ T. c., pp. 647–9 (16 figs.).

Sorosporella Agrotidis g. et sp. n.*—Prof. N. Sorokin obtained this microbe from the caterpillar of *Agrotidis segetum*, an insect which is extremely harmful to corn. The intention of the author was, having found the organism which kills the caterpillar, to obtain the microbe in sufficient quantity, and sow the corn land with it. Within the mummified body of the caterpillar was a powder consisting of large round granules. Under the Microscope these were found to be spores which were rose-coloured when seen in aggregations. In size they are from 4–7 μ; they are invested by a smooth membrane, and their contents are colourless. Under a magnification of about 1400, the cell-contents are seen to be not homogeneous, but filled with oil-drops and vacuoles.

Fermentation of Palm-wine.†—Sig. G. Gasperini finds the cause of fermentation in "leghbi," the alcoholic drink obtained from the juice of the date-palm, to be *Saccharomyces cerevisiæ*, accompanied by large quantities of *Bacillus subtilis*.

New Melampsora.‡—Under the name *Melampsora congregata*, Herr P. Dietel describes a new species parasitic on the leaves of *Euphorbia dulcis*. Both uredospores and teleutospores were observed; the latter are characterized by their dense aggregation, sometimes completely covering the under side of the leaf.

New Urocystis.§—Herr G. Lagerheim describes a new species of *Urocystis*, *U. Junci*, parasitic on *Juncus filiformis* and *bufonius*. It attacks the leaves, causing but little deformity.

Fungi of Mines.‖—Dr. C. O. Harz enumerates 11 species of fungi found in the mines of Germany, belonging to the Thelephorei, Hydnei, and Polyporei. Among them two new species are described:—*Radulum subterraneum* and *Polyporus Engelii*.

Protophyta.

a. Schizophyceæ.

Antiquity of Diatoms.¶—Abbé F. Castracane gives reasons for believing that diatoms belonging to species now existing lived in the Carboniferous period, and discusses the bearing of this fact on the theory of evolution. From the fact that he finds in beds belonging to the older Carboniferous strata diatom-valves identical in the minutest particular with the existing *Epithemia gibba* and *E. granulata*, and that similar facts are recorded also with regard to Foraminifera, he concludes that the same laws of the immutability of generic and specific characters prevailed, and always have prevailed, equally in the lowest and in the highest families of both the vegetable and the animal kingdom.

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 644–7 (13 figs.).

† Nuov. Giorn. Bot. Ital., xx. (1888) pp. 445–51.

‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 400–2 (2 figs.).

§ Bot. Notis., 1888, p. 201. See Morot's Journ. de Bot., ii. (1888) Rev. Bibl., p. 147.

‖ SB. Bot. Vereins München, 1st Dec. 1887. See Bot. Centralbl., xxxvi. (1888) pp. 375, 385.

¶ 'Le Diatomee e il Transformismo Darwiniano,' 20 pp., Roma, 1888.

β. Schizomycetes.

Doctrine of Phagocytes.*—The interest excited by the ingenious hypothesis of Metschnikoff is shown by the number of experiments made and articles written in support or contradiction of the assumption that the mesoblastic cells of Vertebrata inherit the capacity of absorbing and destroying pathogenic bacteria from their ancestors, the unicellular amœbæ, the mesodermic cells of Cœlenterata, Turbellaria, &c. Dr. H. Bitter, in his critique on the doctrine of phagocytes, thus balances the evidence for and against the theory.

Unicellular lower animals, amœbæ, and also mesodermic cells of sponges, take up small plants into their protoplasm, and digest them. In more highly organized animals this intracellular digestion becomes extracellular and fermentative; certain cells, however, still possess a capacity for picking up and dissolving foreign bodies. This contrivance is regarded by Metschnikoff as a special arrangement whereby harmful elements, especially pathogenic micro-organisms, are prevented from penetrating the animal economy, the process being complicated by the resistance made by the parasite to digestion. Those cells which are able to digest foreign bodies are called phagocytes, and are further subdivided into large and small. Infectious diseases are recovered from when the phagocytes overmaster the exciting causes, and immunity after one attack or after inoculation depends on the phagocytes having become accustomed to combat the micro-organisms.

This theory is supported by Metschnikoff's observations on *Daphniæ* which are attacked by a torula with needlelike ascospores. These latter having been swallowed penetrate the tissues; as soon as this happens, a leucocyte appears, and the spores are enveloped and destroyed. If the spores remain unattacked and germinate, the animal is infected. In frogs too, anthrax bacilli are taken up by leucocytes, and destroyed. At a temperature of about 30°, only a few leucocytes take up the bacilli, and the animals become infected. This is explained on the hypothesis that the anthrax bacilli are more potent at this temperature owing to their being accustomed to deal with warm-blooded leucocytes. In warm-blooded animals Metschnikoff rarely found bacilli in leucocytes, but if the animal had been protected by a weakened virus, the bacilli were picked up in quantities and destroyed. Hence it is concluded that immunity is derived from the leucocytes having got used to the poison of the bacteria.

Bacteria-eating phagocytes were also found in erysipelas and relapsing fever, and are also assumed to be present in gonorrhœa, leprosy, and tuberculosis.

According to Hess, the phagocytic privilege is shared by the cells of the splenic parenchyma, and of the liver, and Ribbert asserts that the spores of various kinds of *Aspergillus* and *Mucor* are got rid of in a similar manner. If, however, many spores be injected, the number of leucocytes may not suffice to prevent their development, and this last-mentioned author also believes that the viability of the fungi is diminished by the leucocytes cutting off the supply of oxygen. Other facts in support of the theory are that if an animal survive the introduction of a small quantity of spores, there will be found, on a second injection, a much larger number of leucocytes, and that, as stated by

* Zeitschr. f. Hygiene, iv. (1888) No. 2.

Lubarsch, anthrax bacilli killed by boiling, are not so quickly taken up by leucocytes in the frog, as when injected in the living condition.

Against the theory are ranged numerous writers and experimenters, among whom may be mentioned Baumgarten and Weigert, who while accepting the data, doubt the interpretation of the facts and the correctness of the hypothesis. Experiments made by C. D. Holmfeld showed that only a few bacteria were taken up by leucocytes, and that the greater number of bacteria were destroyed outside the cells. Emmerich gives similar results; thus after inoculating rabbits with erysipelas he found that this conferred a certain immunity against subsequent inoculation with anthrax, and also that the destruction of the bacteria was chiefly extra-cellular, and that the phagocytes made away chiefly with the dead bacilli. Again, it is noticed by the author (H. Bitter), that in none of Metschnikoff's works, or in those of other writers, is it certainly proved that the bacteria are only destroyed by phagocytes, and by these alone, and in conjunction with Nuttall has proved this experimentally.

With regard to Metschnikoff's experiments on frogs at high temperatures, it is obvious that the fluids of the body may become so altered by the increased heat that this fluid is thereby no longer able to weaken the bacteria.

Moreover, a series of observations has shown that anthrax bacilli have always suffered some damage before they became a sacrifice to the phagocytes. On the whole the author inclines to bring in a verdict of not proven.

Bacteria of Fodder and Seeds.*—It had been proposed by Emmerling to ascertain the freshness of fodder by the quantity of fungus germs contained therein, but Herr Hiltner concludes from his researches that bacteria are more suitable for this purpose than fungi, and, therefore, proceeded to go thoroughly into the question of the influence of these microbes (bacteria) on seeds and fodder.

In addition to certain kinds of bacteria not accurately determined, the author found *Clostridium* in all kinds of fodder. In about half the number of cases, on digesting with water, bacteria only developed, and no fungi. If both appear, they do so at different intervals of time; the bacteria first, the fungi later.

With regard to the question where the bacteria originate, the author believes that they are always present within the uninjured seed. Seeds which have lost their germinating power are always found to be full of bacteria; and in badly germinating seeds they may be found in the young roots, which then have brown tips, and look glassy. It is interesting to note that each kind of seed has one or more peculiar bacteria which appear afterwards in the fodder. From investigation it was found that the germinative power of peas was always destroyed by *Clostridium*, and that of red clover by *Bacillus subtilis*.

If the seeds are able to germinate and develope normally, the bacteria cease to be harmful. Late-germinating seeds, the cells of which are full of bacteria, develope quite normally if light and air have free access to the earth above them. They are not even damaged if grown in a nutrient medium crowded and cloudy with bacteria. If, however, a germling be covered with a glass jar, it perishes at once. Thus, experiments with peas showed that the cotyledons were reduced to a pulp in

* 'Landwirthschaftliche Versuchsstation,' xxiv. (1887) pp. 391–402.

three to four days, and on microscopical examination the bacteria were found to have undergone enormous increase, rods with spores being copiously developed; *Clostridium* had dissolved the middle lamella of the cell-membrane, so that the connection between the cells was destroyed. This destructive process, which is here so rapidly completed, proceeds only slowly during the resting period of seeds, because moisture is a requisite for the development of bacteria.

Varieties of Koch's Comma Bacillus.*—Dr. T. Zäslein, who has directed his attention to the varieties of Koch's comma bacillus, has obtained the following results. (1) The variety usually cultivated grows on plates in the way described by Flügge. (2) There exist varieties which grow more strongly at lower temperatures than the freshly imported bacillus, and die earlier at lower maximum temperatures, and at the body temperature the course of their development is hastened. (3) Bacilli obtained from simultaneous European epidemics now behave differently. (4) A bacillus which was grown for a month strictly according to Koch's procedure afterwards became altered in the same medium. (5) The changes which Koch's bacillus has shown take place gradually and irregularly, but may be influenced by artificial cultivation. (6) The author's experiments have not shown that the cholera bacillus, as far as regards the formation of varieties, is not subject to other laws than those laid down by Darwin for plants and animals in general. (7) The formation of definite varieties may take place without artificial cultivation.

Spore-formation in the Bacillus of Typhoid Fever.†—Dr. Pfuhl followed in his investigation the method previously used by Buchner, who, to ascertain the nature of these polar bodies, suspected of being spores, first examined their behaviour towards certain pigments, then their resistance to drying and high temperatures, and lastly their capacity for germination. The conclusion the author arrives at is the same as Buchner's, viz. that these supposed spores are not spores at all, but are, rather, a retrograde condition, or kind of involution form. As the author's method and his conclusions are the same as Buchner's, already noticed in this Journal,‡ there is no need to give the details.

Staphylococcus pyosepticus.§—MM. J. Héricourt and Ch. Richet found in a cutaneous abscess of a dog a microbe which in form, size, colour, reaction, and biological characters is allied to *Staphylococcus pyogenes albus*, but is distinguished therefrom by the following differences:—(1) In fluid cultivations (peptonized meat broth) it grew on the surface, forming whitish colonies, which pass away into viscid filaments, while *S. pyogenes albus* causes all the fluid to become cloudy, and does not form any special collections on the surface. (2) It is more septic and virulent than *S. albus*. One or two drops injected under the skin killed a rabbit (2 kg.) in about 24 hours, while *S. albus* only killed rabbits with stronger doses and after a longer time. (3) The one or two drops injected subcutaneously produced a gelatinous transparent œdema. It begins its development one or two hours after inoculation, and attains its maximum in 24 hours. *S. albus* causes suppuration, but without the œdematous swelling. In animals which do not succumb in

* Deutsch. Med. Ztg., 1888, Nos. 64 and 65.
† Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 769–76.
‡ 1888, p. 1016. § Comptes Rendus, cvii. (1888) p. 690.

the first two days after inoculation the œdema partly disappears and collections of pus, similar to the abscesses produced by *S. albus*, accumulate. In dogs neither death nor œdema occurs, but a large abscess appears. The authors have distinguished their microbe by the name of *Staphylococcus pyosepticus*. Vaccinations with this organism, the virulence of which had been diminished, not only protected against death, but diminished the œdema.

Resistance of the Cholera Bacteria to Heat and Drying.*—Dr. S. Kitasata, as the result of experiments made with the cholera vibrio in reference to its resistance to heat and drying, comes to the following conclusions:—

(1) Between old and young cultivations there is no difference in the resistance.

(2) The time required to kill the Bacteria after they have been dried depends on the way in which the material has been prepared.

(3) This time, moreover, is also dependent on the condition of the cultivation.

(4) No real difference in the behaviour of cholera cultivations at temperatures from 50° to 60° was observed.

(5) The discrepancies of previous observers with regard to this resistance are explicable from the fact that the more quickly and perfectly the drying is effected the more quickly do the cholera bacteria die. No special resting form which renders this bacillus more resistant to drying has been observed by the author, who also failed to discover any evidence of growth from spores. On the contrary, he feels satisfied that new cultivations can only arise from old ones when the latter contain bacilli.

Structure of Staphylococcus pyogenes aureus.†—Dr. Heydenreich finds that *S. pyogenes aureus* is possessed of a more complicated structure than is usually supposed. He states that it is not a coccus but a diplococcus which consists of two halves separated by a transverse line and also surrounded by a mucous layer. As the latter does not stain so well as the protoplasm the outline of the diplococcus is less clearly visible, but this becomes more distinct as the diplococcus ages. The author's method is to treat the unstained cover-glass with 1/2 to 1 per cent. acetic acid, and then to stain it by Gram's method. As seen under the Microscope the organisms vary from $0 \cdot 75\ \mu$ to $1 \cdot 7\ \mu$, or even larger. In cultivating these diplococci forms resembling Sarcina tetrads are seen. Some of these sarcinæ resemble *M. tetragonus*, presenting four equally stained spherules surrounded by a broad transparent membrane. If such a preparation be decolorized diplococci reappear. This near relationship of Sarcina and Diplococcus has been noticed before, especially in the case of Sarcina ventriculi, which is possibly only a variety of diplococcus owing its tetrad form to some unknown condition.

Micro-organisms of Pneumonia of Lambs and Calves.‡—Dr. E. Semmer has observed several cases of red-grey hepatization of the lung in calves. From the expressed juice were obtained cocci $0 \cdot 5\ \mu$ in

* Zeitschr. f. Hygiene, v. (1888) p. 134.

† Wratsch, 1887, No. 42 (Russian). Cf. Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 59–61.

‡ Deutsch. Zeitschr. f. Thiermed. u. Vergleich. Pathol., 1888, p. 242.

diameter, diplococci 1·0 μ long, and bacilli 1·0 μ long and 0·5 μ broad. Injection of these organisms into calves gave a negative result.

In the pneumonia of lambs the author found six different kinds of microbes. (1) Large cocci and diplococci 0·5 μ in diameter; (2) medium sized cocci and diplococci 0·2 μ in diameter; (3) small cocci, diplococci, and streptococci 0·1 μ in diameter; (4) rodlets 0·5–1·0 μ long and 0·3 μ broad; (5) small bacilli 0·5 μ long and 0·1 μ thick; (6) streptobacteria 0·2 μ long and 0·1 μ thick. Grown in bouillon, on gelatin, and on potato, these developed white colonies of single cocci, yellowish-white colonies of short rods, and, on potato, brownish-red colonies of larger bacilli. Most of these were probably the result of secondary invasion.

MICROSCOPY.

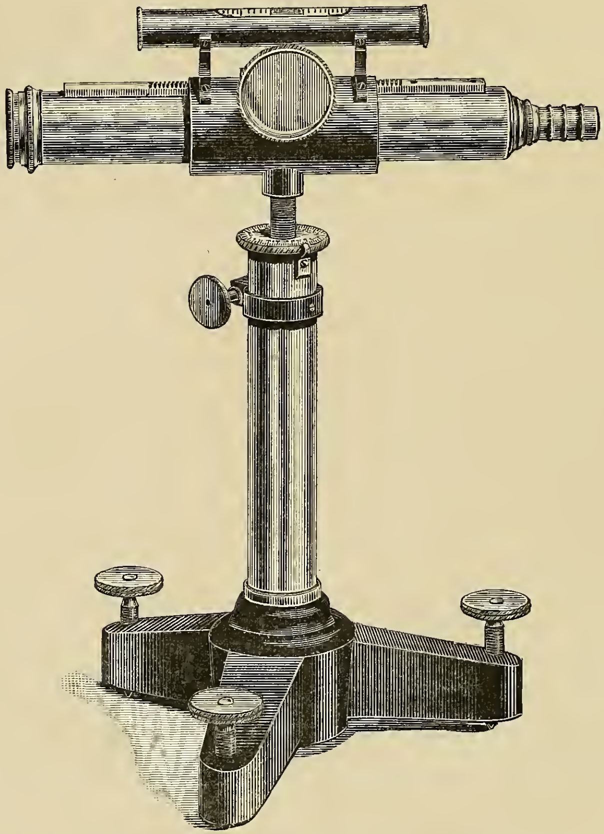
a. Instruments, Accessories, &c.*

(1) Stands.

Pfeffer's Botanical Microscope.†—This instrument (fig. 38) was designed by Dr. W. Pfeffer for measuring the growth of plants, more especially in cases where it would be inconvenient to make use of a lever which requires a thread to be tied to the plant.

The body-tube racks in a horizontal socket, over which is supported

Fig. 38.



a spirit level, the instrument being adjusted by the three screws in the feet of the tripod. The socket is attached to a fine micrometer screw, which works through a screw collar on the top of the pillar; by turning this collar, which is graduated and milled, the screw rises and falls, and with it the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Pfeffer's 'Pflanzenphysiologie,' Band ii. (1881) pp. 84–5 (1 fig.).

socket and body-tube, forming a fine-adjustment. A coarse-adjustment is formed by the collar not being attached directly to the pillar, but to a tube sliding in it, which can be raised and lowered and clamped by a clamp screw. The eye-piece micrometer is somewhat peculiar, every alternate line of the principal set of 24 lines being numbered from 0 to 11, with longer lines at 1, 6, and 11. In the middle of their length the spaces between the principal lines are redivided into 5 subdivisions.

Ahrens' Giant Microscope.—The object of Mr. C. D. Ahrens in constructing this instrument was to have a Microscope with an exceptionally large field for use with his new form of polarizer.*

The body-tube is $4\frac{1}{8}$ in. in diameter at the top, and below the field-lens it cones down to the nose-piece; it has two attachments, one by screws to the top of the stem and tail-piece, and another at the nose-piece, where it is attached to a short bar screwed to the stem. The stage racks on the stem which ends in a cross-piece which carries a short tail-piece on which the mirror socket racks. The pillar rotates on the tripod.

The achromatic eye-lens is $1\frac{3}{4}$ in. in diameter, and the field-lens $3\frac{3}{4}$ in., the foci being respectively 3 in. and 6 in. A diaphragm is placed in the focus of the eye-lens.

Mr. Ahrens considers that the defects in flatness of field † and marginal colour referred to when the Microscope was exhibited were due to the objective used.

* See *infra*, p. 276.
† See this Journal, 1888, p. 1066.

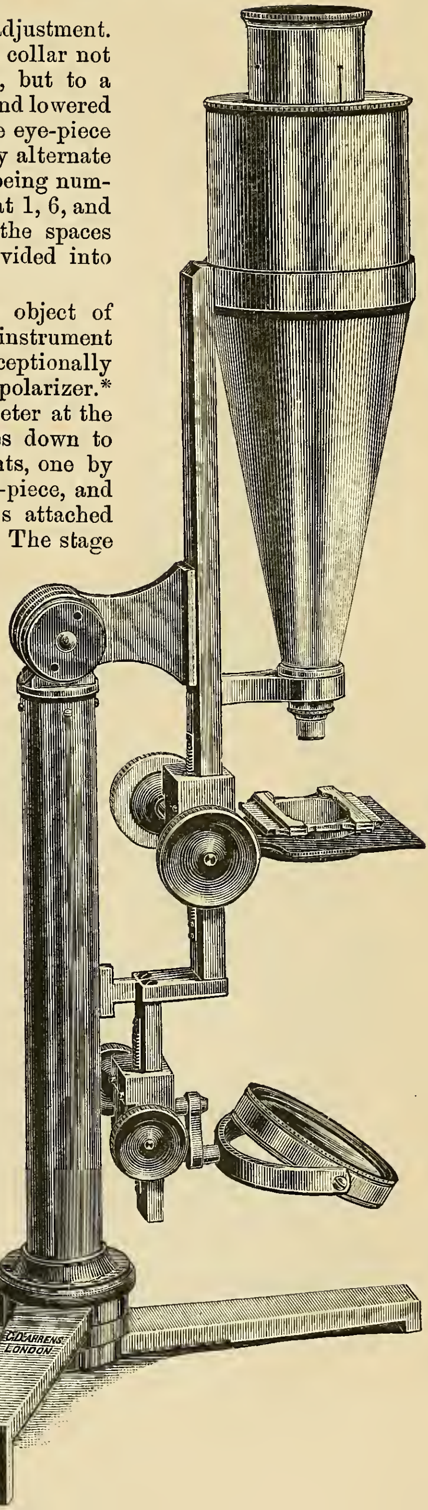
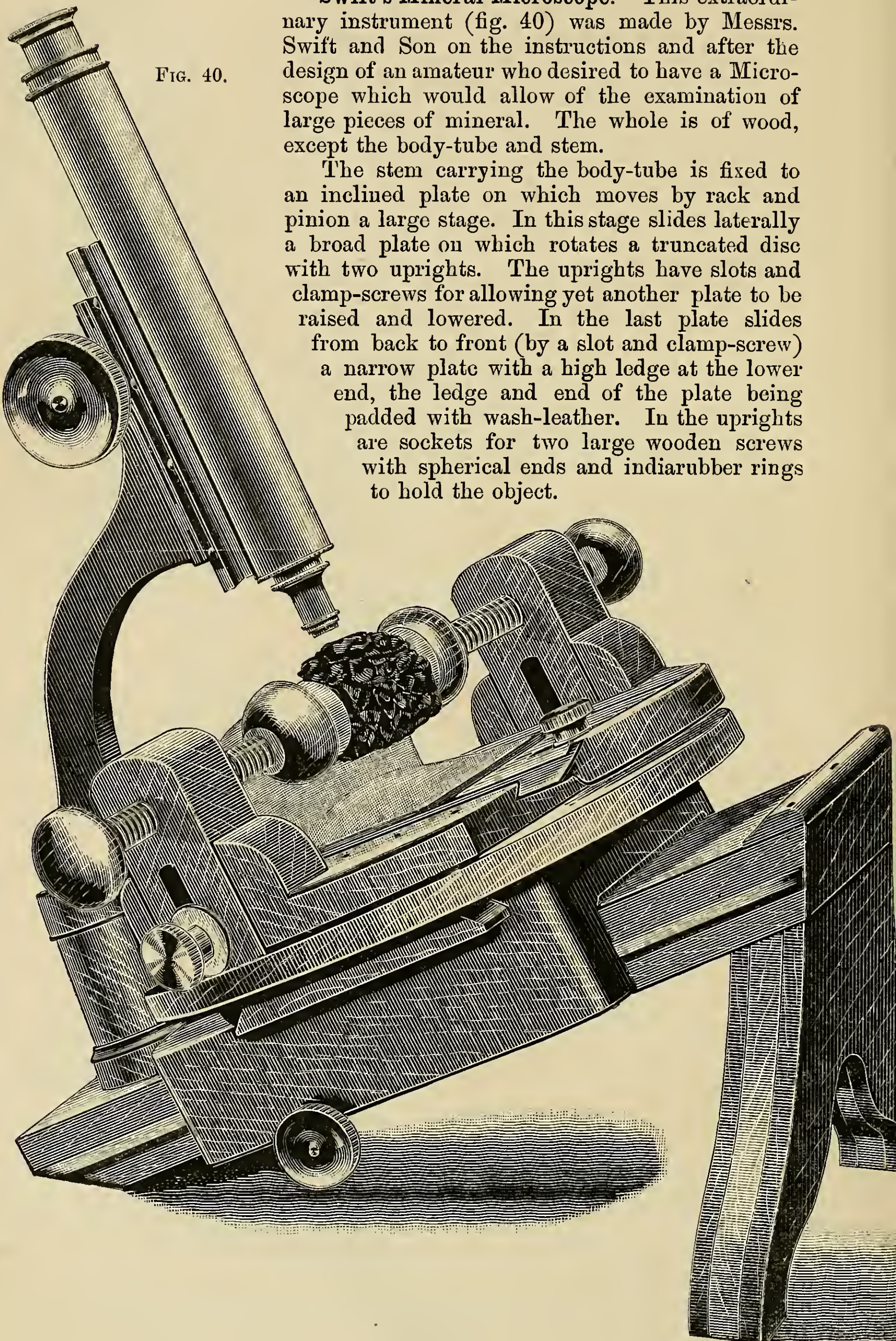


Fig. 39.

Swift's Mineral Microscope.—This extraordinary instrument (fig. 40) was made by Messrs. Swift and Son on the instructions and after the design of an amateur who desired to have a Microscope which would allow of the examination of large pieces of mineral. The whole is of wood, except the body-tube and stem.

The stem carrying the body-tube is fixed to an inclined plate on which moves by rack and pinion a large stage. In this stage slides laterally a broad plate on which rotates a truncated disc with two uprights. The uprights have slots and clamp-screws for allowing yet another plate to be raised and lowered. In the last plate slides from back to front (by a slot and clamp-screw) a narrow plate with a high ledge at the lower end, the ledge and end of the plate being padded with wash-leather. In the uprights are sockets for two large wooden screws with spherical ends and indiarubber rings to hold the object.

Fig. 40.

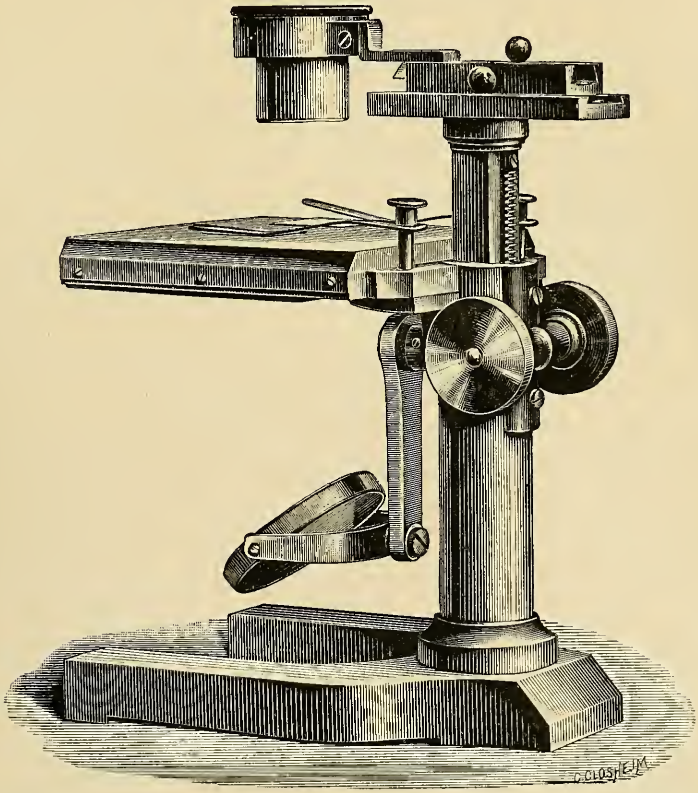


Binocular Dissecting Microscope.*—Prof. F. C. Van Dyck describes a "binocular dissecting and mounting simple Microscope, made of a stereoscope by turning the lenses end for end, and tilting them so as to prevent the disagreeable convergence of optic axes, which an ordinary 'reading glass' necessitates. The arrangement is equivalent to a reading glass cut in two, so that its parts may be set at such angle and distance as prove effective. If you try it by holding a couple of stereoscopic lenses about five inches from a flower, you can prove the comfort of the thing, and try, by shutting one eye, how much good the binocular effect does. The aberrations are very marked, of course, but do not practically annoy."

"I have used mine," he says, "for a year or more, and find it very convenient. The affair is so cheap and so easily made by any one that I am inclined to publish a note on it if new, which it is, so far as I know."

Leitz's large Dissecting Microscope.—The speciality of this Microscope (fig. 41) consists in the arrangement for extending the lens-

Fig. 41.



holder. This is attached to a bar which slides by a small knob in a grooved plate, the latter again sliding in a second grooved plate rotating

* Queen's Micr. Bulletin, v. (1888) p. 25.

on the top of the stem. The second plate is moved by two knobs at the sides.

A blackened brass plate slides beneath the glass stage, so that it can be used for both transparent and opaque objects.

Two large wooden hand-rests, similar to those of Mayer's dissecting Microscope, fit on pins (not shown in the fig.) at the sides of the stage.

HENRICI, J. F., and C. C. MELLOR.—**An Old Microscope of the Culpeper Type.**
[Same model as figured on Plate IV. of 'Adams' Essays on the Microscope,' 1787.] *Proc. Amer. Soc. Micr.*, X. (1888) pp. 140–2) (1 fig.).

PIERSOL, G. A.—**Continental Microscopes.**
Queen's Micr. Bulletin, V. (1888) pp. 23–4.

(2) Eye-pieces and Objectives.

BECK, C.—**The Construction of Photographic Lenses.**
[" The achromatic Microscope was worked out by Lister and others by practical methods, and even at the present time many things are done in practice which are not even known of by theoretical men. I believe I am correct in saying that there is no book which gives a correct representation of a high-power microscopic object-glass, and most of the figures which are to be seen in books are entirely misleading." Also remarks on Jena glass.]
Journ. Soc. of Arts, XXXVII. (1889) pp. 180–92 (6 figs.).

DETMERS, H. J.—**American and European Microscopes.**
[Controversy as to Objectives.]
Proc. Amer. Soc. Micr., X. (1888) pp. 149–54; cf. also *The Microscope*, IX. (1889) pp. 14–15, and *St. Louis Med. and Surg. Journ.*, LV. (1888) p. 348; also Dr. J. Pelletan in *Journ. de Micrigr.*, XIII. (1889) pp. 101–4.

EWELL, M. D.—**American Objectives and Dr. Zeiss's Apochromatic Objectives.**
[Opinion unfavourable to the latter.]
The Microscope, IX. (1889) pp. 30–1.

HEURCK, H. VAN.—**Les Apochromatiques jugés en Amérique.** (The Apochromatics judged in America.) *Journ. de Microgr.*, XII. (1888) pp. 438–40.

JAMES, F. L.—**The Old Nonsense still on its Rounds.**
[Comments on the " Wonderful Swedish Optical Glass " paragraphs. See this Journal, 1888, p. 499.]
St. Louis Med. and Surg. Journ., LV. (1888) pp. 350–1.

(3) Illuminating and other Apparatus.

Ahrens' Modification of Delezenne's Polarizer.*—Mr. C. D. Ahrens has devised a modification of Delezenne's polarizer, which consists of a total-reflection prism combined with glass plates and black glass mirror, arranged so that the polarized beam is parallel to the original one. The combination of plates and mirror is adopted so as to give enough light and still keep the polarization sufficiently good. One or two plates laid over the mirror are found to give the best results. The fact that a beam polarized by reflection is not coincident with the original beam renders it inconvenient if not impossible to rotate the polarizer, and to overcome this defect Dr. S. P. Thompson has arranged two quarter-wave plates, one of which may be rotated. The first plate circularly polarizes the plane-polarized beam, and the second (or rotating one) re-plane-polarizes it in any desired plane.

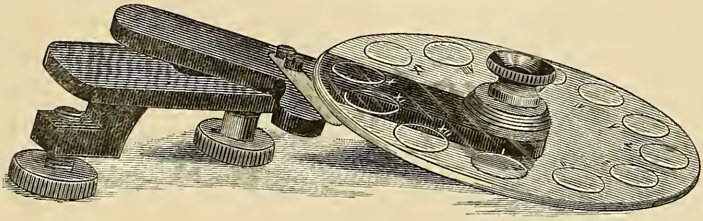
Falter's Rotating Object-holder.—This apparatus (fig. 42) of Messrs. G. Falter & Son of Munich is intended to provide a rotating object-holder which can be adapted to any Microscope.

The objects are arranged round the circumference of a glass disc

* Nature, xxxix. (1889) p. 358.

which rotates on an arm pivoting on a second arm which is clamped to the stage. The first arm can be clamped to the second in any position by the milled head screw shown in the woodcut. A piece of watch-spring beneath the disc serves as a brake to steady the motion. When

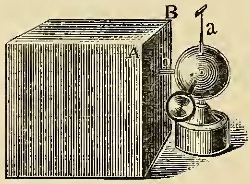
Fig. 42.



the arm is set excentrically, the apparatus enables the observer to search over a fresh gathering of diatoms, &c. Other discs can be substituted as desired.

Apparatus for measuring very minute Crystals.*—Herr G. Lattermann has devised the small apparatus shown in fig. 43, for the measurement on the goniometer of crystals 1/10 to 1/20 mm. in length, which on account of their smallness could not be adjusted on this instrument.

Fig. 43.



The apparatus consists of a small hollow cube of metal, and a jointed piece with axes *a* and *b*. The crystal to be measured is fastened on the point of a fine needle, with somewhat stiff Canada balsam. By turning the axis *a*, the edge between two faces of the zone to be measured (or rather its horizontal projection) is adjusted under the Microscope upon the thread of the eye-piece running from back to front, while at the same time the edge A B is directed on the stage also from back to front. The effect of this movement is to bring the zonal edge into a vertical plane parallel to a face of the cube. The cube is then turned over on its left side, and the zonal edge (now in a horizontal plane) is brought strictly parallel to A B, by turning about the other axis *b*. If the apparatus be now placed on the goniometer resting on a face at right angles to A B, and be centered, the crystal will be in a suitable position for measurement.

Electricity, Application of, to Microscopy.
[Discussion by Dr. W. J. Lewis, Dr. L. D. M'Intosh, and Dr. W. M. Seaman.]
Proc. Amer. Soc. Micr., X. (1888) pp. 178–9 (1 fig.).

Royston-Pigott, G. W.—**The Anti-diffraction Micrometer.**
["In using spider lines a certain amount of diffraction confuses the measurement. When a metallic obstacle is interposed, the impingent rays of light are *dispersed* in a fan-like form. It has occurred to me that a refracting cylinder, on the contrary, would refract or inflect these rays inwards, producing darkness. These principles are best illustrated by optical diagrams. The opaque jaws of the micrometer slides are edged with thin rods of glass,

* Tschermak's Mineral. u. Petrogr. Mittheil., ix. (1887) p. 49 (1 fig.). Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) p. 542 (1 fig.).

fitting together accurately parallel. The image of the object to be measured is brought between them and the ivory wheel, divided into hundredths, each division representing with 1000 the one-millionth of an inch. Each revolution of this wheel is *audibly* marked by a spring catch; besides this, an adjusting screw serves to set the zero-jaw accurately, and teeth 50 to the inch display the number of whole turns."]

Engl. Mech., XLVIII. (1889) p. 389 (1 fig.).

(4) Photomicrography.

Zeiss's large Photomicrographic Apparatus.—Dr. Zeiss supplies for photomicrographic purposes the special stand shown in fig. 44, which is generally similar in form and size to the other large stands of the maker. There is, however, in addition, an unusually large stage, with mechanical movements, rotating by rack and pinion, and having a wide opening for use with a low-power objective giving a very large field of view. The Abbe illuminating apparatus is so arranged that it can be easily removed and replaced by special spectral, polarization, &c. apparatus. The body-tube is also of an unusually large diameter, partly for avoiding internal reflection, and partly to render possible the use of the low-power objective.

The Microscope is not attached to the same support as the camera, but both parts are on separate stands, which it is claimed is more convenient for working. The stand, screwed to a metal support which is provided with three levelling screws, is set up at one end of the platform A (figs. 45 and 46), which is adjustable for height. At the other end of the platform is an angle-plate C, which supports an electric lamp; while the space between the lamp and the Microscope M is occupied by an optical arrangement consisting of two stout metal rails carrying the illuminating apparatus for use with sunlight, two vertical screens E and F, movable by rack and pinion, which can be quickly turned on one side, and again brought back exactly to their old position; a plane mirror G, adjustable in height, with coarse- and fine-adjustment in the vertical as well as in the horizontal axis, in order to correct slight irregularities in the course of the heliostat; and a stand H for the reception of glasses for yellow and blue absorption liquids. For the use of the arc-lamp, as shown in fig. 46, there is a water-chamber T with plate-glass ends for the absorption of the heat-rays, and a lens L for projecting the image of the carbon points on the ground-glass plate. On the end of the metal support B is an arrangement *a*, by which the movement of a Hooke's joint *b* with rod *b'* can be transferred to the micrometer screw. This is effected by means of a toothed wheel which can be brought into gear with the toothed wheel of the micrometer screw. The tube carries a double socket *h* into which, by turning the camera, slides a corresponding socket-piece attached to the end of the camera, so that a very perfect light-proof connection between Microscope and camera is effected without disturbing the former. The socket-piece can be easily removed and replaced by a macroscopic objective for ordinary photographic work. The camera K is mounted on a separate light but solid cast-iron stand SS, provided with iron rails on which it can slide smoothly by means of rollers. The total length of the camera when fully extended is 1·5 m.

In order to fit the apparatus for taking fluid preparations, the camera is divided into two halves, of which the one nearest the Microscope can be turned up vertically, as in figs. 47 and 48, or inclined at any angle.

FIG. 44.

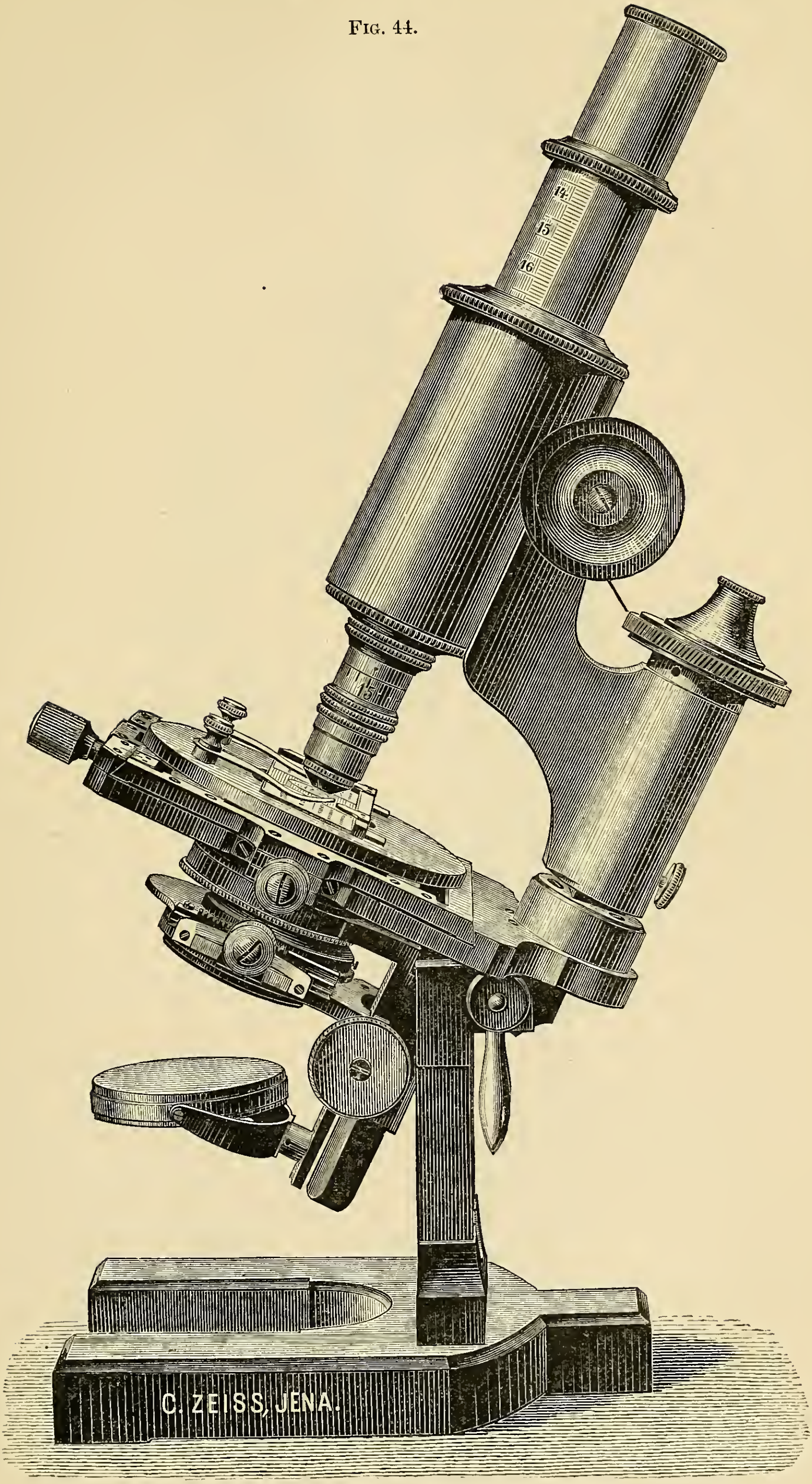
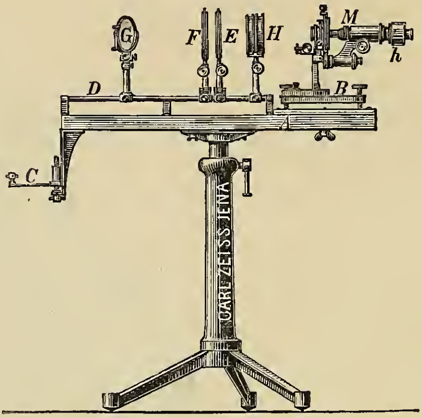


Fig. 45.



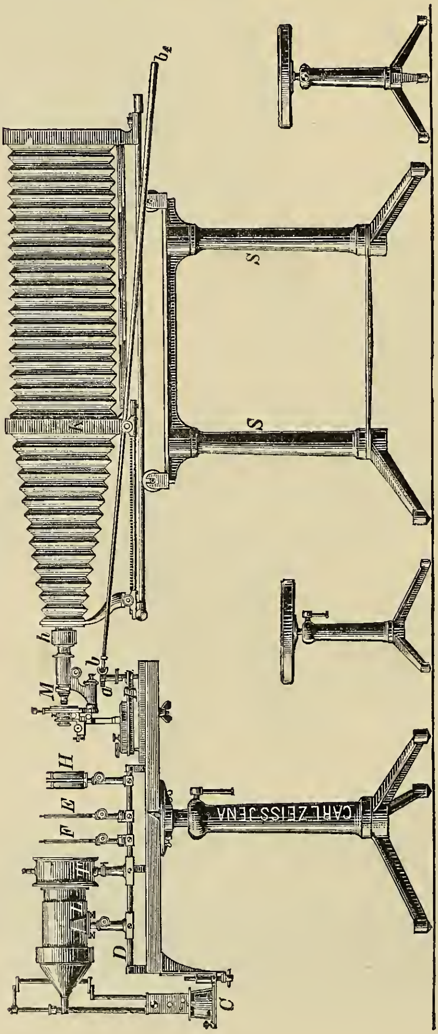
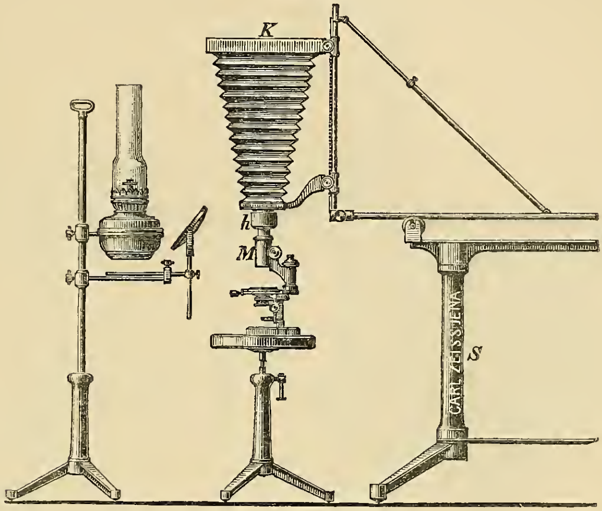


Fig. 46.

Movement of the plane of the image, and also of the Microscope end of the camera is effected by pinions acting on a strong rack. Both halves of the camera are arranged for plate-holders of 24 by 24 cm. which, however, by the addition of frames can be used for plates of any

Fig. 47.



smaller size. Two adjusting plates, one of ground glass, and the other transparent, and provided with a cross on the Microscope side, serve for the coarse- and fine-adjustment of the image. A third plate-holder can be added, which for the purpose of ascertaining the best time of exposure, permits a great number of proofs to be taken one after another on the same plate. To this end the holder is movable in a guide, and is made to pass in front of a slit which allows only a small strip of the image to fall on the sensitive plate. The bellows of the camera can be drawn a little away from the plate-holder, so as to permit the image to be viewed from the front, it being thrown on a piece of white paper as in Nachet's method.

With regard to the choice of a room to serve as a laboratory for photomicrographic work, and the setting up and adjustment of the apparatus, Dr. Zeiss's very elaborate catalogue of photomicrographic apparatus * should be consulted, in which valuable information is also given on the nature of different sources of light and the manner of their use for photomicrography, and on the special precautions required in the chemical part of photomicrography.

In photomicrographic work an objective of 75 mm. focal length has been constructed which serves to take large objects (2 to 4 cm.) under a magnification of ten to fifteen times. It possesses all the advantages of the other apochromatic objectives.

As illuminating apparatus, either an Abbe condenser of 1·20 to

* C. Zeiss, 'Special-Catalog über Apparate für Mikrophotographie,' 4to, Jena, 1888, iv. and 56 pp., 16 pls. and 9 figs.

1·40 mm. aperture, or a specially constructed *achromatic* condenser of 1·0 mm. aperture can be used. To obtain a successful photomicrograph it is necessary that the illumination should be limited to that part of the object which it is desired to photograph, because otherwise the light

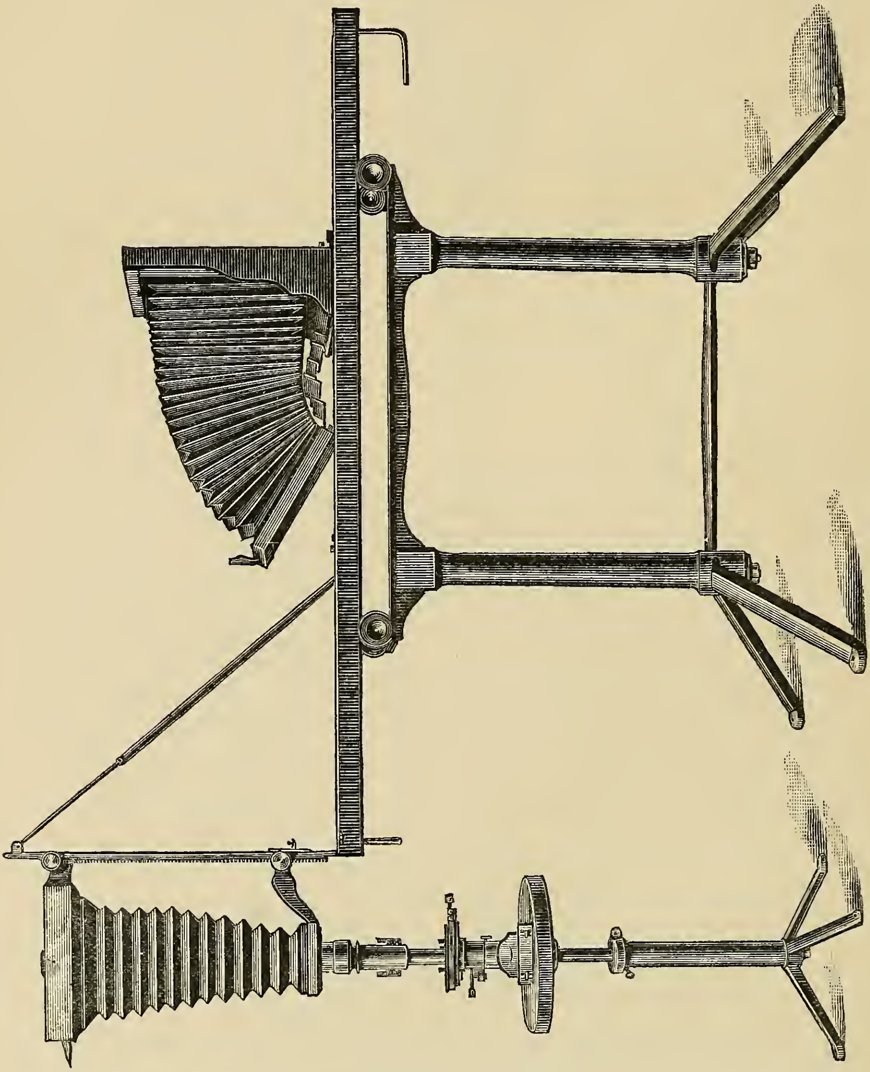
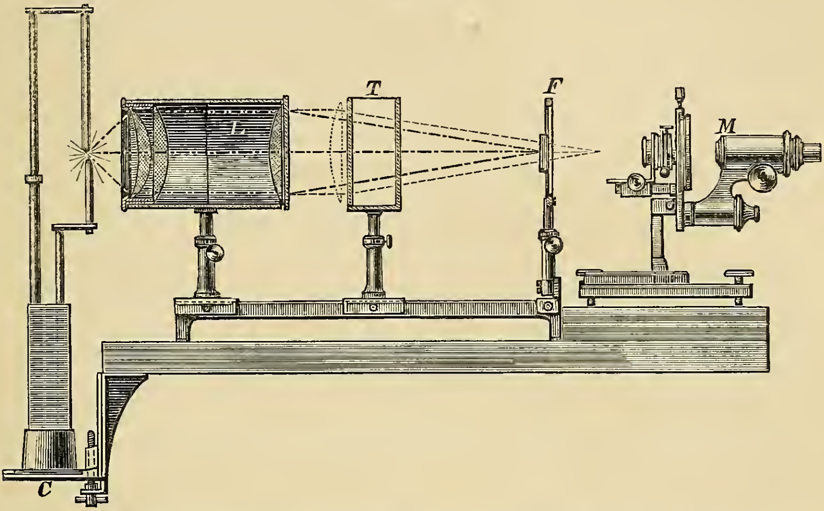


Fig. 48.

coming from the surrounding parts has the effect of fogging the picture. A sharp image of the source of light must therefore be projected upon the object, and to this end the condenser is provided with an arrangement for cross-centering and for fine-adjustment. The limitation of the illuminating cone is effected by an iris-diaphragm.

For the 75 mm. objective a specially small lens of great focal length is used as condenser, since it is here necessary to project an image of the source of light within the objective. The condenser for use with the electric arc light consists of two plano-convex and one concavo-convex lens L (fig. 49). The part of the system near the lamp is fixed

Fig. 49.



once for all at the proper distance for producing a parallel beam, and to diminish spherical aberration the concave face is turned to the lamp. The part turned to the Microscope, which brings the parallel rays again to a focus, is movable in a sliding socket which permits the displacement of the image on the optic axis within pretty wide limits.

Detmers, H. J.—**Photography with High-powers by Lamp-light.**
Proc. Amer. Soc. Micr., X. (1888) pp. 143–8 (1 fig.).
F. C. S.—**Beginner's Guide to Photography.**
[Includes 'Appaiatus for Photomicrography,' pp. 58–62.]
128 pp., 34 figs., 8vo, London, n.d.
Gray, W. M.—**Photomicrography.**
Queen's Micr. Bull., V. (1888) pp. 21–2, from 'Science of Photography.'
Neuhauss, R.—**Anleitung für Herstellung von Mikrophotogrammen.** (Guide to preparing Photomicrographs.) *Aerztl. Centr.-Anzeig.*, 1888, No. 38.
Perken, Son, and Rayment's Photomicrographic Apparatus.
Engl. Mech., XLVIII. (1889) pp. 369–70 (1 fig.).
Swift and Sons' (J.) Photomicrographic Apparatus.
[Lord Edward Churchill's. See this Journal, 1888, p. 1061.]
Scientific News, II. (1888) p. 379 (1 fig.).

(5) Microscopical Optics and Manipulation.

Microscopical Optics.—Recent occurrences would appear to show that we have allowed too long a period as the measure of a microscopical "generation." In ordinary life thirty years is considered to represent a generation, and as it is less than ten years since the more salient facts of microscopical optics were brought prominently before microscopists, we were a little surprised to find that principles which it had cost so much time and trouble and money to record should be suddenly trampled upon in what, from our point of view, was a most unreasoning and unreasonable manner.

As it is possible that the explanation is to be found in the fact that, notwithstanding the shortness of the time, new minds have come upon the scene which were not in being at the time of the old discussions, we propose to consider in detail in this and following numbers of the Journal the various errors above referred to, so that at any rate for the next ten years, we may hope to be free from similar misapprehensions.

(1) We will first deal with the notion that the diffraction theory as promulgated by Professor Abbe is affected either in principle or application by the increase of the theoretical maximum of the apertures of objectives from 1·33 (water) to 1·5 (oil). The text on which we found this explanation is a statement quoted in this Journal for 1888, p. 1034, and the full text of which will be found in the place indicated in the footnote.*

The best answer that can, we think, be given to this notion is the following paragraph from a paper written by Professor Abbe *before* the introduction of homogeneous-immersion lenses, and it will be seen that at that time he assumed the existence of objectives of 1·5 and discussed the capabilities of much larger apertures, a point which we need hardly remind our readers, has not yet been reached.

Professor Abbe said :—" With regard to a still further extension of aperture beyond 1·5 (the refractive index of crown glass), it may be thought that in process of time transparent substances, available for the construction of objectives, will be discovered, whose refractive index will far exceed that of our existing kinds of glass, together with immersion fluids of similarly high refractive power, so as to give new scope to the immersion principle. What, however, will be gained by all this ? We shall, perhaps, with certain objects, such as diatoms, discover further indications of structure where we now see bare surfaces ; in other objects, which now show only the typical striations, we shall see something more of the details of the actual structure by means of more strongly diffracted rays ; *but we should get on the whole little deeper insight into the real nature and composition of the minuter natural forms, even should the resolving power of the Microscope be increased to twice its present amount ;* for, whatever part of the structure cannot at present be correctly represented, on account of its small size, will then also give an imperfect image, although presenting a somewhat higher degree of similarity than before. If, therefore, we are not to rest upon conjectures which surpass the horizon of our present knowledge (as, for instance, would be the expectation of the discovery of substances of considerably higher refractive power than has hitherto been found in any transparent substance), our progress in this direction in the future will be small, and the domain of microscopy will only be very slightly enlarged, the more so because every such advance, however great, will be but of limited utility to science on account of very inconvenient conditions. For a given extension of the aperture can only render possible a correspondingly enhanced performance of the Microscope when the object is surrounded by a medium whose refractive index at

* Eng. Mech., xlviii. (1888) p. 178.

least equals that aperture. If the Microscopes of the future should utilize the refractive power of the diamond, all the objects would have to be imbedded in diamond, without any intervening substance. The result of this consideration is, therefore, that as long as aperture serves that specific function which experiment and theory compel us to ascribe to it at present, there is a *limit* to the further improvement of the Microscope, which, according to the present condition of our knowledge, must be considered as insurmountable."*

It will be seen, therefore, that the diffraction theory, even before the introduction of homogeneous-immersion objectives, took account of apertures higher than 2, so that there is no foundation for the wildly ridiculous suggestion that it is possible to "trace in all Dr. Abbe's "subsequent papers the influence of two moods, and that at times he "could not resist the evidence, as the aperture of the objectives became "larger, that the image given by them was a truthful one." †

In addition to this it should be recalled that the first detailed exposition of the diffraction theory on its final basis was published by Professor Abbe in 1882. As homogeneous-immersion objectives were made by Professor Abbe and Dr. Zeiss in 1878, it is quite a misapprehension to write that "since then has come the oil-immersion objective and "the oil-immersion condenser, throwing a flood of light on the image "not possible under the old methods, and what I cannot understand is that "people should *now revive the old doubts*."‡ Whatever were the old doubts they still remain in the same position—unchanged and unremoved by anything that has happened since they were first shown to exist.

(2) The second point with which we will deal is contained in a statement the text of which is as follows:—

> ". . . Even Dr. Abbe seems to be frightened at the logical outcome of his own theory, for further on he says, 'It is obvious that a perfect fusion in every case of the same diffraction images, and then an exact superposition of the resultant diffraction image upon the absorption image, is only possible when the objective is uniformly free from aberration over the whole area of its aperture.' This clearly means that given perfect correction of the objective there is perfect definition of the object, which to me seems to contradict the former part of the paper." §

The misunderstanding here arises from not comprehending the difference between the defining and the delineating power of an objective.

Take, for example, the case of an objective which has an aperture sufficient only to take in the first set of spectra of *Pleurosigma angulatum.* If the objective is perfectly corrected we shall have perfect definition *of the image to which those spectra give rise.* But the objective not having an aperture sufficiently large to take in the second set of spectra will necessarily give a less perfect image than another objective which takes in those spectra, and the first objective therefore, though perfectly corrected and giving perfect definition of what it *does* show, gives only an imperfect image.

In the next number of the Journal we shall deal with further misapprehensions of the same kind as those above referred to.

* This Journal, 1884, pp. 292-3

† Journ. Quek. Micr. Club, iii. (1888) p. 268. ‡ Ibid., p. 269. § Ibid., p. 268.

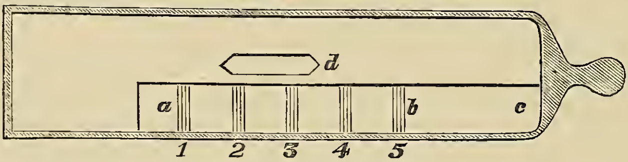
Mode of using the Quartz Wedge for estimating the Strength of the Double-Refraction of Minerals in thin slices of Rock.*—Major-General C. A. McMahon describes a rough and ready method for estimating the strength of the double-refraction of minerals in rock sections, which he has used with advantage for some years. It serves to replace the somewhat complicated methods, requiring special apparatus, of Babinet and Michael Lévy, when perfect exactness is not required.

When a quartz wedge is inserted in a slot in the eye-piece of a Microscope, arranged with crossed nicols, at an angle of 45° to the plane of polarization, a series of chromatic bands will be observed in the wedge, each band consisting of a spectrum of colours in an ascending order, the colours of the first order of Newton's scale being the nearest to the thin edge of the wedge. The width of these bands varies directly with the thickness of the quartz, and inversely with the slope of the wedge.

The stronger the double-refraction of a mineral, the higher will be the order of the tint exhibited by it when slices of different minerals of uniform thickness and at the same angle to an optic axis are examined. The usual method of using the wedge therefore consists in comparing the tint exhibited by the mineral with the corresponding tint in one of the chromatic bands in the wedge.

In working this method the author employs a special wedge (fig. 50), which only occupies half the depth of the slot, so that the observer is

Fig. 50.



able to directly compare the tint of a mineral, say at *d* (fig. 50), with the spectra seen in the wedge *a b c*.

The method now to be described differs from the above in depending on the phenomena produced in the wedge by the passage of light through the mineral to the quartz.

If, while the quartz wedge is inserted in the eye-piece as above, a second quartz wedge be placed on the stage with its axis at right angles to that of the wedge of the eye-piece, the velocity of the extraordinary ray is retarded in one of the two plates and accelerated in the other. A dark line will then appear due to the points where the velocity of the extraordinary ray on emergence from the upper quartz wedge becomes the same as that of the ordinary ray.

If the analysing quartz wedge be kept stationary and the other moved on the stage so that thicker and thicker portions of the quartz are successively brought within the range of vision, the dark line moves gradually from the thin towards the thicker end of the analysing wedge, so that spectra (in inverse order) of the 1st, 2nd, 3rd, and higher orders come in between it and the thin edge of the wedge. Thus the distance

* Geol. Mag., v. (1888) pp. 548–53 (1 fig.).

of the black line from the thin end of the wedge is proportional to the thickness of the quartz on the stage.

By substituting for the quartz wedge on the stage mineral sections of uniform thickness cut at the same angle to the optic axis, the distance of the black line from the thin end of the analysing wedge in each case gives a means of estimating the strength of the double-refraction.

As applied to the examination of minerals contained in rock sections, the method is complicated by the fact that they vary in thickness and also in the angle to an optic axis at which they are sliced. The fact that sections prepared by a skilful lapidary do not differ greatly in thickness, helps to obviate the first difficulty; and the second is partly overcome by choosing for examination the most brilliantly coloured crystals, which are presumedly those cut approximately parallel to an optic axis. At any rate, the method enables one to separate at a glance such strongly refracting minerals as rutite, dolomite, calcite, sphene, anatose, and zircon. So powerful is the double-refraction of rutite, calcite, and sphene that two wedges are sometimes necessary in order to bring the dark line within the range of vision.

So also the minerals of very feeble double-refraction are easily separated. In these cases sometimes the black line is *on the very edge* of the quartz wedge, or is just beyond the range of vision. In the latter case a 1/4 undulation plate is inserted above the object-glass, which has the effect of shifting the spectra up the wedge.

In ordinary rock sections quartz rarely exhibits more than one chromatic band between the dark line and the edge of the wedge; whilst such minerals as muscovite, olivine, and actinolite commonly present three and sometimes as many as five such bands. A feeble double-refracting mineral will never exhibit the phenomena presented by one of strong double-refraction, but the latter when cut approximately at right angles to an optic axis will resemble a mineral of feeble double-refraction cut approximately parallel to an optic axis. In this case, however, the mineral will exhibit characteristic appearances when examined in convergent light.

In cases where a mineral is so minute as to be less in diameter than the width of one of the chromatic bands exhibited by it, the number of bands which come in between the dark line and the thin edge of the wedge can still be counted if, confining his attention to one colour, the observer counts the number of times before extinction that the mineral assumes that colour as the wedge is moved across it.

As an illustration of the close approach to accuracy obtained by the use of the method the author mentions the case of sphene, which the determinations of refractive indices made by M. Lévy and Lacroix show to have a position, as regards intensity of double refraction, between zircon and calcite, a position assigned to it by the author on the evidence afforded by the rough and ready use of the quartz wedge.

"Method of using with ease Objectives of shortest working distance in the clinical study of Bacteria." *—Dr. A. C. Mercer writes as follows:—

"The working distance of homogeneous-immersion objectives of short focus and great numerical aperture is little. In the clinical study of bacteria, sputa and other more or less fluid material are generally

* The Microscope, ix. (1889) p. 46

prepared on the under surface of cover-glasses, commonly, when not measured and assorted, so thick as to make examination with the above most suitable objectives impossible.

To avoid this difficulty I dry and stain the material on the slide, drop homogeneous-immersion fluid upon the preparation, and lower the objective into the drop. Homogeneous fluid replaces both the balsam and the cover-glass with optical propriety.

A twenty-fifth, which has been nearly useless over ordinary cover-glass preparations, is now used with gratifying freedom in manipulation over uncovered, but homogeneously immersed, slide preparations."

"**Back of the Objective and the Condenser.**"*—The following are extracts from an interesting article by Mr. E. M. Nelson on this subject. Observing that a condenser was described as a "fad of English microscopists," he thinks it will be worth while to try and account for this by no means uncommon idea. The task is not an easy one, for there are many fallacies underlying this impression.

"First, we have spherical aberration. Many objectives, both cheap and expensive, are turned out full of spherical aberration. If more than the immediate centre of these lenses is used, the object will be flooded or drowned in light.

There are two kinds of flooding with light: one is due to spherical aberration, as above, the other to the too powerful illumination of the object. This last, however, seldom obtains in the Microscope, but is always made an excuse for the other. Suppose we have a first-rate 1/2 of 60°. This lens will not be performing at its best unless it is illuminated by a solid axial cone of 60° from a condenser, the object being placed in the apex of the two cones.

Under these conditions, it is by no means necessary that the illumination of the object should be too brilliant for the eye. If it is, it may be modified by blue or neutral tinted glass. If the lens is free from spherical aberration, the image will be clearer and sharper than if the cone were to be reduced by means of a diaphragm. But if the lens is mediocre or inferior in its correction for spherical aberration, then the image will be fogged, though not necessarily too bright for the eye. This fog, however, will pass off, as the angle of the illuminating cone is reduced by the diaphragm.

Very many histologists, biologists, &c., prefer their Microscopes without condensers, because they are unable to illuminate their objects with cones large enough to develope, so to speak, the latent spherical aberration in their objectives; at the same time, they seem to be unaware of the fact that neither can they develope the resolving power of the lens.

Secondly, low-angled glasses for penetration: this fallacy is hung on a peg of physical truth—viz. that penetration is inversely proportional to aperture.

The continual parading of this truth, and the placing of it in undue prominence in several well-known microscopical works, has wrought an incalculable amount of mischief.

It has not only held back the progress of microscopy, but it has directed many earnest workers in the wrong way.

* Eng. Mechanic, xlviii. (1888) pp. 236-7 (4 figs.). See also pp. 260, 277, 278, 295, and 296.

I was myself caught with this plausible fallacy some years ago, and lost a good deal of ground before I discovered the error. This fallacy is an exceedingly difficult one to confute in an article such as this, because it does not consist solely of one error, but is, in reality, a whole cluster of errors.

To illustrate one of these errors, I take two quarters, one wide, the other low-angled, both of the same power, and both thoroughly well corrected. I, the demonstrator, allow the demonstratee to select any object out of my cabinet, or bring one of his own; this object is then successively examined by each lens, properly illuminated by a condenser, and by the same eye-piece; the unanimous testimony of the demonstratees being that the observations are much more satisfactory with the wide-angled lens.

I then ask the demonstratee to fix on some definite point in the object illustrating the superior penetrating power of the low-angled lens.

The object is re-examined, the objectives are changed a score of times; but the result of it all is, that they say, they thought there would have been more difference; but, practically, there does not appear to be any. I have devoted a great deal of time to this question, and have gone carefully over these experiments myself, and consequently know what must be the verdict of every impartial observer.

The explanation is as follows:—Let us suppose that a section of tissue is the object,* and the test is to trace the course of a vessel in it. Where no special difficulty arises the one lens is as good as the other,† but the moment the vessel gets involved in similarly coloured or other tissue, the increased resolving power of the wide-angled lens makes itself felt, and at once differentiates the structure, which the narrow-angled lens fails to do.

The difference of focal depth might form an element for consideration if the lens were rigidly fixed at a certain distance from the object; but there is such a thing as a fine-adjustment, and by means of it the observer is able to trace the course of the vessel by the wide-angled lens, and without effort or thought to direct the movement of the lens; therefore, the question of depth of focus assumes more of a theoretical objection than a practical one.

The question will be asked, What has all this to do with condensers? The answer is, that histologists invariably use narrow-angled lenses. A plane mirror when used with diffused daylight near an ordinary window gives a cone of illumination; the angle of this cone varies with the diameter of the mirror and its nearness to the object, say from 10° to 30°. In no instance of mirror illumination, either plane or concave, would I expect to find 30° exceeded, and such an angle as that would never be reached by the average histological Microscope.

Therefore we can see that a histologist would, perhaps, be able to fill his low-angled inch, and to inadequately fill his low-angled 1/4. The 1/4 he would not be able to fill enough to develope any spherical aberration it might have, unless, indeed, the lens was execrably bad.

* Histologists invariably choose this or some similar object. They fight shy of diatoms, because they know the superior defining power of the wider-angled lens would be more apparent. The diatom would exhibit the difference of focal depth better than any other histological object.

† Not strictly speaking, for a narrow-angled lens never gives such a good image as a wide one.

Suppose he now tries his lenses on a Microscope with a condenser. In regard to his low-angled inch, he can find no difference as it was filled before, but with his 1/4 the definition is worse, because he has brought out the spherical aberration of his lens; he therefore prefers the Microscope without a condenser, and calls them a 'fad of English microscopists.' Let him, however, view the same objects with similar lenses, well corrected and of decent angles, properly illuminated by a condenser, and his conversion will be complete.

Thirdly, the object. There is a golden rule for microscopists which has been so frequently stated that I would not repeat it were it not that it is so frequently disregarded. It is this: 'Use as low a power as possible.'

The favourite procedure with histologists is to use a high power uncritically where a low power used critically would be far better.

I would greatly prefer to use a 4/10 of 80° with a 1 in. eye-piece than a 1/6 of the same angle with a 2 in. eye-piece, both being used with a condenser. What shall we say when a 4/10 of 80° with the 1 in. eye-piece is used with a condenser, and the 1/6 of 80° and 2 in. eye-piece is used without?

I am firmly persuaded that we should hear far less of 'low-angled glasses for penetration' if powers suitable to the object were used.

There are published microscopical works with diagrams stated to have been drawn under the magnification of an oil-immersion 1/12, which, as far as the detail in them is concerned, might have been drawn with a 1/2 in.; and yet such a thing calls forth no remark in the microscopical world. . . .

Let me append just two statements out of the many I have heard from histologists themselves on this subject. 'We cannot see anything like this with an oil-immersion 1/12.' The object in this case was tubercle bacillus with a 1/2 in. A yonng graduate fresh from one of the first laboratories in the kingdom remarked, 'We have nothing like this at ——.' Some anatomical subjects under a power of 140 with a 4/10 of 80° called forth that statement. So much for the testimony of others. I will now give two instances from my own experience. A curved piece of pink-stained dirt about the size of a *Rotifer vulgaris* was shown to me for a comma bacillus. If a true comma bacillus had been placed under that Microscope it would have been quite invisible.

On another occasion I was shown *B. anthrax* under an oil-immersion 1/12; in this instance it was just possible to differentiate a something out of the general smudge which might be said to resemble the object when you knew what to look for. The exhibitor has public reputation for microscopical knowledge.

Fourthly, a histologist prefers his Microscope without a condenser, because the condenser would accentuate the deplorable condition of his fine-adjustment. A sharp critical image requires a precise focusing apparatus, but an uncritical image, i. e. an image without an edge * to it, can stand a jerky fine-adjustment.

Fifthly, daylight. Bad as a Microscope without a condenser is, it becomes far worse when illuminated by artificial light instead of daylight.

With lamplight a cone from the plane mirror becomes an impossibility, so one has to be contented with the best that can be got (sometimes

* An image in which the boundaries of the detail are all fluff.

diverging rays) from what is often an ill-arranged* concave mirror. The concave mirror is generally made too small, and of too shallow a curve.

I now come to the second part of my subject, viz. the condenser and the objective back.

1. It is advantageous to know the maximum aperture of your condenser. It can be easily measured by an Abbe's apertometer.

2. It is of more importance, however, to know the aperture of the largest cone free from spherical aberration which can be obtained from a condenser. This cannot be found out by the apertometer.

3. It is also of paramount importance to know the apertures of the cones which the various diaphragms will give. These, of course, could be measured by an apertometer; but with very many forms of diaphragms it could only be accomplished with difficulty.

I will now endeavour to give some useful hints with regard to these questions. I will take No. 3 first.

Fig. 51 exhibits the back of a dry lens of N.A. 0·5 = 60°, illuminated by a condenser of greater aperture free from spherical aberration, the condenser and flame image having been centered and focused.

Fig. 52 shows the same objective, with a smaller diaphragm placed at the back of the condenser. The edge of this diaphragm is seen just

Fig. 51.

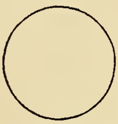


Fig. 52.

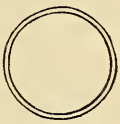


Fig. 53.

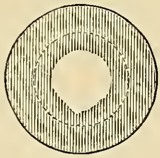
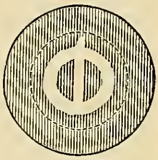


Fig. 54.



appearing at the margin of the objective. The aperture of the condenser, when used with this diaphragm, is therefore a shade less than N.A. 0·5—say 55°.

In a similar manner the apertures of the condenser with other diaphragms may be estimated with sufficient accuracy for all practical purposes.

Now with regard to No. 52, it is necessary to have a wide-angled objective; the condenser and flame are centered and focused as before, the eye-piece removed, and while the back of the objective is being examined the condenser is slowly racked up. It will be noticed that a point is reached when the disc of light is at its largest (fig. 53); on a further movement of the condenser two black spots appear, one on either side of the middle of the disc (fig. 54), and these increase as the condenser is further racked up. *The last point before the appearance of the black spots indicates the largest aperture of the condenser free from spherical aberration, and is the limit of the condenser for critical work.* Any further advance of the condenser gives merely annular illumination, which, of course, is to be avoided, except in the case of dark grounds with stops for low powers. The extreme margin of even the best condenser is only useful for giving an oblique beam with a slot."

* The concave mirror is usually fixed to the tail-piece, with or without a crank. This is thoroughly wrong in principle. A concave mirror should always be fixed to a tube sliding in the tail-piece to allow of it being focused. The crank-arm is quite of secondary importance.

Aperture Table.—The following Table of Apertures has for some years been printed on the wrapper of this Journal, but as part of the space which it occupies is now required for other purposes a condensed table will in future be used, the full table being reprinted here for future reference.

Numerical Aperture. ($n \sin u = a$)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1·00$).	*Water* ($n = 1·33$).	*Homogeneous Immersion* ($n = 1·52$).	White Light. ($\lambda = 0·5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0·4861\ \mu$, Line F.)	Photography. ($\lambda = 0·4000\ \mu$, near Line *h*.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·739
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·746
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·741
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·763
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·775
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·787
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·800
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·813
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·826
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·840
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·855
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·870
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·885
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·901
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·917
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·935
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·952
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·971
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·990
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·010
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·031
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·053
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·075
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1 087
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·099

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle (2 u) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\,\mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\,\mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\,\mu$, near Line h.)		
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·124
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
0·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
0·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
0·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43,179	·116	2·941
0·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3·125
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
0·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
0·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
0·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
0·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
0·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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[1. Application of mineralogical and chemical methods to microscopical study. By A. M. Lévy. 2. Physical and optical facts. By A. M. Lévy and A. Lacroix. (Microscopes and Comparator, pp. 54–9, 4 figs.).]
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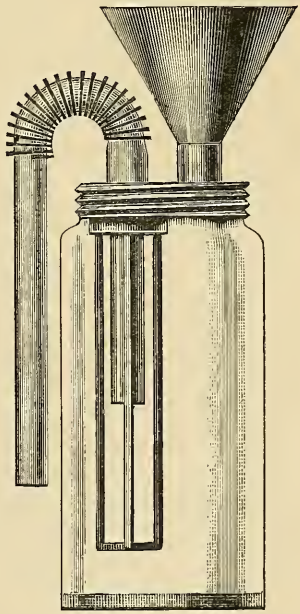
β. Technique.*

(1) Collecting Objects, including Culture Processes.

Improved Form of the "Wright" Collecting Bottle.†—The bottle I now use, says Dr. H. N. Lyon, is made of an ordinary metal-top fruit jar (fig. 55). In the cover are two holes. In one is soldered a funnel for the entrance of the water. In the other is a tube about half an inch in diameter. This tube reaches half-way to the bottom of the bottle on the inside, and extends far enough above the cover for a piece of rubber tubing to be firmly fastened to it. Surrounding the tube is a square frame reaching almost to the bottom of the bottle, made of four brass rods. This is covered for three-quarters of an inch at the upper end by a brass ferrule soldered to the rods and to the cover.

FIG. 55.



The strainer, which is of fine muslin, is made like a long narrow bag, and is drawn over the frame and secured by a thread passing round the ferrule. A rubber tube is attached to the outer end of the central brass tube, and a spiral spring is slipped over it to keep it from bending too short. This tube reaches about an inch below the bottom of the inner tube, and serves as a siphon to draw off the surplus water. It is self-acting, starting when the water in the funnel reaches the level of the highest

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Queen's Micr. Bull., v. (1888) p. 33 (1 fig.).

part of the bend in the siphon; it continues to act until the level of the water reaches the bottom of the inside tube. From four years' experience the author asserts that this strainer never becomes clogged.

Culture of Fungus of Favus (Achorion Schonleinii).*—Dr. A. J. Munnich obtained beautiful cultivations of the Favus fungus upon Löffler's alkaline-gelatin-agar, with 1 per cent. grape sugar, hydrocele-agar, and upon blood-serum. It grew most quickly and luxuriantly on meat-pepton-agar acidulated with lactic acid.

Pure cultivations were only obtained by taking the root of a hair, which had been cut off with every care from a scalp previously well cleaned, and dropping it into tubes of fluid gelatin or agar. Other methods such as plate cultivations and the like were always complicated with all sorts of fungi. Achorion grows best at 30°, and only slowly at 22°. The mycelium consists of filaments of different lengths and thicknesses, which end terminally in spheroidal or somewhat flattened expansions, or in bodies somewhat resembling the oogonia of Saprolegnia. There are also other bodies, perhaps sclerotia; these are large and small, flat or round, oval or reniform. Inoculation of the cultivations on animals were unsuccessful.

Ordinary Foodstuff as Media for propagating Pathogenic Micro-organisms.†—Prof. A. Celli has made some experiments to ascertain how far our ordinary foodstuffs offer suitable conditions for the growth and multiplication of pathogenic micro-organisms. The experiments were made from pure cultivations of the bacilli of anthrax, typhoid, Asiatic cholera, *Staphylococcus pyogenes aureus*, bacteria of fowl-cholera, glanders, streptococci of erysipelas, and Finkler-Prior's vibrio, partly on sterilized and partly on unsterilized media. These media were egg-albumen, meats fresh, boiled, salted, smoked, and roasted, ricotta (buttermilk curd), various cheeses, and some fruits, apples, pears, melons, and pumpkins. The conclusion drawn is that it is quite possible that our foods may become the vehicle for the spread of infectious diseases. Although most of the results might have been anticipated from *à priori* considerations, others are worth mentioning. Thus, fresh meat, when dried, loses its nutritive capacity. The cholera vibrio dies in twelve hours on boiled ham, and in six hours on saveloys, while the typhoid bacillus retains its viability for about a month, and anthrax for about two and a half months. On ricotta, typhoid germs were still viable after five days, while cholera vibrios were no longer so. On uncooked cheese, the viability of cholera germs was found to be impaired in twelve hours, while those of typhoid, anthrax, aud of *Staphylococcus* retained their activity after seventeen days. On sterilized cheese, cholera germs did not seem to be able to obtain a foothold. On apples and pears, cultivations of typhoid bacilli and *Staphylococcus* did not thrive, and cholera bacilli were only recognizable microscopically; the latter seemed to lose in six to twenty hours their power of reproduction on transference to other media, although they retained their characteristic form, even if the fruit were dried. On pumpkins and melons, the bacteria of typhoid, anthrax, and cholera, and *Staphylococcus* kept pure up to six

* Archiv f. Hygiene, viii. (1888) p. 246.

† Bull. R. Accad. Med. Roma, 1888. Cf. Centralbl. f. Bacteriol. u. Parasitenk., v. (1889) pp. 159–61.

hours, that is to say, pure cultivations could be obtained by transference to gelatin. After about six hours the colonies were no longer pure.

Solid Media prepared from Milk.*—Dr. Van Puteren produces solid media for the cultivation of micro-organisms from milk in the following manner. The milk is evaporated with rennet which contains no pepsin, and it is then filtered in a vacuum. This procedure will produce a sufficiently transparent medium in 3/4 to 1 hour, and if gelatin or agar be added, in 1½ to 2 hours a crystal clear medium is obtained. The milk whey is prepared as follows. 1 litre of skim milk is poured into a tin saucepan holding 1½ litre ; to this is added 5–6 ccm. of rennet essence, and the mixture warmed over a Bunsen's burner to 40°–42°. When coagulation has set in (3–5 minutes) the mixture is filtered through gauze folded eight times. The filtrate, amounting to 860–880 ccm., is repoured into the saucepan, and 6 to 10 per cent. dry gelatin and the albumen of two eggs added. When dissolved the fluid is again filtered, and 2 per cent. of sodium albuminate is added. It is then neutralized with a weak solution of caustic potash, and afterwards filtered through a simple cotton-wool filter moistened with hot water in an exhausted space. 100 ccm. of distilled water are afterwards added to make up for the loss in boiling. The filtrate sets well, and is suitable for all bacteriological work. If a crystal clear solution be desired the filtration as before must be repeated, and afterwards through a paper filter on a Plantamour's hot funnel.

Another solid medium is made with agar. The same procedure is adopted, the only differences being that 1 per cent. of agar is added to the filtrate and 1 per cent. of sodium albuminate.

A list of some thirty micro-organisms examined on these media is given. The list includes Blastomycetes, Hyphomycetes, and Schizomycetes.

(2) Preparing Objects.

Demonstrating Transverse Striations in Axis-cylinders and Nerve-cells.†—M. J. Jakimovitch, who has been examining by the silver method the transverse striations on the axis-cylinders of the central and peripheral fibres, has found that similar striations exist in the large nerve-cells of the anterior cornua. The following method is recommended:—

Very small pieces of nerve or spinal cord from a recently killed and healthy animal are placed in silver solution in the dark. For the central nerves the solution should be 1/4 per cent., for the peripheral 1/2 per cent., and for the nerve-cells 1 per cent. The nerves are left 24 hours, the cells 48 hours in the solution. The preparations are then carefully washed in water and exposed in this to the light. When the preparation has become of a dark brown colour it is placed in a mixture of formic acid (1 part), amyl-alcohol (1 part), and water (100 parts). The object exposed to the light in this mixture for 2 or 3 days at first becomes brighter, a part of the reduced silver being dissolved; hence the mixture must be renewed from time to time. When all the silver has dissolved a darker colour is permanently assumed. The nerve-cells are left in this mixture for 5 to 7 days.

* Wratsch (Russian), 1888, No. 15. Cf. Centralbl. f. Bacteriol. u. Parasitenk., v. (1889) p. 181.

† Journ. de l'Anat. et de la Physiol., xxiii. (1888) pp. 142–67 (1 pl.).

Preparations thus made are teased out in a drop of dilute glycerin, or they may be sectioned after hardening in spirit.

Macerating Fluid for Nerve-cells.*—Dr. G. C. Freeborn obtains nerve-cells from the spinal cord in the following manner:—Thin slices of spinal cord or cerebellum not over 1/16 in. thick are placed in fifty times their volume of a 5 per cent. aqueous solution of potassium chromate for 24 hours. At the end of this time the grey matter has become jelly-like and transparent, and then, having been cut away from the white, is placed in a long narrow tube. Mohr's burette with the lower end plugged with a cork answers the purpose perfectly. The burette is then filled up to within an inch of the top with fresh macerating fluid and a cork forced in until it comes within 1/2 in. of the surface of the fluid. The burette is then inverted, and this manipulation is repeated at intervals of half an hour until the bits of tissue are reduced to powder. The burette is then placed upright, and when the material has all settled the fluid is poured off. The material is then carefully washed with distilled water by repeated decantation, and finally poured into a conical glass burette. The water is then poured off and the material stained with picro- or ammonia-carmine. This, which takes from 12 to 15 hours, is followed by washing in distilled water and preservation in a mixture of 1 part spirit and 3 parts glycerin.

By this method cells from spinal cord and cerebellum may be obtained with their processes attached down to the fourth division.

Preparing small Intestine.†—For hardening the small intestine in order to examine the epithelium, Dr. R. Heidenhain recommends a saturated aqueous solution of picric acid, alcohol or chromic acid, then alcohol. Sections parallel or vertical to the surface show bridges of protoplasm uniting the adjacent cells. In order to render the rodlets clearly visible, pieces of intestine on the cells are placed for a day in a 5 per cent. solution of chromate of ammonia. In the fresh villi similar results can be obtained by placing pieces of the fresh mucosa in about 2 per cent. salt solution (1–3 per cent. according to the animal) for 15 to 20 minutes, then fixing in 0·1–0·2 per cent. osmic acid, and isolating the cells in order to examine the relation of the rodlets to the protoplasm. To show the nodular thickenings at the lower end of the rodlets, the mucosa is best hardened in alcohol and stained with hæmatoxylin and chromate of potash.

In order to differentiate by staining the separate elements in the villous stroma the following method is said to be very good. The pieces of intestine taken from a recently killed animal are placed for 24 hours in a half per cent. salt solution saturated with sublimate. They are then transferred every 24 hours to alcohol of 80, 90, 97, and 100 per cent. The pieces are then treated with xylol, imbedded in paraffin, and sections 0·005 to 0·01 mm. thick made; these are fixed warm on the slide with 50 per cent. alcohol. It is important that the temperature should not exceed 35° C. or the villous tissue will be much shrunken. Staining on the slide is done with the following solution: orange 100 ccm., acid fuchsin 20 ccm., methyl-green 50 ccm., all saturated solutions. This

* Amer. Mon. Micr. Journ., ix. (1888) pp. 231–2.

† Pflüger's Arch. f. d. Gesammt. Physiol., xliii., Supplement (1888) pp. 1–103 (4 pls.).

mixture is diluted with water in the proportion of 1 to 60–100, in order to stain the sublimate preparation. In order to stain many sections at once, glass troughs 15 cm. long, 2·5 cm. broad, and 5 cm. high were used, and half filled with the staining solution. Herein, the preparations remained for 6 to 24 hours. Excess of the dye was removed with 90 per cent. alcohol, and after dehydration in 98 per cent. spirit and clearing up in xylol, the preparations were mounted in xylol balsam.

It is remarked that in the leucocytes found in the intestinal mucosa black granules become visible after treatment with osmic acid, but as these stained red after the foregoing solution, and were insoluble in ether and xylol, they could not be fat.

Investigation of Nervous Elements of Adductor Muscles of Lamellibranchs.*—Sig. R. Galeazzi made use of the following method in his investigation of the nervous elements of the adductor muscles. The muscles were placed in a mixture of one-third formic acid, and two-thirds water, in order to soften the connective tissue which surrounds the muscular bundles. After ten minutes they were washed with distilled water, and then cut into small pieces in the direction of the longitudinal axis of the muscular fibres; then were put into a 1 per cent. solution of chloride of gold, where they were left till they had a yellowish-orange colour. They were then placed in distilled water, to which a third part of formic acid had been added, and were placed in the shade; after 24 to 36 hours they were coloured dark violet. They were next placed in a mixture of water, glycerin, and nitric acid, and, after 24 to 36 hours, could be easily isolated in glycerin. This method is much to be preferred to that of making sections.

Preparing Musca vomitoria.†—For fixing the chrysalides of flies, Dr. J. van Rees coagulated the albumen by means of warm fluids, water, alcohol of 30 to 100 per cent., and weak chromic acid. Imbedding was effected in paraffin with benzin; sometimes 3 to 5 days were found necessary for saturating with paraffin heated from 52° to 58° C. Ranvier's picrocarmine and Flemming's hæmatoxylin did good service singly or combined, also double staining with hæmatoxylin and eosin, and lithium-carmine.

The logwood staining is made more effective by washing in slightly acidulated 70 per cent. alcohol, and the acid afterwards neutralized in ammoniated alcohol.

For examining the cutaneous muscular system of the larva or chrysalis the author belauds eosin dissolved in oil of cloves.

Examination of Thysanura and Collembola.‡—Dr. J. T. Oudemans dissected with needles living specimens of these insects, under the dissecting Microscope, but he examined them in 15–20 per cent. alcohol, and not in water. The tracheal system was studied in specimens opened in dilute glycerin. Other examples were hardened and cut into sections with Jung's microtome. Hardening was effected by warmed dilute picro-sulphuric acid (1 part acid to 5 parts water), and then by 80, 90, and 100 per cent. alcohol; another method, which had some advantages, was the use of 1 part alcohol 80 per cent., and 1 part alcohol 80 per cent. saturated with sublimate, and later, alcohol as before. To

* Arch. Ital. Biol., x. (1888) p. 389.
† Zool. Jahrb. (Anat. Abth.), iii. (1888) p. 1.
‡ Bijdragen tot de Dierkunde, xvi. (1888) p. 152.

insure rapidity of hardening it is well to remove a part of the chitinous membrane, after the animal has been for a few minutes in the fluid. Sublimate and alcohol with a drop of nitric acid were used for hardening the free enteric canal; for the examination of the eyes use was made of Grenacher's depigmenting mixtures. The staining of sections, which were fixed to the slides by Meijer's albumen, gave better results than staining the whole animal or parts thereof; Weigert's picrocarmine, alum-carmine, and others were used, but hæmatoxylin gave the best results.

Method of investigating Cyclops.*—In his researches into the morphology of *Cyclops* Prof. M. M. Hartog sometimes found it necessary to examine living specimens; undue pressure was avoided by putting under the cover a frond or two of *Lemna;* this arrangement has the advantage that by a push at the edge of the cover the *Cyclops* can be rolled over. The Abbe condenser was found invaluable. For dissection, French spear-head needles were used; the hard parts are best seen in water after treatment of the fresh animal with ammonia. For preservation Giesbrecht's method was used; staining was effected with Mayer's saturated tincture of cochineal in 70 per cent. spirit, or Kleinenberg's hæmatoxylin. For imbedding xylol was used, and paraffin little by little added. Hæmatoxylin is to be preferred for staining, but cochineal runs it close, especially when osmic acid has distinctly browned the specimen, the resulting colours varying from brick-red to chocolate-brown or violet, much like gold chloride. The last-named reagent was not very successful, owing to the tendency of the soft structures to shrink from the cuticle; for rapid staining diluted glycerin and picrocarmine is a useful medium.

Examination of Nematodes.†—Herr N. A. Cobb states that he obtained the most instructive results by dissecting Nematodes under the dissecting Microscope with a needle and a small knife about 1 mm. broad. It is best to cut along the lateral areas. For the examination of the central nervous system of the larger species he took about half a centimetre of the front end of the body and divided it by a longitudinal section in such a way as to get two lateral or, in other cases, dorsal and ventral halves. After removing the œsophagus the pieces were stained and imbedded in Canada balsam. In the case of the smaller free-living species, which it was impossible to dissect, they were either examined alive or after treatment with 1 per cent. osmic acid; the nervous system was most distinct after two or three hours' treatment. A compressorium was sometimes necessary; in its place the use of the following process was often found to be attended with good results. The worm was placed in a drop on a slide; two fine hairs were laid on either side of the drop, and over it a large cover-glass. If the drop of water was not sufficient to fill the space between the slide and the glass the animal could be squeezed between the slide and the cover-glass, and its position altered as might be required by moving the latter.

The preparation of good sections of large Nematodes is not easy, as, after imbedding in paraffin, the object becomes very hard, and sections difficult to cut; in fact, it became evident that good sections could not be obtained in the ordinary way. At last Herr Cobb set his razor perpendicularly to the path of the microtome and cut as quickly as possible;

* Trans. Linn. Soc. Lond.—Zool., v. (1888) pp. 2–3.
† Jenaisch. Zeitschr. f. Naturwiss., xxiii. (1888) pp. 42–3.

by this method he obtained bands consisting of perfect series. The sections were, almost without exception, treated by Schällibaum's method. Double-staining with hæmatoxylin and eosin sometimes gave good results, as did also those reagents with osmic acid added. The last reagent may be recommended for the nervous system, borax-carmine for the generative organs, gold chloride and hæmatoxylin with eosin for the cuticle. The reagents performed their work best when the preparations were placed in the warm oven. For the careful examination of the cuticle, and in the study of the ova, the author made use of a 2 mm. apochromatic immersion lens by Zeiss, the use of which he strongly recommends.

Preparing the Brain of Somomya erythrocephala.*—In order to harden the brain of *Somomya erythrocephala* Dr. J. Cuccati uses Flemming's mixture for 24 hours, or Rabl's fluid. In order that these may penetrate the head quickly he cuts away part of the cuticle and of the front of the mouth, and thus exposes the air-spaces in the head. In order to keep the heads immersed they were placed in test-tubes plugged with perforated discs of elder-pith. After hardening they were washed for a quarter of an hour, and then transferred to spirit of 36 and 40 per cent. for half an hour. This was followed by a mixture of spirit and chloroform for 12 hours. They were then imbedded in paraffin, and the chloroform slowly evaporated. The sections were stuck on with Meyer's albumen, then transferred to alcohol and water, and next stained with the following solution:—acid fuchsin, 3 grm.; distilled water, 100 ccm.; chloral hydrate, 1 grm. In half an hour they were stained, and then washed for 10 minutes in water, and having been dehydrated in alcohol were passed through oil of cloves and mounted in Canada balsam.

Preparing Megastoma entericum.†—Dr. B. Grassi and W. Schewiakoff, on examining *Megastoma entericum*, found that these endoparasitic Flagellata became detached from the epithelial cells of the small intestine (rats and mice), swam about, and died. They avoided this by scraping off the villi and teasing them out in an artificial serum composed of albumen 20 ccm., water 200 ccm., salt 1 gr. The animals were then killed in the vapour of osmic acid slightly warmed, and treated with a 10 per cent. soda solution, in order to examine the cilia, flagella, and undulating membranes. Staining of the nuclei was difficult, the best results being from Brass's acid carmine and hæmatoxylin. Previous treatment with Flemming's chrom-osmium-acetic acid was found to be advantageous.

Preparation of Muscineæ.‡—M. Amann prepares the peristome and leaves in the following manner. The two halves of the moistened capsule divided longitudinally are placed in a drop of a mixture of equal parts pure glycerin and strong carbolic acid. A cover-glass is imposed, and the slide heated with a spirit-lamp until the fluid boils and all the air-bubbles have disappeared.

Preparations thus mounted in carbolated glycerin may be preserved for years if kept in a dust-tight box, and the liquid which evaporates in the course of the first few days replaced.

* Zeitschr. f. Wiss. Zool., xlvi. (1888) pp. 240– (2 pls.). See this Journal, 1888, p. 944.

† Zeitschr. f. Wiss. Zool., xlvi. (1888) pp. 143–54 (1 pl.). Cf. this Journal, 1888, p. 599.

‡ Journ. de Micrographie, xii. (1888) pp. 527–9. Rev. Bryol., xv. (1888) pp. 81–3.

If a more stable mounting is desired, proceed as before, and then cover the specimen with a drop of carbolated gum, after which the cover-glass is put on. This medium is preferable to glycerin jelly, as it is manipulated cold. The gum is made as follows. Best white gum-arabic 5 grm., distilled water 5 grm. After the gum has dissolved add 10 drops of carbolated glycerin and warm gently until the fluid clears.

The author states that with a little practice very good sections can be made by merely placing the object moistened with water on the thumbnail of the left hand and chopping at it with a razor.

The sections are put in a drop of carbolated glycerin on a slide between two cover-glasses, and covered with a third cover-glass, so that the latter is supported by the two former. This renders their manipulation easy.

For bringing out the details of the structure of the peristome, and to distinguish certain cell-walls, the author uses a dilute solution of perchloride of iron (officinal solution of perchloride 1 part, distilled water 9 parts).

Clearing recent Diatomaceous Material.*—The preparatory clearing, says Mr. F. W. Weir, must of course vary with the nature of the material. A poor gathering, requiring a quart or two of material to commence with, and consisting chiefly of coarse sand, should be placed in a large pail of water, and stirred with a very rapid rotary motion, allowed to settle a moment, poured off and saved. This process should be repeated until the portion saved is sufficiently concentrated to be suitable for further treatment. If the collection is comparatively rich, and consists of the usual marsh deposit, it should be at once subjected to acid treatment, with, however, a thorough washing with salt. In order not to lose any diatoms it is often necessary to use the filter. For acid treatment the author prefers sulphuric acid and bichromate of potash. Place the wet material in a porcelain vessel; add about half as much powdered bichromate of potash as there is material; while stirring pour in sulphuric acid slowly, but with increasing rapidity. Allow the acid to cool, and pour into a gallon jar of filtered water. When thoroughly settled draw off the liquid with a siphon, repeating the process until the acid is entirely removed. If the acid clearing have been complete, there will now remain undesirable matter of three kinds, coarse sand, fine sand, and fine amorphous matter, which must be removed in three ways: coarse sand by centrifugal force, fine sand by friction, and amorphous sand by gravity.

Place a proportionate quantity of the material in a small tumbler; between the thumb and finger take a glass rod about 10 inches long, suspend with lower end in the glass, and by giving the hand a rotary motion in a small circle, cause the lower end of the rod to travel round the periphery of the bottom of the glass with the utmost possible speed. This keeps up the coarse sand in the centre, and the remainder may be drawn off before settling with a siphon applied to the edge of the bottom of the glass. Repeat the process until nothing but sand remains. Take the settlings and go through a similar process until sand no longer collects in the centre of the glass.

Now place the material in a wide-mouthed vial of suitable size. Fill the vial two-thirds full of filtered water and shake vigorously. Allow

* The Microscope, ix. (1889) pp. 1–4.

to settle for ten minutes, then draw off the water with the siphon and repeat the process until perfectly clear.

Next attack the fine sand. Take a shallow glass dish with very slightly concave bottom (a photographer's "bender" is most suitable), and place in it a quantity of the material not sufficiently great to heap up much. Separation is effected by rocking and tipping and shaking gently from side to side. As the diatoms are separated from the sand, draw them off with a pipette, add more water, and continue until none are left; repeat the process until all the sand is removed. Next allow to settle until all forms desired in a given settling are precipitated, draw off the water into a larger vessel, fill up the vial, shake and settle the same length of time as before, and continue until everything which will not settle in that time is washed out. The material will then be finished. Then take the residue, shake and settle longer, to deposit the next smaller forms desired. Proceed thus until all the forms are separated. If it be not desired to separate the different forms, but only to remove any fine particles which may remain, simply shake the vial vigorously, allow the material to settle until the Microscope shows that all the diatoms have sunk, siphon off the water and renew it, adding a few drops of ammonia, and repeat until all is clear, always replacing the filtered with distilled water in the last three or four shakings. As a mounting medium the author considers that styrax properly prepared is superior to any other and that no cement is better than hard oil finish. This, with the addition of finest dry lampblack, makes a cement that is not excelled.

Chitin Solvents.*—Mr. T. H. Morgan uses the Labaraque and Javelle solutions (potassium and sodium hypochlorites) for dissolving the chitinous parts of insects, so that they may be sectioned and rendered penetrable to staining fluids. The material, say the eggs of the common cockroach surrounded by the chitinous raft, is placed in the Labaraque solution, diluted five or six times, and slightly warmed for thirty minutes to an hour. The embryos are, after being well washed, then transferred to picrosulphuric acid, then to alcohols up to 95 per cent., then imbedded in paraffin cemented on the slide, and stained on the slide.

Corrosive sublimate and chromic acid were also used, but with less satisfactory results. Embryos transferred directly from Javelle solution to alcohol were nearly as good as those put through picrosulphuric acid.

Benda, C. — **Makroskopische und mikroskopische Präparate für eine neue Härtungsmethode.** (Macroscopical and microscopical preparations for a new hardening process.)
Anat. Anzeig., III. (1888) p. 706.
(*Verh. Anat. Gesellsch. Würzburg.*)

Greppin, L.—**Mittheilungen über einige der neueren Untersuchungsmethoden des Centralen Nervensystems.** (Notes on some of the recent methods of investigating the central nervous system.)
Corrbl. Schweizer Aerzte, XVIII. (1888) No. 16.

Mosso, A.—**Esame critico dei metodi adoperati per studiare i corpuscoli del sangue.** (Critical investigation of the methods used in the study of the blood-corpuscles.)
Atti R. Accad. Lincei—Rend., IV. (1888) pp. 427–33.

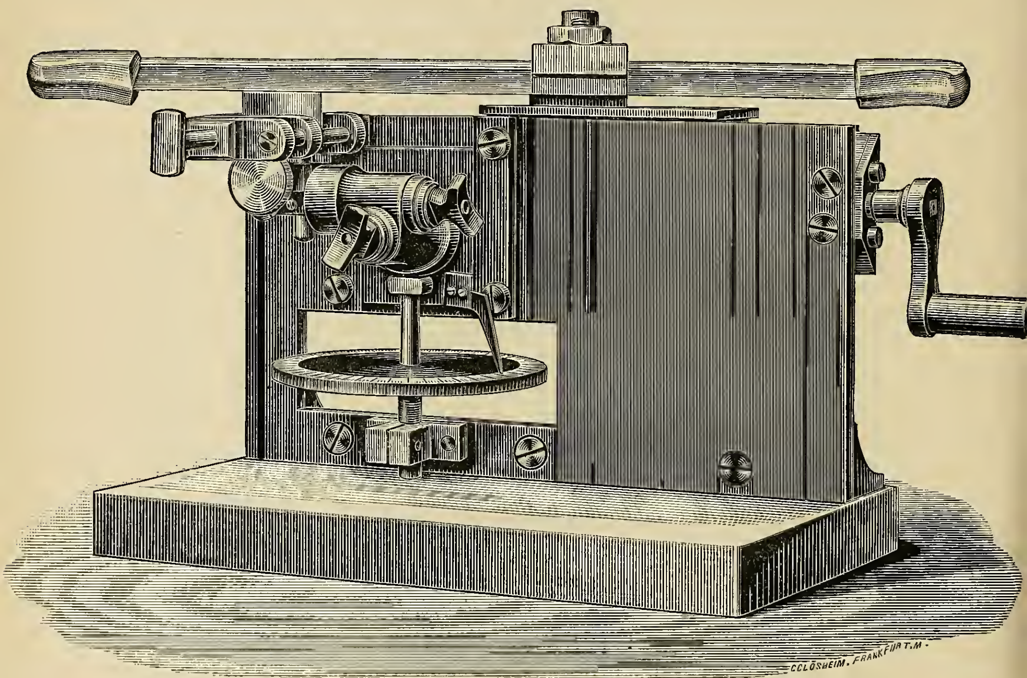
„ „ **Kritische Untersuchung der beim Studium der Blutkörperchen befolgten Methoden.** (Critical investigation of the methods used in the study of the blood-corpuscles.)
Virchow's Archiv, CXIII. (1888) p. 410.

* Amer. Mon. Micr. Journ., ix. (1888) p. 234.

(3) Cutting, including Imbedding and Microtomes.

Leitz's "Support" Microtome.—The speciality of this microtome (fig. 56) which is on the Schanze model, consists in the motion given to

Fig. 56.



the knife, which is not actuated by hand, but by the handle seen on the right, by which the knife is made to pass over the section.

Taylor's Combination Microtome.*—Dr. T. Taylor's microtome is adapted to three methods of section cuttings. The instrument is of metal screwed to a block of polished mahogany. There is a revolving table with graduated margin in the centre of which is fitted a freezing box having two projecting tubes, one to admit freezing water, the other as an outlet for it. The water is supplied from the reservoir and carried off by means of rubber tubing attached to these metal tubes, the terminal end of the outlet tube being furnished with a small glass tube, by which means a too rapid outflow of water is prevented. The tubes of the freezing box are so arranged as to prevent their revolving with the revolutions of the table.

When ether is used a little brass plug in front of the freezing box is removed and the rubber tubing detached.

In preparing to make sections, remove the freezing box altogether, and in its place substitute a cork, which projects suitably and presents the object from which sections are to be taken, imbedded in wax or paraffin,

* The Microscope, ix. (1889) pp. 4–5 (1 fig.).

at the proper angle to the blade of the knife, regulated by means of the finely cut screw-thread of the table.

The knife is curved, about five inches in length, and about one inch in breadth, ground flat on the under side, and held in position by a binding screw after the fashion of several microtomes now in use. A straight knife may be used if desired.

Substitute for Corks in Imbedding.*—Dr. G. C. Freeborn suggests as a substitute for corks, cylinders of white pine, one inch high, and varying in diameter from half to one and a half inches. These "deck plugs" offer the same advantages as corks for celloidin imbedding, but do not, like corks, get soft in spirit.

HUBRECHT.—**Demonstration des De Groot'schen Mikrotomes.** (Demonstration of the De Groot microtome.)
Anat. Anzeig., III. (1888) p. 722.
(*Verh. Anat. Gesell. Würzburg.*)

"**Microtomes** *ad infinitum* have been invented within the past few years for the purpose of more effectually slicing into infinitesimal and well-nigh invisible sections the 'harmless, necessary cat,' and other animals. This may be called the microtome era of microscopy—microtomes rival camera-lucidas in multitude."
Queen's Micr. Bulletin, V. (1888) p 32.

SCHIEFFERDECKER, P.—**Mittheilungen von den Ausstellungen wissenschaftlicher Apparate auf der Anatomen-Versammlung zu Würzburg und der 61. Versammlung deutscher Naturforscher und Aerzte in Köln im Jahre 1888.** (Notes on the Exhibitions of Scientific Apparatus at the Anatomists' Meeting at Würzburg, and the 61st Meeting of German Naturalists and Physicians at Cologne in 1888.)
[Contains especially notes on the various microtomes at the exhibitions.]
Zeitschr. f. Wiss. Mikr., V. (1888) pp. 471–81 (2 figs.).

(4) Staining and Injecting.

Carminic Acid Stain.†—Dr. G. C. Freeborn recommends Dimmock's solution for histological work. This is a 3/4 per cent. solution of carminic acid in 85 per cent. alcohol. The sections are stained in two to five minutes. If a pure nuclear stain be required, wash in 1 per cent. hydrochloric acid. The solution stains ganglion-cells very well if used in the following manner: sections of central nervous system are overstained in Dimmock's solution, and then washed in a 10 per cent. aqueous or alcoholic solution of the officinal solution of the chloride of iron. Herein the colour of the sections changes from red to black, and as soon as the hue alters to yellow, the section is washed thoroughly in water, dehydrated, cleared in origanum oil, and mounted in balsam.

By this process the nerve-cells and their processes are stained black, the intercellular substance being yellowish.

Staining Connective Tissue with Nigrosin (Indulin, Anilin Blue-black).‡—Dr. G. C. Freeborn recommends nigrosin for staining connective tissue. The solution used is made by mixing 5 ccm. of a 1 per cent. aqueous solution of nigrosin with 45 ccm. of an aqueous solution of picric acid. This makes a dark olive-green fluid. Sections are placed in this solution for three to five minutes, and then washed in water until their colour changes from a yellowish-green to a deep blue. The sections are then dehydrated, cleared in oil of cloves, and mounted in balsam.

After dehydration the sections may be double stained for five or six

* Amer. Mon. Micr. Journ., ix. (1888) p. 232. † Ibid., p. 231.
‡ Ibid., p. 231.

minutes in a mixture of 1 ccm. of a saturated alcoholic solution of eosin and 49 ccm. of 97 per cent. spirit.

Sections by the first method show the connective-tissue fibres stained bright blue, nuclei blackish, all other elements greenish-yellow. In the second method the yellow colour is replaced by red.

Clearing and Staining of Vegetable Preparations.*—In his researches on the development of Vascular Cryptogams,† Dr. D. H. Campbell strongly recommends the practice of imbedding, and cutting with the microtome for similar investigations. In examining the structure of the megaspores of *Pilularia*, the spores were imbedded in paraffin, and then cut with a Cambridge rocking microtome. Schönland's methods, with some simplifications, were used in most cases, but in others the spores were gradually brought into clove-oil, and then into xylol instead of turpentine. This method requires little time, and often gives excellent results, but it is not always to be relied on, though in the early stages it answered very well, and the penetration of the paraffin was facilitated. When chromic acid mixtures were used, the specimens were brought gradually into absolute alcohol, which was then replaced by clove-oil, and finally by a saturated cold solution of paraffin in turpentine, before being placed in the melted paraffin. As a staining agent hæmatoxylin was used to some extent, but the best results were had with safranin and gentian-violet, the latter especially giving particularly beautiful colouring, the nuclei being much better differentiated than with the other colours.

Staining of Vegetable Tissues.‡—M. C. Sauvageau recommends the following process. If a section is treated with concentrated sulphuric acid, the cellulose-walls disappear almost instantly, while the intercellular cuticular coatings (the protoplasmic layer of Russow) remain unaffected, united to one another by the median lamellæ which separate two contiguous cells; but the rounded walls of the cells and of the intercellular canals have become rectilinear. After the action of the sulphuric acid, the delicate network which remains may be stained and preserved in the following way. If some grains of fuchsin are added to the sulphuric acid, the liquid becomes orange-yellow, or even dark brown if the quantity of fuchsin is sufficiently large. A drop of this liquid placed in much water gives it a rose-colour, like that given by a drop of fuchsin to alcohol. The very thin sections are laid in a drop of dark brown sulphuric fuchsin, and covered by a cover-glass. Some drops of water are placed by the side of the cover-glass, and a piece of blotting-paper—which should be made from flax, and not from cellulose, in consequence of the less action upon it of concentrated sulphuric acid—placed on the other side in order to remove the sulphuric acid and replace it by the water, and as this is gradually effected the orange-yellow colour turns gradually to red as if coloured directly by the fuchsin. The section is then composed entirely of the cuticular coatings of the aeriferous canals united by the median lamellæ. If the sections are treated with sulphuric acid and eosin, the cell-walls swell, and the cuticular coating is very clearly distinguished from the cellulose by its greater refringency. The parietal cytoplasm is coloured rose, and the punctations in the cell-walls are readily seen; there are usually one or

* Ann. of Bot., ii. (1888) p. 243.

† See *ante*, p. 254.

‡ Morot's Journ. de Bot., ii. (1888) p. 400.

two very narrow ones in the wall which separates two contiguous cortical cells, but the author has not seen them on the walls which separate cells from aeriferous canals. The observation is rendered easier by immersion for some moments in hæmatoxylin dissolved in alcohol; the protoplasm preserves the rose-colour given to it by the eosin; the cellulose swells and becomes light violet, and the cuticular coatings, the corners, and the median lamellæ are coloured dark violet.

Red Stain for Vegetable Sections.*—Dr. F. L. James says that a beautiful red stain for vegetable sections may be extracted from the parings of wine-sap and other red apples, by absolute alcohol. The paring of a single medium-sized apple gives about 1 drachm of a very deep ruby-coloured solution. The author has experimented but little with the stain, but can say that it is apparently stable.

Staining Bacilli of Rhinoscleroma.†—Dr. G. Melle advises the following new method for staining the bacillus of Rhinoscleroma. The sections are stained for 10–15 minutes in gentian-violet (2 parts gentian violet, 15 alcohol, 100 water), they are then immersed for 2–3 minutes in the iodine solution, and decolorized in absolute alcohol. Decoloration is completed by placing the sections for 1–2 minutes in a 30–40 per cent. nitric acid, and afterwards again in alcohol. The sections are next stained for 4 or 5 minutes in an aqueous solution of safranin. The bacilli are stained violet, and the ground tissue of the cells, &c., red.

By this method of staining the capsule environing the bacilli is not seen, and these are found in collections of 10–40 within the cells.

Injecting and Preparing the Circulatory System of Fishes.‡—For examining the circulatory system, says Dr. P. Mayer, injections are requisite. As the removal of coagula from the vessels of fishes is impossible, it is necessary to take special precautions. For killing the animals the author recommends fresh water, or a strong solution of potassium chloride in fresh water. Before the occurrence of rigor the animal must be cut through close behind the anus, and injected with distilled water or 10 per cent. alcohol. If the vessels be empty of blood the tissues may be allowed to relax, and then injected with soluble Berlin blue of the following composition:—1. Liq. ferri perchlor., 10 ccm.; aq., 500 ccm. 2. Ferrocyanide of potash, 23 g.; aq., 500 ccm.

No. 1 solution is poured into No. 2, and left for 12 hours, the yellow fluid is poured off, and the filtrate washed until it trickles through a deep blue. About 1 litre of injection fluid is thus obtained, and this will keep for about six months. As this gives a precipitate with salts and with blood, the vessel must be well washed out. A slight addition of acetic acid to the injection water is useful as in the presence of alkalies Berlin blue loses colour.

If a greater pressure than usual be required this may be obtained by inserting a 10 litre glass vessel provided with a manometer, in which the air can be compressed by means of a spray bellows. The caudal vessels were injected through the aorta by means of a conical glass cannula, and the superficial vessels from the venæ laterales cutaneæ. The injection completed, the vessel is plugged with a glass cone, and

* The Microscope, ix. (1889) p. 24; from 'National Druggist.'

† Resoconto d. Accad. Med.-Chi. di Napoli, 28 Aug., 1887. Monatschr. f. Prakt. Dermatol., 1888, p. 82.

‡ MT. Zool. Stat. Neapel, viii. (1888) p. 307.

the animal transferred to weak and afterwards to strong spirit. If the skin be softened for about 15 minutes in strong acetic acid, or brushed over with hydrochloric acid, it is easily scraped off, and from young specimens of *Scyllium canicula* can thus be obtained workable preparations of the superficial veins. If the lateral muscles be cut away and the rest mounted in balsam, the deeper vessels are obtained.

Of young animals decalcified with 90 per cent. spirit and nitric acid, sections 1/2 mm. thick are easily made. These are stuck on by Föttinger's method and then stained with weak acid carmine. If picric acid be added to the alcohol for washing and dehydration a picro-carmine stain is obtained. The relations of the valves must be examined in uninjected specimens.

Simple Apparatus for Injecting Fluids for Bacteriological Purposes.*—Dr. R. J. Petri's injector consists of three parts, a needle-cannula, a pipette, and a spray-bellows, the tube of which is fitted with a stopcock. The fluid to be injected is sucked up into the pipette, the needle is then fitted on the point, and the tube of the spray-bellows adjusted at the other end. The stopcock is turned off up till now. Then the web-covered ball is distended and the cock turned on. This is found to give sufficient force to inject 5 ccm. of fluid. In case of bellows not being at hand the fluid may be blown in.

BRÜCKE.—**Ueber das Verhalten des Congo-rothes gegen einige Säuren und Salze.** (On the behaviour of congo-red with some acids and salts.)
SB. K. Akad. Wiss., XCVII. (1888) p. 5.

DOR, L.—**Méthode de Coloration rapide des Bacilles de la tuberculose et de la lèpre.** (Method of rapidly staining the bacilli of tuberculosis and leprosy.)
Lyon Méd., 1888, No. 18.
Centralbl. Klin. Med., 1888, p. 573.

FERRIA, L.—See Griesbach, H.

GRIESBACH, H.—**Demonstration mikroskopischer Tinctionspräparate.** (Demonstration of microscopical stained preparations.)
Anat. Anzeig., III. (1888) p. 745.
(*Verh. Anat. Gesellsch. Würzburg.*)

„ „ **Kurze Bemerkung zu Dott. L. Ferria's Mittheilung: 'La colorazione delle fibre elastiche coll' acido cromico e colla safranina.'** (Short note on Dr. L. Ferria's article, 'The staining of elastic fibres with chromic acid and safranin.')
And reply by Dr. L. Ferria.
Zeitschr. f. Wiss. Mikr., V. (1888) pp. 486–90 and 490–1.

KLAATSCH.—**Doppelfärbung von Ossifications-schnitten.** (Double staining of ossification sections.)
Anat. Anzeig., III. (1888) p. 722.
(*Verhandl. Anat. Gesellsch. Würzburg.*)

(5) Mounting, including Slides, Preservative Fluids, &c.

Fixing Objects to Cover-glasses.†—Dr. Von Sehlen fixes samples of fluids or any non-viscous matter to cover-glasses by means of albumen. The albumen mixture is made by mixing the white of an egg with an equal quantity of cold saturated boracic acid solution (about 4 per cent. of the acid). If after being kept a precipitate is thrown down, the solution is cleared by filtration.

The solution is merely dropped on a cover-glass, and then some of the material to be examined is intimately mixed with it. An even layer

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 785–7 (3 figs.).
† Ibid., pp. 685–7.

is then made in the usual manner, and the cover-glass dried in the air and fixed in the flame.

Glycerin Mounts.*—G. H. C. says that for this purpose it is best to use a cell made of hard rubber, unless the object be very thin, in which case cement cells may answer, but they should be at least two or three weeks old, otherwise the cement in drying may shrink, so that the cell becomes too small to contain all the glycerin, part of which may thus be forced out and rupture the mount. Clean the cover, and having centered the slide on the turntable run a ring of fresh cement tolerably thick around the top of the cell, and as quickly as possible put in the glycerin, about a drop more than enough to fill the cell up level. Run a needle around inside the cell to draw the glycerin quite up to the cement all round but not on to it, otherwise you may have trouble with bubbles. Put in the object and arrange it as quickly as possible. Take the cover between the thumb and the forefinger, wipe the cement, brush so that there is no excess of cement on it, and draw a ring of about 1/16 in. wide round the cover. Take it in the tweezers at the place where the cement is widest, not letting the points extend any further into the ring of cement than is unavoidable, breathe on the cover, invert it over the cell, and press down all round with a needle-handle. Rinse off the excess of glycerin with clear water and dry with blotting-paper. You may ring round afterwards or not as you please, but if you have been quick enough not to give the cement time to dry they will be tight and permanent.

BECK, J. D.—**A beautiful and durable Cement for ringing Balsam Mounts.**
["To a thick solution of gum arabic add a little glycerin to prevent cracking. Ring balsam mounts with this first, then finish with the cement coloured with magenta, or fuchsin, or the 'Diamond' black dye dissolved in water. Ornament with gold paint, &c., and finish with Winsor and Newton's mastic picture varnish. Try cement on a blank slide; if brittle when hard, add a little more glycerin, so that it will harden in twenty-four hours without brittleness."]
The Microscope, IX. (1889) p. 18.

BENEDIKT und EHRLICH.—**Zur Kenntniss des Schellacks.** (On shellac.)
SB. K. Akad. Wiss. Wien, XCVII. (1888) p. 127.

Cement ("inside") for Balsam Mounts.
[(1) Clear shellac cement, or colourless marine glue. (2) Seiler's gelatin cement.]
Queen's Micr. Bulletin, V. (1888) p. 45.

Dry Mounts. *Ibid.*, p. 25.

(6) Miscellaneous.

Practical Utility of the Microscope to Textile Workers.†—A question arising as to whether a large lot of yarn delivered at a mill equalled in quality the sample lot on which the order was based, tests were made as follows:—In lot No. 1, fifty fibres averaged under the Microscope 1/1265 in. in diameter. In lot 2, fifty fibres averaged 1/1260 in. in diameter. Of lot 1, thirty-six fibres, and of lot 2, thirty-five fibres, ranged in diameter between and including 1/1500 and 1/1200 in., showing a most remarkably close approach in quality of a large delivery to the sample order.

Sixteen loose outside fibres from a two-ply No. 40 worsted yarn,

* Queen's Micr. Bulletin, v. (1888) p. 42.
† T. c., p. 19.

averaged 1/833 in. in diameter, while ten ditto from a two-ply No. 28 worsted yarn averaged 1/833 in. Both yarns were from one spinner and both (as was afterwards discovered) made of three-eighths blood wool, which fact explains the exact correspondence in diameter as above.

The superintendent of one of the largest mills in New England uses the camera lucida for microscopic measurement of fibres, by a method effecting great saving of time and eyesight. His mill sorts wool into eight different sorts, and he states a good sorter has no difficulty in determining one quality from another, wherein the difference as between two sorts is measured by less than 1/1000 in. in average diameter of fibres, which fact he has determined with the Microscope. A large establishment giving him a sample of foreign cloth to duplicate, he ascertained by the camera lucida method the quality of wool in both warp and weft threads, and knowing from previous records the measurements of his own mill's sortings of wool, was thus enabled to pick out from stock on hand what would give, when worked up, a practical duplicate of the foreign fabric.

The condition as to health or disease in wool fibres, the freedom from or appearance of previous manipulation (as in shoddy yarns), the lumpiness apt to prevail in yarns constituted largely of noils (fine waste stock), the adulteration of yarns by the smuggling of cheaper materials into wool, silk, &c. (the Microscope led to detection of fifteen per cent. cotton in a so-thought worsted yarn), the source of foreign matters found on the face of cloth, as discovered when dyed, whether cotton off the spinning machinery or flax from the twine of the wool-sacks, or grasses from the sheep pastures, all these are matters largely determinable through the use of the Microscope, which it is considered will be more and more generally employed in textile industries, as competition becomes intense and general culture advances.

The writer concludes:—"As to the use of the Microscope on made-up goods this is microscopy in the gross, and is, I fancy, mainly confined to thread-counting. Consult some maker of fine cassimeres. A woman with a fifty-cent thread-counter can, I take it, distinguish much better as to the quality of two pieces of muslin or linen, by simply counting the threads to the quarter-inch, than she could by feel or naked eye."

Value of the Microscopic Analysis of Rocks.*—M. A. Renard in a lecture at the Royal Institution said:—"Our knowledge of eruptive rocks came to be enriched in an unexpected manner by the application of the Microscope to lithology. We need not here recall the almost marvellous results obtained by this method of investigation, inaugurated by Mr. H. C. Sorby, but we may say, in a word, that the microscopic analysis of rocks has changed the face of petrography. Let us confine our attention to some of the conceptions relating to modern volcanic rocks, as revealed by these new methods, methods which in delicacy, in certainty, and in elegance, are unsurpassed in any other branch of natural science. Not only have they enabled us to verify and control hypotheses, but they have led to the remarkable discoveries to which I am about to refer.

The eye, assisted even by the most powerful lenses, could recognize in lavas only those minerals which appeared in rather large crystals;

* Nature, xxxix. (1889) pp. 271–7.

chemical analysis generally gave merely the composition of the total rock, and its mineralogical composition was only suspected. The intimate texture of the rock remained impenetrable; it was impossible to determine with certainty the order in which the constituents of the molten mass had solidified; neither could we trace the various states through which the crystals had passed—their germs, primordial forms, and skeletons—or the aspect of the rock at different stages of its development.

Let us now apply the Microscope to the examination of a thin slice of lava, rendered transparent by polishing. The lavas, as we have said, may be compared to vitreous masses; but whilst in our artificial glasses we seek to obtain a pellucid and homogeneous product, the liquefied matter of volcanoes, when it flows forth, already contains certain differentiated products. The glass which contains these bodies may be regarded as the residue of the crystallization, whence the numerous crystalline individuals have extracted their constituent elements. In the black, brilliant, volcanic glasses, apparently opaque and destitute of crystallization, the Microscope discovers a world of mineral forms. It shows us their various states of growth, and the arrest of their development, consequent on the more or less rapid consolidation of the mass. It is especially in those rocks which, like obsidian, have preserved almost wholly their vitreous character, and are homogeneous to the naked eye, that we find the rudimentary crystals of curious form, representing the first step in the passage of the amorphous matter to the crystalline condition. Owing to the rapidity with which the vitreous paste consolidated, the crystals were unable to grow, and their development was sharply arrested. Hence the origin of these embryonic crystals which abound in natural glasses, and which we designate as *crystallites*. Analogous crystallites are produced in blast furnace slags, which have close relations to the matter of lavas. Their common origin is betrayed by certain family likenesses which the Microscope reveals. The slags, examined in thin sections, exhibit rudimentary crystalline forms, similar to the crystallites of volcanic glasses.

But usually the crystals have not remained in this embryonic state. If the lava has not been too rapidly cooled, the molecular movements are retained, even in a semi-liquid mass, and the paste developes crystals of minute dimensions, called *microlites*. These microscopic crystals are formed in the heart of the vitreous magma during its slow consolidation. Notwithstanding their infinite minuteness, these small polyhedra exhibit with marvellous exactitude all their specific characteristics, such as we are familar with in much larger crystals, and which we should not expect to find in lavas. They often form by their interlacement a beautiful network in the microlitic structure.

The dimensions of these microlites, invariably microscopic, and their arrangement, prove that they may be referred to a period of disturbance; that they were formed, indeed, at a time when the lava, though still in motion, was solidifying. They separated from the magma during the very act of outflow or eruption.

Besides these microscopic crystals and these groups of crystallites, which belong to the last stage of consolidation, the lava contains also a supply of larger crystals, more fully developed, and in many cases recognizable by the naked eye. These have been formed under calmer conditions, analogous to those presented by a tranquil fluid in which crystallization is proceeding slowly. They were formed in the molten magma when it was still inclosed in the subterranean reservoirs. This slow growth is clearly proved by the formation of the crystals in concentric zones, and by their size. These large crystals, existing ready formed in the lava at the time of its eruption, are surrounded by microlites or by a vitreous mass. It was after their slow development in the magma, during an intra-telluric period, that the mass in which they floated was upraised. The period of calm was succeeded by one of agitation, and the lava in its violent ejection carried forth the crystals, breaking them, corroding them, and partially fusing them. The Microscope offers distinct evidence of these phenomena. We see the large crystals dislocated and their fragments dispersed, their edges rounded and eroded, and their substance invaded and penetrated by the paste.

While the physical and chemical agencies brought into play by the movement of the lava thus attack the ancient crystals to the verge of demolition, the microlites are in course of formation. This vitreous matter, in which the large crystals float, solidifies as a mass of microscopic individuals. The latter are therefore related to a second phase of crystallization: they are developed in a moving viscous magma, and their further growth is arrested by the rapid cooling which induces solidification *en masse.*

The fluidal arrangement of the microlites distinctly shows, too, that the crystalline action was contemporaneous with the movement of the lava-flow. Indeed, we see in microscopic preparations that the microlites are accumulated around the large sections of crystals, forming wavy trains and presenting the arrangement which micrographers designate as *fluidal structure.* It is marked by the orientation of these infinitely small acicular crystals. When these streams of microlites meet the large imbedded crystals, they sweep round them, crowding into the spaces between the large sections, accommodating their flow to these outlines, and preserving for us the last movement of the mass at the very moment of solidification.

The Microscope, therefore, proves that crystallization in lavas belongs to two periods: the first, anterior to the eruption, during which the large crystals already found are suspended in a mass that we may regard as entirely vitreous; and the second period, when the microlites and embryonic crystalline forms are separated, dating from the ejection or outflow, and contemporaneous with the solidification of the rock.

From these microscopic observations on the crystals of the second period, we may conclude that they are formed purely and simply by igneous action, without requiring the hypothetical temperatures and pressures formerly considered necessary, and without that absolute repose regarded as needful for the regular crystallization of minerals. We see, indeed, that the microlites are formed after the outflow, at the normal barometric pressure and at a temperature far from being as high as generally supposed, and we witness the births of the crystals during the very flow of the lava stream. When the cooling is extremely rapid, the microlites have no time to form, and the lava can produce only crystallites.

But the Microscope enables us to determine the chronology of the crystals in lava in a still more detailed manner. We have already distinguished two great periods in their history; let us now indicate in a general way how we may establish, to some extent, the date at which each species of the two groups is separated from the magma. Data leading to the determination of their relative age are afforded by their inclusions.

A crystal developed in a vitreous mass frequently incloses particles of the medium in which it grows. In this way certain sections under the Microscope appear penetrated with vitreous grains, imprisoned in the interior of the crystals and frequently arranged along the zones of successive growth. These inclusions prove that the crystals in question were formed in a vitreous mass, liquefied by heat. In other cases the inclusions are mineral species in the form of microlites; and it is clear that they must have been anterior in date to the mineral in which they are inclosed. Finally, in other cases, a species will mould itself around sharply defined crystals, conforming to other outlines, and filling up all the spaces between the minerals, thus showing that the crystals are of earlier origin than the surrounding mineral.

From these facts, which speak for themselves, we have been able to draw up chronological lists indicating the relative date of crystallization of each species of the two great periods. I will not stop to cite these lists, but we shall soon see how the law which governs the successive formation of the crystals, and their relative age, is evolved from synthetic experiments.

I have traced in broad outline the history of a lava, but have sketched only a few of the details which modern researches on lithological phenomena have developed with such startling reality; nevertheless, what we have seen is sufficient to show in a striking manner the power of analysis when supported by reasoning. I think I am not wrong in saying that from this point of view the study of a lava presents one of the finest examples of the application of the inductive method to the natural sciences. We hardly know whether to admire most the analytical processes, or the subtilty of observation, or the logical method by which the observed phenomena have been brought into connection.

Microscopic analysis, powerful as a method of investigation, has enabled us to trace, with close exactitude, the progress of crystallization in a rock where the unaided eye could discover only an indistinct and uniform mass; to penetrate into this marvellous tissue of volcanic products, where millions of polyhedra occur within the volume of a cubic centimetre; to determine, with mathematical precision, the nature of each of these infinitively small bodies; to track them to their birth, and follow them throughout their development, tracing all the modifications to which they have been subjected under the influence of physical and chemical agents."

"The great improvements in the construction of apparatus, and the application of the Microscope to lithology, have at length enabled us to successfully attempt the reproduction of all the modern volcanic rocks."

Microscopical Examination of Urine for Bacteria.*—Dr. von Sehlen recommends the addition of boracic acid to urine, as it does not precipitate the albumen, and acts as an antiseptic, thus preserving the urine and its sediment for future examination. The solution is made by dissolving 8 per cent. borax in hot water, then adding 12 per cent.

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 687-9, 722-4.

boracic acid, and afterwards 4 per cent. more borax. On cooling, the excess of the salt crystallizes out. In practice, 20 to 30 per cent. of this solution is added to the urine, so that the latter contains from 2 to 4 per cent. of boracic acid.

Action of Bleaching Agents on Glass.*—Prof. H. M. Whelpley calls attention to the fact that the ordinary bleaching agents employed in microscopy will corrode the glass of the solid watch-glasses sold for microscopic purposes. The action of those agents turns the glass opaque, and renders them unfit for use on the stage of the Microscope, where they are often employed, in low powers, in the examination of transparent bodies.

Micro-organisms of the Bible.†—C. W. S. points out that the lips are most sensitive to the reception of disease germs, and from the motly throng of dirty and diseased persons who appear in court and kiss the Bible, what infectious germs may not be obtained through this medium of distribution? It would be interesting for microscopists to examine such greasy and worn backs of court bibles as they can have access to, and to report the kinds and amounts of bacteria found thereon.

Certainly it is a wise precaution to keep court Bibles off the lips. Swearing with uplifted hand is not only safer, but more dignified.

In a Massachusetts school, where scarlet fever and measles had prevailed, some text-books fell into disuse, were put away for a time, and, when wanted, got out and redistributed, several months having elapsed. In but a few days after the reissue of the books the children began to be ill with measles. There can be little doubt that scarlet fever is transmitted in the same way.

Brown, F. W.—**A Course in Animal Histology.** VIII.
[Bone.] *The Microscope*, IX. (1889) pp. 47–51.
Freeborn, G. C.—**Notices of New Methods.** VII.
Amer. Mon. Micr. Journ., X. (1889) pp. 30–3.
Holway, E. W. D.—**[Use for the Microscope during the winter months.]**
["Some time spent in collecting through the other seasons would have provided beautiful objects in abundance."]
The Microscope, IX. (1889) p. 24, from 'Swiss Cross.'
Prize offered to Medical Microscopists.
[Dr. L. D. Mason, Vice-President of the American Association for the Study and Cure of Inebriety, offers a prize of one hundred dollars for the best original essay on "The Pathological Lesions of Chronic Alcoholism capable of Microscopic Demonstration." The essay is to be accompanied by carefully prepared microscopic slides, which are to demonstrate clearly and satisfactorily the pathological conditions which the essay considers. Conclusions resulting from experiments on animals will be admissible. Accurate drawings or photomicrographs of the slides are desired.]
St. Louis Med. and Surg. Journ., LVI. (1888) pp. 26–7.

* The Microscope, ix. (1889) p. 25, from 'Meyer Bros.' Druggist.'
† Amer. Mon. Micr. Journ., x. (1889) p. 44.

PROCEEDINGS OF THE SOCIETY.

ANNUAL MEETING OF 13TH FEB., 1889, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (DR. C. T. HUDSON M.A., LL.D.), IN THE CHAIR.

The Minutes of the meeting of 9th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Harting, P., Bijdrage tot de Kennis der Mikroskopische Fauna en Flora van de Banda-Zee. 34 pp., 3 pls. (4to, Amsterdam, 1863)	*Mr. Crisp.*
Müller, O. F., Von Würmern des süssen and salzigen Wassers. 200 pp., 16 pls. (4to, Kopenhagen, 1771)	"

The President having appointed Mr. W. W. Reeves and Mr. H. Epps to act as Scrutineers, the ballot for the election of Officers and Council for the ensuing year was proceeded with.

The Report of the Council was read as follows:—

Fellows.—During the year forty Fellows have been elected whilst twenty-eight have died or resigned, a somewhat larger average than usual.

Four Honorary Fellows have died: Mr. G. R. Waterhouse, Prof. A. de Bary, and Dr. Asa Gray, whose deaths were noticed in the last Report, and Mr. P. H. Gosse, an obituary notice of whom appears in the current volume of the "Proceedings" of the Royal Society. In their places were elected: Prof. Virchow, Prof. Lovén, Prof. Govi, and Prof. Allman.

One ex-officio Fellow has also been elected; the President of the Nottingham Naturalists' Society.

This leaves the list of Fellows, 641 Ordinary Fellows, 50 Honorary Fellows, and 88 ex-officio Fellows, or 779 in all.

Finances.—Notwithstanding that the deaths and resignations have exceeded the average of previous years, yet as these have occurred to a large extent amongst the compounders and Fellows paying the old rate of subscription, the increase in the revenue of the Society is larger than previously, namely 41*l.* 9*s.* 6*d.*, as against 34*l.* 2*s.* 6*d.* in 1887, and 25*l.* 3*s.* in 1886. The invested funds of the Society consist of freehold mortgages, 1200*l.* and India Three per Cents, 875*l.* 10*s.* 8*d.*, including the Quekett Memorial Fund, 100*l.* The total revenue of the Society from Fellows' subscriptions alone is 920*l.*

Library.—The Council regret to have to announce that they have received notice from the authorities at King's College that, after the present year, the Society can no longer be accommodated at the College. As this notice has only been very recently received, the Council have not had an opportunity of considering future arrangements; but this will form the subject of discussion at the first meeting of the new

THE TREASURER'S ACCOUNT FOR 1888.

Dr.

1888.	£	s.	d.
To Balance brought from 31st December, 1887	99	11	9
„ Interest on Investments	83	17	1
„ Admission Fees	77	14	0
„ Annual Subscriptions	811	0	7
„ Compositions	94	10	0
„ Journals sold by Assistant-Secretary	10	11	6
„ Reprints „ „	6	1	6
„ Screw tools „ „	1	1	6
	£1184	7	11

Cr.

1888.	£	s.	d.
By Rent, Gas, and Attendance	96	1	0
„ Salaries, Reporting, and Commission	174	16	8
„ Books and Binding	98	2	11
„ Expenses of Journal	500	0	0
„ Reprints of ditto	8	19	6
„ Postage of Journal	73	11	1
„ Stationery and Miscellaneous Printing	51	15	5
„ Coffee at Evening Meetings	19	18	6
„ Fire Insurance	1	10	0
„ Petty Cash	40	9	9
„ Subscription to Mr. Bolton's Bottles	2	2	0
„ King's College Hospital	1	1	0
„ Balance remaining 31st December, 1888	116	0	1
	£1184	7	11

LIONEL S. BEALE, *Treasurer.*

Investments, 31st December, 1888.

1200*l.* Freehold Mortgages. 875*l.* 10*s.* 8*d.* India Three per cents. (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 17th January, 1889.

A. DE SOUZA GUIMARAENS, FREDERICK A. PARSONS, } *Auditors.*

Council. It will probably be found convenient to arrange to share a meeting-room with some other societies.

The Catalogue of the Library is now ready for distribution, and can be obtained by any Fellow on application to the Librarian. The Council have fixed its price at the moderate sum of 1*s*.

Cabinet.—An important addition has been made to the cabinet by Mr. A. D. Michael's donation of 130 type-slides, illustrating his work on the Oribatidæ, another set of which has been deposited in the British Museum. Mr. Suffolk has continued during the year his valuable revision of the slide cabinet, which is now completed. The thanks of the Society are due to Mr. Michael and to Mr. Suffolk for their contributions to the efficiency of the cabinet.

Bye-Laws.—As mentioned in the last Report, the Bye-laws of the Society have been remodelled, and the Council have thought it desirable that they should be issued as part of the prefatory matter of the Journal, so that they may be preserved for future reference, great difficulty having been experienced in obtaining copies of the former Bye-laws.

Upon the motion of Mr. Bettany, seconded by Mr. J. J. Vesey, it was resolved that the Report be received and adopted.

The Treasurer presented his annual statement of accounts, and read the balance-sheet, duly audited by Messrs. Guimaraens and Parsons, who were elected Auditors at the preceding meeting. (See p. 317.)

Upon the motion of Mr. A. D. Michael, seconded by Mr. Ingpen, the adoption of this Report, together with a vote of thanks to the Treasurer for his services during the past year, was duly passed.

The President then read his Annual Address and exhibited a number of large transparencies of foreign rotifers and other objects, which were greatly admired by the Fellows present.

Mr. James Glaisher said he rose to propose that a very hearty vote of thanks be given to the President for the most interesting and valuable address to which they had just had the pleasure of listening, and also for the exhibition of drawings by which they had all been so much interested. With regard to the address, he could only say that it contained matter which would afford them much profitable thought in their studies at home. He had also put them under a further obligation when he said that their Journal was so full of matters relating to the progress of microscopical science that it was no longer possible to find materials for a President's Address by a detail of what had been done during the year, and that therefore they were to have in the future addresses which would enlarge their knowledge upon special subjects, instead of a repetition of facts with which the Journal had already made them acquainted. He felt that the Society was deeply indebted to the President for his address, and he had the greatest pleasure in moving that their hearty thanks be given him for it.

Prof. Bell said he should be very glad to second the vote of thanks for the most instructive, and, he might also add, entertaining, presidential address to which they had just been listening. It was full of matter for reflection, and he had been especially struck by the concluding paragraph, which breathed so entirely the spirit in which they ought to attack the subjects of biology. It had also raised questions of great interest as showing how Nature often did the same things in different ways under different circumstances. The Rotifera were not the only creatures common to various parts of the world, or to this country and to Australia; the Protozoa of both showed similarities of type and structure; but in their case the cause was doubtless altogether different from the causes which had been assigned to account for the wide distribution of many forms of the Rotifera. If he might make one criticism, it would be to point out one serious omission from it, and that was that the President had not mentioned the work on the Rotifera which he had lately published, in which they had the results of researches which laid all students of the subject under the deepest obligations to him.

Mr. Glaisher having put the motion, it was carried by acclamation.

The President said he had to thank them very heartily for the way in which they had received his address, and for the cordial manner in which they had responded to the vote of thanks by Mr. Glaisher and Prof. Bell. He was glad on his part that he had been able to please them in that respect, and as he found that they had done him the honour to re-elect him as their President for another year, he hoped to have the pleasure of again addressing them on a future occasion. He also hoped that during his second year he should be more successful than in the past in the matter of regular attendance at the meetings. He had not yet entirely recovered from the effects of his accident, but was much better than he had been for some time past, and he ventured to hope that he should be able to occupy his place as often as occasion required.

The Scrutineers having handed in the result of their examination of the balloting-papers,

The President declared that the whole of the Fellows nominated were elected as follows:—

President—Charles T. Hudson, Esq., M.A., LL.D. (Cantab.).

Vice-Presidents—Rev. W. H. Dallinger, LL.D., F.R.S.; *James Glaisher, Esq., F.R.S., F.R.A.S.; *Prof. Urban Pritchard, M.D.; Prof. Charles Stewart, F.L.S.

Treasurer—Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

Secretaries—Frank Crisp, Esq., LL.B., B.A., V.P. and Treas. L.S.; Prof. F. Jeffrey Bell, M.A., F.Z.S.

Ordinary Members of Council—Alfred W. Bennett, Esq., M.A., B.Sc., F.L.S.; *Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; Rev. Edmund Carr, M.A.; Prof. Edgar M. Crookshank, M.B.; Prof. J. William Groves, F.L.S.; George C. Karop, Esq., M.R.C.S.; John Mayall, Esq., jun.; Albert D. Michael, Esq., F.L.S.; *Thomas H. Powell, Esq.; *William Thomas Suffolk, Esq.; Charles Tyler, Esq., F.L.S.; *Frederic H. Ward, Esq., M.R.C.S.

The President then proposed that the thanks of the Society be given to the Auditors and Scrutineers for their services.

The motion having been seconded by the Rev. Edmund Carr, was put to the meeting and carried unanimously.

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* The names with an asterisk have not held during the preceding year the office for which they were nominated.

Mr. A. D. Michael said they should not separate that evening without passing a hearty vote of thanks to their Secretaries, who had done the work of the Society so admirably during the past year. How well they had performed their duties was so perfecty well known to the Fellows that it was impossible for him to say anything new about it; he would, therefore, simply move that the best thanks of the Society be given to the Secretaries for their valuable and efficient services during the past year.

The motion was seconded by the Rev. T. S. King, and on being put to the meeting by the President, was carried unanimously.

Prof. Bell said that his feelings, when any allusion was made to the secretarial work, might be compared to those of one of two men who had agreed to share a bottle of wine together; the other man was such an efficient drinker that the amount which he got himself was only a very small glass now and then. He thought that in the matter of thanks for work done in connection with the office, he deserved the one-hundredth part and Mr. Crisp the other ninety-nine hundredths. It was probably due to the fact that Mr Crisp thought he had usually so little to do that he put upon his shoulders the difficult task of responding to-night to the vote. He thanked the Fellows, on behalf his colleague and himself, for the way in which they had passed it.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. Anthony Dalzell; C. W. Turner, M.R.C.S.; Charles H. Wright; and Miss Mary Ann Booth.

MEETING OF 13TH MARCH, 1889, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (DR. C. T. HUDSON, M.A., LL.D.) IN THE CHAIR.

The Minutes of the meeting of 13th February last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Bennett, A. W., and G. Murray, A Handbook to Cryptogamic Botany. viii. and 473 pp., 382 figs. (8vo, London, 1889) ..	*The Authors.*
8 Photomicrographs — *Arachnoidiscus Ehrenbergii*, scale of Test Podura (2), scale of *Degeeria domestica*, *Surirella gemma* (2), *Coscinodiscus centralis* (2)	*Mr. T. F. Smith.*
Photomicrograph of spermatozoon, showing filament	*Mr. E. M. Nelson.*
8 Slides of *Psamathiomya pectinata*. 1. Slide of adult ♂. 2. Slide of adult ♀. 3. Wings of ditto. 4. Ovipositor. 5. Male anal forceps. 6. Leg with foot and appendages. 7. Larva. 8. Pupa with male escaping from it	*Mr. Deby.*

Mr. Crisp called attention to Bennett and Murray's 'Cryptogamic Botany' and read some extracts from the introduction.

Mr. Bennett, in reply to a question from Mr. Crisp, said he had nothing further to say with reference to this book, because in a recent number of the Journal a description was given of the principal changes which it was proposed to make in the classification of the organisms, and in the book before them it would be found that the altered method had been followed.

Mr. Crisp exhibited a Microscope which had been made to order for the purpose of examining large specimens of minerals (*supra*, p. 274).

Mr. J. Mayall, jun., thought it would be unfair to criticize an instrument of that sort except as to its adaptation for the purpose for which it was designed. This one, notwithstanding its unusual appearance, might answer its purpose very well, and he thought if a person had a block of granite or quartz to examine, he would hardly like to use a valuable Microscope of ordinary construction for the purpose.

Mr. T. F. Smith exhibited a number of photomicrographs of Podura scales and diatoms taken with one of Zeiss's apochromatic objectives, the former showing secondary markings not previously described, and some illustrating the difference of appearance presented by the same object with different corrections of the objective; the peculiarities presented were further illustrated by drawings upon the blackboard.

Professor Stewart said he should be glad to know what was the result of Mr. Smith's final examination as to the general meaning of the entire structure of the Podura scale. In a specimen which he saw exhibited at the Quekett Club, the turned-over edge of the scale was clearly shown, and the interrogation marks appeared to be upstanding processes from the surface of the scale (drawn on the board). What did Mr. Smith think was the real structure of the scale, the upper surface being smooth and the lower apparently bearing these projecting markings?

Mr. Smith said he had at present no definite idea of the real structure, because he found that when the scale was examined in media of high refractive index, the whole appearance was altered. His impression was, however, that these markings lay between two membranes, one corrugated and one plain, the latter being at least as thin as 1/140000 in. In butterfly scales the existence of a second membrane could be sometimes shown, but in others, and in the Podura scale, it was optically invisible.

The President inquired how, if the markings were between two membranes, the appearance of their projection could be accounted for?

Mr. Smith said he thought that there was a fine membrane spread over the surface of the scale, and that the markings extended between the two. He regarded the projections as being real, although they did not really stand out from the outer surface of the scale in consequence of being included within a fine membrane, which was in itself too delicate to be optically visible.

Professor Stewart suggested that it was rather a dangerous proceeding to assume the existence of a membrane which they could neither see nor demonstrate by any means whatever.

Mr. J. Mayall, jun., said that Mr. Smith had come forward repeatedly, both there and in other places, attempting to determine the structure of objects of this class from the appearances presented. He had himself, had perhaps as much experience in these matters as most persons, and he could only say that to attempt to interpret such structures merely by the optical images produced by them, was entirely illusive. If Mr. Smith based his conclusions on such grounds, then he could only say that his explanations were quite beside the mark, and, unless he would intelligently follow up the Abbe diffraction theory and make himself master of the practical conclusions to which it pointed, his remarks upon the subject could possess no value whatever.

Mr. Smith said he had brought these photographs for exhibition rather as test objects, than as showing the structure.

The President said they were very glad to have seen the photographs, many of which were extremely interesting; but as regarded the nature of the structures that Mr. Smith thought he could determine, he rather agreed with what had been said, that under the conditions it was at present a somewhat hopeless matter.

Mr. E. M. Nelson's letter was read as follows:—

"Some time ago I had the honour of bringing to the notice of the Royal Microscopical Society the different appearances a transparent positive of an *Amphipleura pellucida* presented when viewed under different sources of illumination. I now find that a film of water on the surface of the gelatin will cause an alteration in the image similar to that made by the edge of the flame in the former case. When the film of water has run off the gelatin the image is normal, although the gelatin is saturated with water. The saturation of the gelatin with water has nothing whatever to do with it; what is necessary to produce the phenomenon is that a film of water should be on the surface of the gelatin. I consider this matter extremely important, as I know of no physical law of light which will account for these strange appearances.

I also inclose a photomicrograph of the 'filament' at the head of a human spermatozoon. It is a very delicate object, and can only be seen in the Microscope with close attention."

Mr. J. Mayall, jun., said that at the Stuart Exhibition, now open at the New Gallery in Regent Street, there was a Microscope said to have belonged to Charles I. At Mr. Crisp's request he went to examine it, but, on viewing the Microscope, he found that it had been misnamed. He held in his hand a Microscope from Mr. Crisp's museum, which was identical with the so-called Charles I. Microscope, except that it possessed a clamping collar: in fact, when he that day put the two instruments side by side they were found to be so exactly alike that they could only be distinguished by the covering of the tubes, which in one case was of parchment, and in the other of red leather. Having established the identity of the two forms, the question arose as to when they were made, and he thought this was conclusively settled by reference to an old work in Mr. Crisp's library, which contained a figure of the instrument, and assigned the date as 1686. In M. Nachet's collection there was also a model, which almost exactly corresponded with it. The body-tube was a good specimen of Italian work of the 17th century, and in that case it had been traced to the possession of Homberg, a member of the Academy of Sciences of Paris. The same kind of work was also seen in a model which belonged to Pope Benedict, also in one at the Jena University, and in one belonging to George III. One peculiarity of this model was that the draw-tube was made to slide outside the other tube, and not inside as in more modern forms; and by moving it the distance was altered between the field lens and the eye lens. As to the Stuart Microscope, Charles I. died in 1649, so that, of course, if the date assigned to the Homberg Microscope was correct, it was not made before 1686, and therefore not until nearly forty years later than Charles I. It was mentioned by Ciampini as being recently invented, and therefore, though it might have belonged to Charles II., or possibly to James II., and on that account might be called a "Stuart" Microscope, it could not have belonged to Charles I., as stated in the Exhibition Catalogue.

The President said they were much indebted to Mr. Mayall for his very interesting account of this curious old Microscope.

Mr. Deby read his paper "On a new Dipterous insect *Psamathiomya pectinata*" (*supra*, p. 180), the subject being illustrated by drawings, and by slides shown under the Microscope. Mr. Deby also presented to the Society a set of slides illustrative of the subject of the paper.

Professor Stewart thought the peculiar form of the foot in this insect was very well adapted for walking upon damp seaweed, keeping it free from any chance of a sucking action. There was a certain resemblance to what was found in the foot of the spider, where the comb-like structure admirably fitted it for running upon the web; and it was very likely that in the case of this insect it would save it from entanglement in the fine filaments of the seaweeds over which it passed.

The President hoped some enthusiastic member might go over to Ostend, and would make a search for the insect mentioned by Mr. Deby.

Mr. Crisp exhibited, on behalf of Mr. T. B. Rosseter, of Canterbury, some slides illustrative of his observations on the presence of Cysticercoids in the body-cavity of *Cypris*.

Prof. Bell said that he was afraid Mr. Rosseter, notwithstanding his laborious and painstaking observations, did not give sufficiently detailed information to enable a clear opinion to be formed on the subject. He thought the objects were the encysted parasites of some species of tape-worm, and in this surmise he was probably correct; it was also, he believed, a fact that no observer had yet put on record the discovery of parasites of a cestoid character in the Cypridæ. But it was well known that the encysted stage was not the most important part of the life-history of these creatures, and the life-history required to be worked out thoroughly. In tracing out the history of these parasites it was absolutely necessary to find in what creatures their various stages were passed, and to select some for experiment which might probably turn out to be the next host. If, therefore, the duck or the goose were taken, there might have been some probability of finding the next stage.

The President said that at the last meeting he mentioned the fact of some Rotifera having been found in Australia almost at the same time as in this country. Curiously enough the next night he heard that Mr. Gunston Thorpe had found *Trochosphæra* in great abundance at Brisbane, and as they had found it there he hoped it might be found here also. It was a rather remarkable form, being perfectly globular, surrounded by an equatorial belt of cilia, having two red eyes, and almost the whole of the animal's structure lying in the upper hemisphere. The point he should like to get confirmed was the action of the contractile vesicle, a large kind of bladder opening into the cloaca, but entirely detached from the lateral canals, which came into the cloaca independently. It was generally thought to be an excretory system, and that the excretory products passed out into the contractile vesicle and thence into the cloaca. In some of the animals it was remarkable to note that the contractile vesicle was very large in proportion to their size, being nearly 1/3 the size of the creature, and when it was seen that it would contract and fill again in about 1/3 of a minute, discharging each time a bulk of fluid nearly equal to 1/3 the size of its own body, it became a question whether so much excretory matter could be produced in so short a time, or whether it was, after all, water which was taken in and passed through. For his own part he did not see any reason why both ideas should not be true, and that there should be a mixture of the two fluids. Cohn, in endeavouring to test the action, put some pigment into the water, and he saw some of the pigment particles afterwards in the contractile vesicle, and though it was possible that he might have been mistaken as to the plane in which he saw these particles, through not using a binocular Microscope, yet he was himself inclined to think the observation was a correct one. That the contractile vesicle did drive water out of the cloaca was positively certain. By means of a drawing on the board it was shown how in the male of *Asplanchna* the tube swelled out at one part, forming a kind of bulb which was seen to traverse the tube during the action of the contractile vesicle. He thought the Society would be glad to know that *Trochosphæra* had got as near as Australia, and hoped that it might be found in this country before long.

Prof. Stewart said he quite agreed with the President that they had in these cases to deal with an indrawing and a driving-out process, and he found a parallel in the case of the Infusoria, having seen a non-living particle lying near the mouth of the contractile vesicle shot out suddenly by the action described. He had come to the opinion that it was mainly filled with the drainage from the watery media by which it was surrounded, and that at the same time it to a certain extent took in water as well. As another case of curious coincidence of the finding of a new species in widely different localities about the same time, he remembered that in 1856 Mr. Carter described a new genus *Otostoma* in the 'Annals and Magazine of Natural History.' In this—as shown by a drawing upon the board—the bars were arranged in a beautiful shell-like form, spirally curled, from which circumstance it received its name. Within a week of the appearance of the description in the Annals, he found the same creature in the water filling the impression of a cow's foot in the neighbourhood of Plymouth. It might have been overlooked, but as his friend—to whom he was at that time acting as jackal in these matters—had been for some time engaged in making accurate drawings of all species to be found in the locality, he thought that it was not likely to have been the case; but he remembered very well bringing it in, and that as soon as it was seen his friend exclaimed, "Good gracious! it's a new thing; why it is the same as described in the Annals."

The following Instruments, Objects, &c., were exhibited :—

Mr. Crisp :—Swift's Mineral Microscope.

Mr. J. Deby :—Slide of 300 forms of *Coscinodiscus* in Monobromnaphthalin. Slide of 379 Marine forms of *Navicula* in Monobromnaphthalin.

Mr. J. Mayall, jun. :—Microscope from the Stuart Exhibition.

Mr. Nelson :—Photomicrograph of Spermatozoa showing filaments.

Mr. T. F. Smith :—8 Photomicrographs of Scales and Diatoms.

Mr. T. B. Rosseter :—Cysticercoids in body-cavity of *Cypris*.

New Fellows :—The following were elected *Ordinary* Fellows :—Messrs. C. Haughton Gill, F.C.S.; William E. R. Martin; Enoch Mather, M.D.; and Henry G. Thompson, M.D., J.P.

The Journal is issued on the second Wednesday of
February, April, June, August, October, and December.

1889. Part 3. JUNE. To Non-Fellows, Price 5s.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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WILLIAMS & NORGATE.
LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED,] [STAMFORD STREET AND CHARING CROSS.

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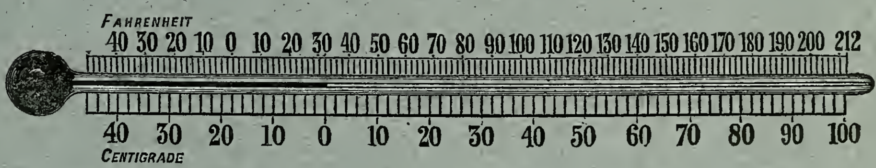
APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1\cdot00$).	*Water* ($n = 1\cdot33$).	*Homogeneous Immersion* ($n = 1\cdot52$).	White Light. ($\lambda = 0\cdot5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0\cdot4861\ \mu$, Line F.)	Photography. ($\lambda = 0\cdot4000\ \mu$, near Line h.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·729
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·741
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·746
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·08	..	108° 30′	90° 34′	104,123	112,864	137,158	1·166	·926
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.
°	°	°	°	°	°	°	°	°	°
212	100	158	70	104	40	50	10	- 4	- 20
210·2	99	156·2	69	102·2	39	48·2	9	- 5·8	- 21
210	98·89	156	68·89	102	38·89	48	8·89	- 6	- 21·11
208·4	98	154·4	68	100·4	38	46·4	8	- 7·6	- 22
208	97·78	154	67·78	100	37·78	46	7·78	- 8	- 22·22
206·6	97	152·6	67	98·6	37	44·6	7	- 9·4	- 23
206	96·67	152	66·67	98	36·67	44	6·67	- 10	- 23·33
204·8	96	150·8	66	96·8	36	42·8	6	- 11·2	- 24
204	95·56	150	65·56	96	35·56	42	5·56	- 12	- 24·44
203	95	149	65	95	35	41	5	- 13	- 25
202	94·44	148	64·44	94	34·44	40	4·44	- 14	- 25·56
201·2	94	147·2	64	93·2	34	39·2	4	- 14·8	- 26
200	93·33	146	63·33	92	33·33	38	3·33	- 16	- 26·67
199·4	93	145·4	63	91·4	33	37·4	3	- 16·6	- 27
198	92·22	144	62·22	90	32·22	36	2·22	- 18	- 27·78
197·6	92	143·6	62	89·6	32	35·6	2	- 18·4	- 28
196	91·11	142	61·11	88	31·11	34	1·11	- 20	- 28·89
195·8	91	141·8	61	87·8	31	33·8	1	- 20·2	- 29
194	90	140	60	86	30	32	0	- 22	- 30
192·2	89	138·2	59	84·2	29	30·2	- 1	- 23·8	- 31
192	88·89	138	58·89	84	28·89	30	- 1·11	- 24	- 31·11
190·4	88	136·4	58	82·4	28	28·4	- 2	- 25·6	- 32
190	87·78	136	57·78	82	27·78	28	- 2·22	- 26	- 32·22
188·6	87	134·6	57	80·6	27	26·6	- 3	- 27·4	- 33
188	86·67	134	56·67	80	26·67	26	- 3·33	- 28	- 33·33
186·8	86	132·8	56	78·8	26	24·8	- 4	- 29·2	- 34
186	85·56	132	55·56	78	25·56	24	- 4·44	- 30	- 34·44
185	85	131	55	77	25	23	- 5	- 31	- 35
184	84·44	130	54·44	76	24·44	22	- 5·56	- 32	- 35·56
183·2	84	129·2	54	75·2	24	21·2	- 6	- 32·8	- 36
182	83·33	128	53·33	74	23·33	20	- 6·67	- 34	- 36·67
181·4	83	127·4	53	73·4	23	19·4	- 7	- 34·6	- 37
180	82·22	126	52·22	72	22·22	18	- 7·78	- 36	- 37·78
179·6	82	125·6	52	71·6	22	17·6	- 8	- 36·4	- 38
178	81·11	124	51·11	70	21·11	16	- 8·89	- 38	- 38·89
177·8	81	123·8	51	69·8	21	15·8	- 9	- 38·2	- 39
176	80	122	50	68	20	14	- 10	- 40	- 40
174·2	79	120·2	49	66·2	19	12·2	- 11	- 41·80	- 41
174	78·89	120	48·89	66	18·89	12	- 11·11	- 42	- 41·11
172·4	78	118·4	48	64·4	18	10·4	- 12	- 43·60	- 42
172	77·78	118	47·78	64	17·78	10	- 12·22	- 44	- 42·22
170·6	77	116·6	47	62·6	17	8·6	- 13	- 45·40	- 43
170	76·67	116	46·67	62	16·67	8	- 13·33	- 46	- 43·33
168·8	76	114·8	46	60·8	16	6·8	- 14	- 47·20	- 44
168	75·56	114	45·56	60	15·56	6	- 14·44	- 48	- 44·44
167	75	113	45	59	15	5	- 15	- 49	- 45
166	74·44	112	44·44	58	14·44	4	- 15·56	- 50	- 45·56
165·2	74	111·2	44	57·2	14	3·2	- 16	- 50·80	- 46
164	73·33	110	43·33	56	13·33	2	- 16·67	- 52	- 46·67
163·4	73	109·4	43	55·4	13	1·4	- 17	- 52·60	- 47
162	72·22	108	42·22	54	12·22	1	- 17·22	- 54	- 47·78
161·6	72	107·6	42	53·6	12	0	- 17·78	- 54·40	- 48
160	71·11	106	41·11	52	11·11	- 0·4	- 18	- 56	- 48·89
159·8	71	105·8	41	51·8	11	- 1	- 18·33	- 56·20	- 49
						- 2	- 18·89	- 58	- 50
						- 2·2	- 19		



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102	3 inches	12	2 10 0					
103	2 inches	10	1 10 0	22	36	67	90	112
104	2 inches	17	2 10 0					
105	$1\frac{1}{2}$ inch	23	2 10 0	30	48	90	120	150
106	$\frac{2}{3}$ inch	25	2 0 0	70	112	210	280	350
107	$\frac{2}{3}$ inch	32	2 10 0					
108	$\frac{1}{2}$ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	$\frac{1}{4}$ inch	75	3 10 0	200	320	600	800	1000
112	$\frac{1}{5}$ inch	120	4 10 0	250	400	750	1000	1250
113	$\frac{1}{8}$ inch	130	5 0 0	400	640	1200	1600	2000
114	$\frac{1}{10}$ imm.	180	5 5 0	500	800	1500	2000	2500
115	$\frac{1}{15}$ imm.	180	8 0 0	750	1200	2250	3000	3750
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152	1 inch	18	1 5 0	46	61	106
153	$\frac{1}{2}$ inch	38	1 5 0	90	116	205
154	$\frac{1}{4}$ inch	80	1 5 0	170	220	415
155	$\frac{1}{6}$ inch	110	2 5 0	250	330	630
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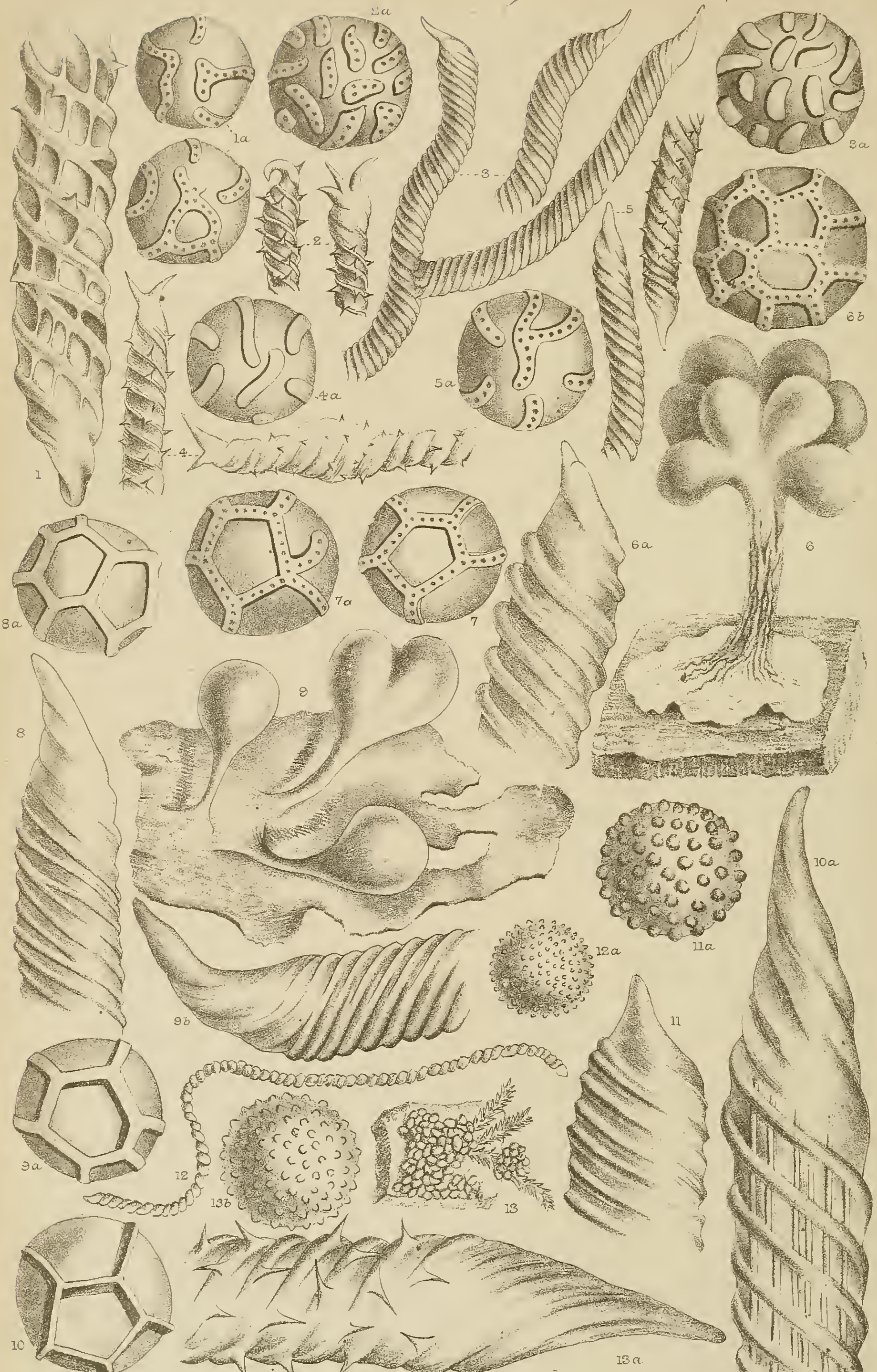

G Massee del. West Newman lith.

Trich...

G Massee del.

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Trichiaceæ.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1889.

TRANSACTIONS OF THE SOCIETY.

VI.—*A Revision of the Trichiaceæ.* By George Massee.

(*Read* 10*th April*, 1889.)

Plates V., VI., VII., and VIII.

Trichiaceæ, Rost. (emended).—Sporangia sessile or stipitate, dehiscing irregularly or in a circumscissile manner near the apex, wall of sporangium single or double, without lime (except in *Hemiarcyria paradoxa*); capillitium without lime, elaters free, or attached to the wall of the sporangium, or sunk in the hollow of the stem, either simple, or branched, or combined into a net, and furnished with raised bands or

EXPLANATION OF THE PLATES.

Plate V.

Fig. 1.—*Trichia intermedia*, Mass., tip of elater, × 1200; 1*a*, spores of same, × 1200.
„ 2.—*Trichia abrupta*, Cooke, tips of elaters, × 500; 2*a*, spore of same, × 1200.
„ 3.—*Trichia sulphurea*, Mass., tips of elaters, × 500; 3*a*, spore of same, × 1200.
„ 4.—*Trichia Balfourii*, Mass., tips of elaters, × 500; 4*a*, spore of same, × 1200.
„ 5.—*Trichia Jackii*, Rost., tips of elaters, × 500; 5*a*, spore of same, × 1200.
„ 6.—*Trichia superba*, Mass., entire plant, × 50; 6*a*, tip of elater, × 1200; 6*b*, spore, × 1200.
„ 7.—*Trichia affinis*, De Bary, spore, × 1200; 7*a*, spore showing a free end on the raised network, × 1200.
„ 8.—*Trichia Kalbreyeri*, Mass., tip of elater, × 1200: 8*a*, spore of same. × 1200.
„ 9.—*Trichia verrucosa*, Berk., group of plants springing from a broad hypothallus, × 50; 9*a*, spore of same, × 1200; 9*b*, tip of elater of same, × 1200.
„ 10.—*Trichia chrysosperma*, Rost., spore, × 1200; 10*a*, tip of elater of same, × 1200.
„ 11.—*Trichia nitens*, Fr., tip of elater, × 1200; 11*a*, spore of same, × 1200.
„ 12.—*Trichia nana*, Mass., elater, × 400; 12*a*, spore of same, × 1200.
„ 13.—*Trichia scabra*, Rost., plant nat. size; 13*a*, tip of elater, × 1200; spore, × 1200.

Plate VI.

Fig. 14.—*Trichia fragilis*, Rost., botryoid form, × 50; 14*a*, elater, × 400; 14*b*, tip of elater, × 1200; 14*c*, spore, × 1200.
„ 15.—*Trichia Carlyleana*, Mass., group of plants, nat. size; 15*a*, plants, × 50; 15*b*, portion of wall of sporangium seen from the inside, and showing numerous amorphous lumps of organic matter arranged in clusters, × 300; 15*c*, tip of elater, × 500; 15*d*, spore, × 1200.
„ 16.—*Trichia heterotrichia*, Balf. fil., spore, × 1200; 16*a*, tip of elater, × 1200.
„ 17.—*Trichia varia*, Rost., normal spore with minute rounded warts, × 1200; 17*a*, spore of same, showing the warts with a tendency to become elongated, thus forming a transition to the section having spores with flat, raised

ridges arranged in a spiral manner; spores globose or subglobose, epispore smooth or ornamented with warts or raised bands variously arranged.

Rost., Mon., p. 243; Cooke, Myx. Brit., p. 61 (in part).

Rostafinski divides the *Mycetozoa* or *Myxomycetes* into two primary groups depending on the colour of the spores. *Amaurosporeæ*, spores

---

bands, × 1200; 17*b*, a young spore with the epispore yet smooth, after immersion for an hour in absolute alcohol; *a*, epispore; *b*, protoplasm contracted; *c*, nucleus, × 1200; 17*c*, spore germinating after being in water for 22 hours; *a*, epispore: *b*, endospore; *c*, ciliated zoospore escaping from the spore; *d*, its contractile vesicle, × 1200; 17*d*, portion of an elater, × 1200; 17*e*, tip of an elater after immersion for an hour in dilute potassic hydrate, the prominent ridges have disappeared, and a narrow cavity terminating in the swollen portion near the tip, and containing a granular substance, is brought into view, × 1200; 17*f*, portion of wall of sporangium seen from the inside, the circular or crescent-shaped markings are thickened portions of the wall, × 500.

Fig. 18.—*Trichia minima*, Mass., spore, × 1200; 18*a*, group of plants seen from above, × 50.

„ 19.—*Alwisia bombarda*, B. and Br., plants, × 2; 19*a* and 19*b*, plants × 50; 19*c*, threads of capillitium attached by one end to the wall of the sporangium near its base, × 400.

„ 20.—*Oligonema minutula*, Mass., plants, × 50; 20*a*, spore of same, × 1200; 20*b*, tip of elater of same, × 1200.

PLATE VII.

Fig. 21.—*Trichia fallax*, Rost., section of stem and base of sporangium, showing the hollow of the stem filled with masses of an organic substance, *a*, *a*, which pass by degrees into normal spores, *b*, *b*; × 350.

„ 22.—*Oligonema Broomei*, Mass., group of plants, × 35; 22*a*, tip of elater and two spores, × 400.

„ 23.—*Prototrichia flagellifer*, Rost., branched elater, × 400; 23*a*, spores of same, × 400.

„ 24.—*Prototrichia cuprea*, Mass., branched elater and spores, × 400.

„ 25.—*Oligonema nitens*, Rost.; var. *Bavarica*, elaters, × 400.

„ 26.—*Prototrichia metallica*, Mass., plants, × 35; 26*a*, elater, × 400; 26*b*, spores, × 400.

„ 27.—*Trichia fallax*, Rost., *α genuina*; entire plants, × 35.

„ 28.—*Trichia fragilis*, Rost., *γ serotina*; plants, × 50.

„ 29.—*Oligonema nitens*, Rost., cluster of plants nat. size; 29*a*, spores of same, × 1200; 29*b*, elaters of same, showing ring-like thickenings at *a*; on one of the elaters, a very diffuse single spiral is present.

PLATE VIII.

Fig. 30.—*Hemiarcyria Ellisii*, Mass., plants nat. size; 30*a*, botryoid or fasciculate form, × 50; 30*b*, portion of capillitium, × 400; 30*c*, spore, × 1200.

„ 31.—*Hemiarcyria rubiformis*, Rost., spore, × 1200.

„ 32.—*Hemiarcyria stipitata*, Mass., plants nat. size; 32*a*, fasciculate form; 32*b*, simple form, with the elastic capillitium, *a*, expanded, × 50; 32*c*, spore, × 1200; 32*d*, portion of capillitium, × 400.

„ 33.—*Hemiarcyria leiocarpa*, Cooke, entire plant, × 35; 33*a*, spore, × 1200.

„ 34.—*Hemiarcyria serpula*, Rost., entire plant, × 5; 34*a*, tip of elater, × 1200; 34*b*, spores, × 1200.

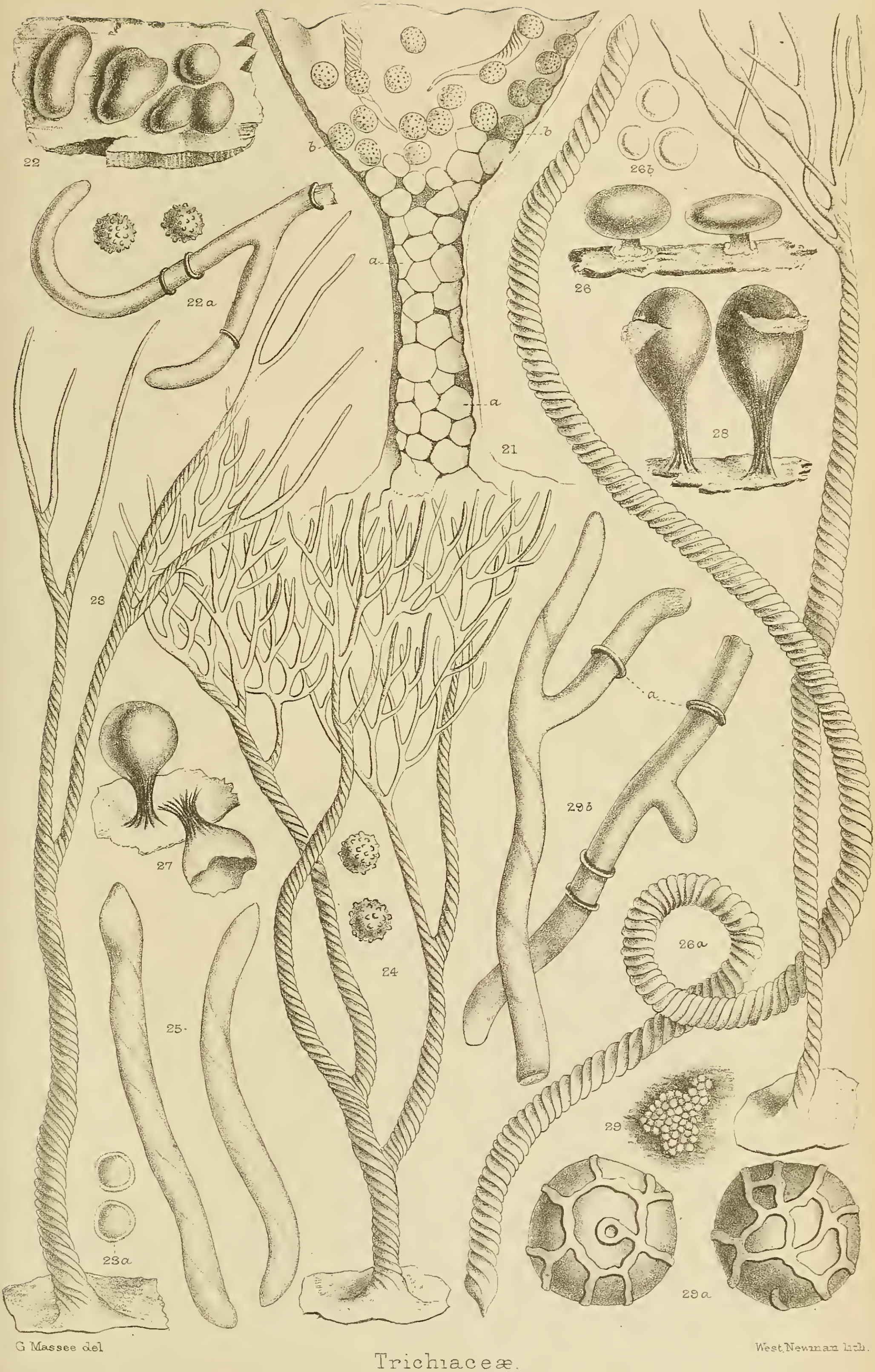
„ 35.—*Hemiarcyria paradoxa*, Mass., plants, × 50; 35*a*, portion of capillitium, × 400; 35*b*, free tip of branch of capillitium, × 1200; 35*c*, spore, × 1200.

„ 36.—*Hemiarcyria Karsteni*, Rost., portion of capillitium, × 400.

„ 37.—*Hemiarcyria chrysospora*, Lister, spore, × 1200.

„ 38.—*Trichia advenula*, Mass, elaters, × 400; 38*a*, spore, × 1200.

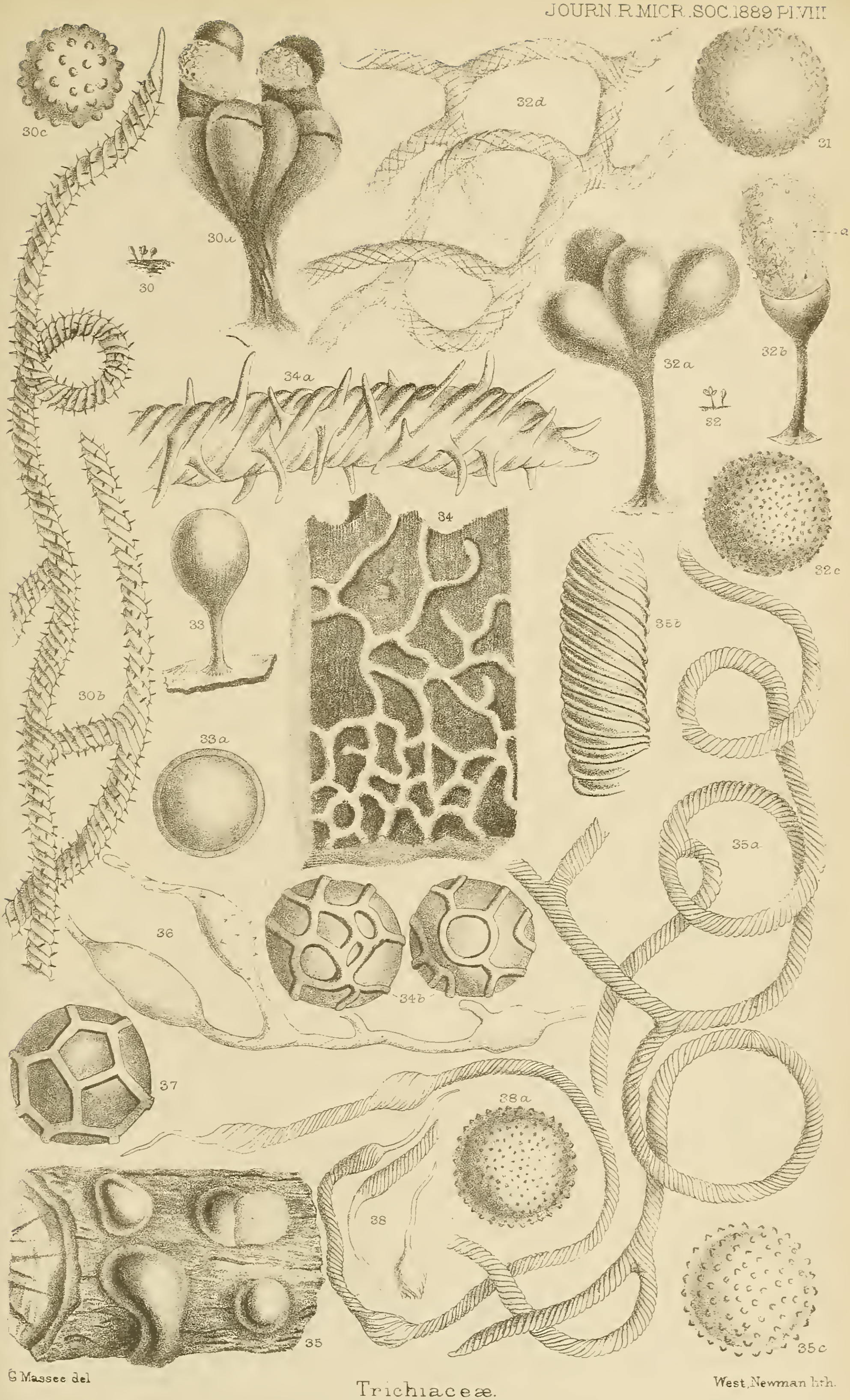
The structures said to be magnified 1200 diameters are enlarged, but the ornamentation is as seen under a power of 1200 diameters.



G. Massee del.

West, Newman lith.

Trichiaceæ.



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Trichiaceæ.

West, Newman lith.

violet or brownish-violet; *Lamprosporæ*, spores variously coloured, usually some shade of yellow, but never violet. These primary groups are each again divided into two sections, *Atrichæ*, sporangia without a capillitium, and *Trichophoræ*, sporangia furnished with a capillitium.

The *Trichiaceæ* belong to the *Lamprosporæ*, section *Trichophoræ*, and the leading characteristic of the family consists in the *spirally arranged ridges on the elaters* or threads forming the capillitium. The species are all minute, not exceeding 4 mm. high, generally very much less, but, owing to the gregarious habit, are often conspicuous objects, especially after dehiscence, when the bright yellow spores of most species cannot fail to attract attention. The most usual habitat is decaying wood, where most species pass the vegetative period, and from which in all probability their food is obtained, but during the commencement of the reproductive stage, the motile plasmodium frequently creeps to the surface, or even passes on to living leaves, &c., where the sporangia are formed. Rostafinski first suggested the worthlessness of external form in the discrimination of species, and accordingly his species are distinguished by the microscopic characters furnished by the spores and capillitium when present, and the question arises as to the relative value of the form of the sporangium and presence or absence of a stem on the one hand, and the microscopic characters of the capillitium and spores on the other. It is perfectly true that if we adopt the form of sporangium and presence or absence of stem as the primary idea in determining species, we must ignore the microscopic features; whereas if the structure of the capillitium and spores constitutes the basis of classification, then we bring together forms in which the sporangia are sometimes of a definite form and seated on a distinct stem, in other instances sessile, and sometimes very irregular in shape and forming shapeless conglomerations; nevertheless, the sequence from one shape of sporangium to another is in numerous instances, even in the same cluster, so very evident, that in all probability, Rostafinski's idea, although not altogether satisfactory, is the best known, and has been followed in the present paper. A very constant sequence of development in the ornamentation of the epispore is evident in every genus belonging to the family under consideration, which is as follows:—(1) species with the epispore *smooth*; (2) species with the epispore rough with *rounded warts*; (3) species having the epispore *with slightly elongated raised bands, the surface of the raised bands plain*; (4) the raised bands as in (3), but having *the surface of the bands ornamented with minute pits*; (5) species having the epispore with *elongated and curved raised bands that remain distinct from each other*, *surface of raised bands plain*; (6) species with bands as in (5) but *surface of bands with minute pits*; (7) species having epispore with *raised bands anastomosing to form a more or less regular polygonal network, surface of bands plain*; (8) species with the epispore having bands as in (7) but *surface of bands with minute pits*. This peculiar sequence of spore ornamentation is not confined to the *Myxogastres*, but is also present in other groups of fungi, as the *Tuberaceæ.* The same sequence is also to be met with in some genera belonging to the *Hepaticæ.* Throughout the fungi the rule is that the largest and most elaborately ornamented spores are met with in the morphologically lowest groups, and the same rule holds good for the species constituting a genus.

Externally the species included in the *Trichiaceæ* frequently resemble each other closely, and, from what has already been said, it will be seen that general form is of little value in the discrimination of species as understood in the present work; hence I have not attempted to give synonyms dating further back than Rostafinski's monograph, unless justified by the existence of type specimens; but for the peace of mind of those who consider synonyms as of far greater importance than a knowledge of the organism treated of, I have added the synonyms given by Rostafinski, but it must be clearly understood that they rest entirely on the authority of the last-mentioned author, whose genius in being able to give so many, and with such apparent certainty, I admire.

Key to the Genera.

I. *Elaters free.*

Trichia.—Elaters simple or branched, spirals well marked.

Oligonema.—Elaters simple or branched, spirals rudimentary.

II. *Elaters fixed by one end to wall of sporangium, not combined into a net.*

Alwisia.—Free tips of elaters simple or slightly branched, spirals rudimentary.

Prototrichia.—Free tips of elaters much branched, spirals well marked.

III. *Elaters combined in a net usually with free ends.*

Hemiarcyria.—Spirals well marked, often furnished with spines.

Trichia, Haller (emended).

Wall of sporangium single, dehiscing irregularly; capillitium consisting of free, simple or branched threads having the walls furnished with raised bands arranged in a spiral; spores globose, epispore smooth or variously ornamented, yellow or orange, sometimes tinged with red or brown.

Trichia, Haller, Helv., iii. p. 114; Rost., Mon., p. 243; Cooke, Myx. Brit., p. 61 (in part); Sacc., Syll., v. 7, pt. i. p. 438 (in part).

A genus marked by the presence of well-developed external ridges arranged in a spiral manner on the perfectly free elaters or threads of the capillitium. The elaters are in most species unbranched, cylindrical or fusiform, and more or less attenuated at the ends into a smooth spine. In a few species the elaters are branched, the ends varying from three to ten. The only other genus with free elaters is *Oligonema*, but here the spirals are at best rudimentary, and the tips obtuse.

The genus is cosmopolitan, some species having a wide distribution. Twenty-nine species are known, twenty-two of which are met with in Europe.

A. *Spores smooth.*

* *Elaters fusiform.*

Trichia Carlyleana, Mass. (n. sp.) fig. 15.

Sporangia clavate or cylindric-oblong, stipitate, dark purple-brown, smooth, dull; stem about half as long as sporangium, equal or slightly incrassated downwards, and expanded into a small discoid base, wrinkled longitudinally, coloured like the sporangium; *inner surface of sporangial wall and hollow of stem with numerous rather large organic masses of a bright reddish-purple colour;* mass of elaters and spores dingy deep yellow; *elaters fusiform*, 5–6 μ at thickest part, simple or frequently branched, tips attenuated into a long, smooth, very fine, straight or flexuous spine, *spirals crowded, thin,* not prominent; spores globose, *smooth*, 10–12 μ diameter.

On wood, Britain. (Carlisle ! * Dr. Carlyle.) (Type in Herb. Kew.) Sporangia in fascicles of 3–5; 2–3 mm. high. Superficially resembling some forms of *Trichia fragilis*, but perfectly distinct in the smooth spores, and the narrow, crowded, and not at all prominent spirals of the elaters which are frequently branched near the tips, and above all in the organic lumps of a deep reddish-purple colour which line the inside of the wall of the sporangium and the hollow of the stem. The colouring matter in the organic masses is soluble in dilute potassic or ammonic hydrate.

* * *Elaters cylindrical.*

Trichia heterotricha, Balf. fil., fig. 16.

"Sporangia sessile in clusters, dark yellow, wall thick, tough and leathery, inner layer areolate; elaters few, cylindrical, ·0071 mm. diameter (thickenings excluded), with walls of medium thickness, irregularly and variously thickened, either *with spines often twice diameter of elater, or with short prickles or warts, or with complete or half-rings, or sometimes with interrupted and irregular spirals leaving large intervening unthickened portions,* swollen towards the extremities, and ending in a tapered, rarely smooth, arcuate or twisted point, in length twice the diameter of elater, tube ·0035 mm. diameter terminating in the swelling of elater, or sometimes continued to the apex; spores globose, ·0160–·0178 mm. diameter, with a very thick *smooth* membrane.

Balf., Grev., v. 10, p. 117; Sacc., Syll., n. 1505.

In Herb. Currey. No locality. On bark. (Type in Herb. Kew. !)

A species resembling most nearly forms of *Tr. varia*, Pers., but

* The sign ! signifies that a specimen has been examined from the locality indicated.

the few elaters with the very varying sculpturing and the larger smooth spores sufficiently separate them."

A very distinct species, characterized by the very irregular ornamentation of the elaters and the large smooth spores. The type specimen is in the Currey collection, now in the Kew Herbarium, and although no locality is given, the species is in all probability British.

B. *Spores with rounded warts.*

* *Elaters fusiform.*

Trichia fragilis, Rost., figs. 14 and 28.

Sporangia pyriform or subglobose, *stipitate*, either solitary or fasciculate on a common stem, colour variable, most frequently blackish brown, sometimes paler brown or yellowish, stem dark, wrinkled, equal or attenuated upwards, erect or drooping; mass of capillitium and spores *separated from the hollow stem by a membrane*, varying from dull orange to clear yellow: *elaters fusiform*, 4–5 μ *at the thickest part, spirals flat, rather broad, not very prominent, tips smooth, tapering to a thin point*; spores globose, *minutely warted*, 11–14 μ diameter.

α. *genuina.* Sporangia pyriform, solitary or fasciculate, clear or blackish-brown, opaque; mass of capillitium and spores varying from reddish-brown to dirty ochre; stem erect.

β. *Lorinseriana.* Sporangium pyriform, solitary or fasciculate, reddish-brown, polished; mass of capillitium and spores dirty ochraceous; stem generally drooping.

γ. *serotina.* Sporangia clavate or pyriform, solitary or fasciculate; mass of capillitium and spores clear yellow or ochraceous; stem erect.

δ. *lateritia.* Sporangia subglobose, solitary or fasciculate, almost black; mass of capillitium and spores dark brownish-orange; stem erect, attenuated upwards.

Trichia fragilis, Rost., Mon., p. 246, figs. 203, 204, 225, 226 (in part); Cooke, Brit. Myx., p. 63, figs. 203, 204, 225, 226 (in part); Sacc., Syll., n. 1494 (in part); Balf., Grev., v. 10, p. 116 (in part).

Trichia lateritia, Lév., Ann. Sci. Nat., ser. iii. vol. v. p. 167 (in part).

Trichia botrytis, Schroeter, p. 112 (in part); Raunk., Myx. Dan., p. 67 (in part).

Sphærocarpus fragilis, Sow., t. 279.

Exsicc.—Cooke, Fung. Brit., 612! (as *Trichia Neesiana*)! Rab., Fung. Eur., 244 (as *Trichia pyriformis*, Batsch)! Jack, Leiner u. Sitzenb. Krypt. Badens, 329! (as *Trichia pyriformis*, Hoffm.); Erbar. Crittogam. Ital., 640! (as *Trichia fallax*, b. Pers.); Ellis and Everhart, N. Amer. Fung., ser. iii. n. 2097 and 2098! Fuckel, Fung. Rhen. 1437! (as *Trichia pyriformis*, Hoffm.).

On wood, twigs, &c. Britain (Brighton! Kew! Gloucester!

Orton Wood, Leicester! Castle Howard, Yorks! Carlisle! Appin, N.B.!)! France! Germany! Sweden! Bohemia! Belgium! Italy! Finland! Denmark! United States! Canada! Chili! Ceylon! S. Africa! S.W. Australia! Tasmania! New Zealand!

In the form and colour of the sporangia, and in the colour of the capillitium and spores, the present species varies considerably, the constant characters are the fusiform elaters with flat bands and smooth taperings tips, and the delicately warted spores. The plants vary from 2–4 mm. in height, and the sporangia may be solitary on the stem, or in fascicles of from 2–7, in which case the common stem is obviously composed of several stems more or less confluent, or entirely welded together and often twisted. The elaters are in rare instances branched towards the tips. I have had an opportunity of examining the type specimen of *Trichia lateritia*, Lév., in the Herbarium of the Paris Museum, and find that it agrees exactly in the elaters and spores with *Trichia fragilis;* the spores are certainly warted, quite as much so as in *T. fragilis*, although under a quarter-inch objective they would probably be described as smooth. Rostafinski does not appear to have been acquainted with *T. lateritia*, or at all events, not with the type specimen, as his description of the species is copied from Leveille. The British specimen from Orton Wood, described by Professor Balfour, has warted spores.

The size of the warts on the spores varies in specimens from different localities, and in some instances they are very minute, as in No. 2097 of Ellis and Everhart's N. American Fungi.

(Rostafinski's Synonyms.)

Lycoperdon bombacinum, Batsch, El., p. 153 (1783).

Stemonitis botrytis, Pers., in Gmel., Syst., 1468 (1791).

Trichia botrytis, Pers. Disp., p. 9 (1797); Ic. Pict., t. 12, f. 1, 2.

Trichia botrytis, β minor, Pers. Disp., 54 (1797).

Trichia serotina, Schrad., Journ., t. 3, f. 1 (1799); Eng. Fl., v. p. 310; Cooke, Hdbk., No. 1181.

Sphærocarpus fragilis, Sow., t. 279 (1803).

Trichia notata, Fl. Dan., 1680 (1823).

Trichia badia, Fr., Stirp. Femsj., 83 (1823).

Trichia pyriformis, Fr., S. M., iii. 184 (1829); Curr. Mic. Journ., iii. t. 2, f. 9, 10; Cooke, Hdbk., No. 1178.

Trichia Lorinseriana, Corda, Ic., f. 228 D (1837); Curr., Micr. Journ., v. p. 129; Cooke, Hdbk., No. 1180.

Trichia pyriformis, β serotina, Rtfki., in Fckl., Symb. 2, N. 75 (1873).

Craterium floriforme, Schw., Am., No., 2307.

Alwisia bombarda, B. and Br., Ceylon Fungi, No. 784, t. ii. f. 6, (1873).

Trichia purpurascens, Nyl.

Sporangia stipitate, ovate or spherico-ovate, solitary or gregarious, *purplish-red*, opaque; stem striato-rugose (when dry), erect or cernuous, rather firm and thickish, coloured like the sporangium, which it equals in length; elaters yellow, 5 μ thick at the centre, *attenuated at each end into a smooth, rather flexuous, very long, tapering apiculus*, about 45 μ long; spirals three, rather prominent, separated by interstices from two to three times their width; spores globose, *verruculose*, yellowish ochre; yellowish under the Microscope, 9–11 μ diameter. Nylander, in Sällsk. pro Faun. et Flor. Fenn. notis. Ny. Ser. H, I, p. 126; Sacc., Syll., 1508; Myx. Fenn., iv. p. 137.

On old fir-wood, Helsingfors, Finland.

Of the above species I have seen no authentic specimen, but, judging from the description, it appears closely related to, if really distinct from *Trichia fragilis*.

Trichia fallax, Rost., figs. 21 and 27.

Sporangia pyriform or broadly clavate, stipitate, ochraceous, olive-yellow, or sometimes with a tinge of olive-green, dull or shining; *stem dark, usually wrinkled longitudinally, filled with cells which towards the apex pass by degrees into normal spores;* mass of elaters and spores yellow; *elaters simple or branched, fusiform*, 5–6 μ at thickest part, ending in long, smooth, tapering tips, spirals rather close, not prominent; spores globose, *minutely verruculose*, 10–13 μ diameter.

The following forms are recognized by Rostafinski, but they do not appear to be so well defined as the forms of some other species.

a. minor. Sporangia pyriform or clavate, dirty ochre or brownish, about 1·5 mm. high.

β. genuina. Sporangia pyriform or clavate, ochraceous or olive-green, 2–3·5 mm. high.

γ. cerina. Sporangia pyriform, usually olive-yellow, very thin, and when empty shining, 4–5 mm. high, elaters simple or branched.

Rost., Mon., p. 243, figs. 211, 221, 222, 233–236; Cooke, Myx. Brit., p. 61, figs. 211, 221, 222, 233–236; Sacc., Syll., v. 7, part i., n. 1493; Schroeter, p. 111; Raunk., Myx. Dan., p. 66, t. 4, f. 4.

Exsicc.—Fuckel, Fung. Rhen., 1435 (*Trichia fallax*, var. *minor*); Jack, Leiner u. Sitzenberger, Krypt. Badens, 420; Rab., Fung. Eur., 1666; Moug. and Nestler, 284 (as *Trichia clavata*); Roum., Fung. Sel. Gall., 42 (as *Licea circumscissa*, Pers., var. *pannosa*, Roum.).

On rotten wood. Britain, (King's Cliffe, Norths.! Kew! Bristol! Scarborough! Carlisle! Linlithgow and Glamis, N.B.! Coed Coch!); France! Germany! Switzerland! Denmark! United States! Cuba!

A well-marked species, characterized externally by the pyriform sporangium supported on a dark-brown or almost black, longitudinally wrinkled stem. The microscopic characters are also well marked,—spores minutely verruculose, elaters fusiform, spirals close, not prominent. In some plants the elaters are simple, and often in other plants all branched, the number of ends varying from three to ten.

Rostafinski in his monograph represents a portion of an elater belonging to the present species (fig. 222) as having *flattened* spirals, which is not correct.

(Rostafinski's Synonyms.)

Mucor capitulis pyriformis, Fl. Dan., t. 647, f. 2 (1770).
Mucor miniatus, Jacq., Misc., t. 229 (1778).
Stemonitis flavescens, Schrank., p. 19 (1792).
Lycoperdon aggregatum, Liljeb., Fl. Scan., 460 (1792).
Lycoperdon pusillum, Hedw., Abh., t. 3, f. 2 (1793).
Trichia fallax, Pers., Obs., iii. t. 4, 5 (1797); Nees, f. 113; Corda, Ic., iv. 97; Eng. Fl., v. 319; Cooke, Hdbk., 1182.
Physarum pyriforme, Schum., Saell., 1448 (1803).
Trichia virescens, Schum., Saell., 1459 (1803).
Trichia cerina, Ditm., t. 25 (1817); Curr., Micr. Journ., v. p. 127; Cooke, Hdbk., n. 1184.
Trichia fulva, Purt., Mid. Fl., 1534 (1817).
Trichia clavata, Wigand, No. 3 (1863).
Trichia furcata, Wigand, No. 4 (1863).
Arcyria elongata, Bong. Herb.

** *Elaters cylindrical.*

§ *Spirals not spinulose.*

Trichia nitens, Fries, fig. 11.

Sporangia sessile on a broad base, crowded, circular or subangular, *bright yellow, smooth and shining*; mass of elaters and spores dull orange; *elaters cylindrical*, 14–16 μ *thick*, rather short, ending in a very short, abrupt, smooth apiculus, spirals rather prominent, distant, not spinulose; *spores globose, warted*, 14–16 μ *diameter.*

(Specimen from Fries in Herb. Kew, and named by him "Trichia nitens, Fr.")

On wood. Upsala!

A very fine and distinct species, externally closely resembling *Oligonema nitens* (Lib.), Rfki., distinct from *T. varia* in the polished, shining sporangia, and the thicker elaters with very short, abruptly apiculate tips.

Trichia varia, Rost., fig. 17.

Sporangia scattered or aggregated, sessile on a broad base, turbinate, or subspherical and distinctly stipitate, smooth, yellow, dirty ochraceous, sometimes tinged olive, stem when present, blackish; mass of capillitium and spores yellow; *elaters cylindrical*, 4–5 μ thick, *spirals distant, prominent, more especially on the convex side when the elaters are curved*, tips smooth, tapering, straight or bent, 8–10 μ

long, but sometimes shorter, the elaters are sometimes swollen at the commencement of the tapering tips; spores globose, *minutely warted*, 10–14 μ diameter.

a. nigripes. Sporangia stipitate, stem blackish, length variable.

β. sessilis. Sporangia sessile, base narrow.

γ. genuina. Sporangia sessile on a broad base, often compressed, circular or sausage-shaped.

The above forms cannot be considered as true varieties, the first is most permanent, the other two may frequently be seen passing into each other in the same cluster.

Rost., Mon., p. 251, figs. 191, 202, 208, 212, 218, 237; Cooke, Myx. Brit., p. 63, figs. 191, 202, 208, 212, 218, 237; Schroeter, p. 112; Sacc., Syll., n. 1497; Raunk., Myx. Dan., p. 65, t. 3, f. 14, and t. 4, f. 3.

Exsicc.—Jack, Leiner u. Sitzenberger, Kr. Bad., 419! Karst., Fung. Fenn., 288! Fuckel, Fung. Rhen., 1431! Roum., Fung. Gall., 1101! Rab., Fung. Eur., 799 and 2137! Sydow, Myc. March., 487! Rab., Fung. Eur., 2138! (as *Trichia nigripes*, = *T. varia*, v. *nigripes*); Fuckel, Fung. Rhen., 1433! (as *Trichia nigripes*, = *T. varia* v. *nigripes*); Roum., Fung. Gall., cent. xiv. n. 1315! (as *Trichia chrysosperma*, = *Trichia varia*); Karst., Fung. Fenn., 699! (as *Trichia chrysosperma*, = *Trichia varia*); de Thum., Myc. Univ., 1999! (as *Trichia fallax*); Sacc., Myc. Ven., 794!

On bark, wood, moss, &c., Britain (Weybridge! Kew! Bishops' Wood, Highgate! Staunton, Notts! Bristol! Scarboro'! Carlisle! Abergavenny! Appin, N.B.!); France! Denmark! Germany! Finland! Italy! Bohemia! United States! Tasmania! New Zealand!

A well-marked species without marked affinity with any known species, differing considerably in the form of the sporangia, and presence or absence of a stem, but readily recognized by the minutely warted spores and cylindrical elaters with distant, prominent spirals. In the specimen in Rab., Fung. Eur., n. 2137 (Brit. Mus. copy), the warts show a tendency to become elongated and flattened, thus forming a transition to the section with the spores having bands not connected into a network, but in other respects the plant is typical. The elaters are rarely slightly bifurcate at the tip, as shown by Rostafinski, fig. 237. The plant is pure white when immature.

(Rostafinski's Synonyms.)

a. Trichia varia, v. *nigripes*.

Mucilago minima, Mich., t. 96, f. 4 (1729).
Embolus albissimus, Hall, Herb., p. 8 (1742).
Embolus, Hall, No. 2138 (1768).
Mucor pyriformis, Scop., Fl. Carn., 492 (1772).
Mucor pomiformis, Leers, Fl. Herb., 1136 (1775).
Mucor lacteus, Leers, Fl. Herb., 1132 (1775).
Stemonitis pyriformis, Willd., Fl. Ber., 409 (1787).

Embolus lacteus, Hoff., Veg. Cr., t. 11, f. 3 (1790).
Sphærocarpus chrysospermus, Bull., t. 417, f. 4 (?).
Trichia olivacea, Pers., Obs. 1, 62 (1796).
Arcyria olivacea, Rausch (1797).
Trichia cylindrica, Pers., Obs. 11, 33 (1799).
Trichia cordata, Pers., Obs. 11, 33 (1799).
Trichia nigripes, Pers., Syn. 178 (1801).
a pyriformis, *β cordata*, *γ cylindrica*, *δ vulgaris*; Fl. Dan., t. 1313, f. 2; Curr., Micr. Journ., v. p. 128; Cooke, Hdbk., n. 1185.
Trichia craterioides, Corda, Ic., ii. f. 85 (1838).

γ. *Trichia varia*, v. *genuina.*

Lycogala luteum, Mich., t. 95, f. 4 (1729).
Mucor quintus, Schff., 296 (1770).
Mucor granulatus, Schff., 286 (1770).
Lycoperdon vesiculosum, Batsch, 283 (1786).
Sphærocarpus chrysospermus, Bull., t. 417, p. 4 (?).
Stemonitis varia, Pers., in Gmel., Sys., 1470 (1791).
Stemonitis vesiculosa, Gmel., Sys., 1470 (1791).
Trichia varia, Pers., Disp., p. 10 (1797); Eng. Fl., v. 320; Cooke, Hdbk., n. 1188.
Lycoperdon luridum, Hedw., Obs., t. xiv. (1802).
Trichia favoginea, Schum., Saell., 1455 (1803).
Trichia applanata, Hedw., in D. C. Organ., t. 60, f. 1 (1827).

Trichia proximella, Karst.

Sporangia stipitate or sessile, spherical or often irregularly subspherical, pale dirty ochre, rather shining, about 0·4 mm.; elaters *cylindrical*, yellow, 4–5 μ thick, very rarely furcate, apiculus oblique, smooth, in length about equal to the diameter of the elater or a little more, *spirals three or four, rather prominent*, separated by interspaces scarcely double their width; spores globose, *warted*, ochraceous or ferruginous ochre in the mass, under the Microscope yellow, 12–14 μ diameter. Karsten, Myc. Fenn., iv. p. 139; Sacc., Syll., n. 1507.

On wood. Finland.

Allied to *T. inconspicua*, but differs in the larger sporangia, spores, and elaters; the spirals on the elaters are also more prominent. (Karst.)

Trichia inconspicua, Rost.

Sporangia *very minute*, subspherical, *brown, shining*, collected in clusters or scattered, hypothallus absent; elaters *cylindrical*, 3·3 μ thick, tips pointed, 6–7 μ long, curved, sometimes with elongated swellings near the ends, *spirals* 3–4, *but slightly prominent*, rather close; spores *delicately verruculose*, 10–12 μ.

Rost., Mon., p. 259; Sacc., Syll., 1502.

Germany; France.

Trichia advenula, Mass. (n. sp.), fig. 38.

Sessile on a broad base, densely crowded, rarely scattered, circular, or subangular from mutual pressure, primrose-yellow, rather shining; *mass of capillitium and spores orange*; elaters *cylindrical*, 4–5 μ thick, *usually inflated at one or both ends and also with from* 1–3 *interstitial swollen portions*, beyond the swollen ends, *terminating in a thin straight or usually flexuous slender spine* 15–20 μ long, spirals very close, thin, but little prominent, almost obsolete on the inflated portions; spores globose, *minutely verruculose*, 12–14 μ diameter.

(Type in Herb. Berk., Kew.)

On rotten wood. Scotland (Glamis !). Forming densely crowded patches, 1–2 inches across. Most nearly related to *Trichia minima*, but distinguished by the long, slender tips to the elaters and the interstitial swollen parts; in *T. minima* the capillitium and spores are pale primrose in the mass, and not orange as in the present species.

Trichia minima, Mass. (n. sp.), fig. 18.

Sporangia crowded, sessile on a broad base, circular, elliptical, or irregular from mutual pressure, pale primrose-yellow; mass of elaters and spores same colour; *elaters cylindrical*, 6–7 μ *thick*, ending in smooth tapering points about 8–10 μ long, spirals thin, rather distant, not prominent, *without spines*; spores globose, *very minutely warted*, 10 μ *diameter*.

(Type in Herb. Kew.)

On wood. Britain (Oldham !).

Allied to *T. scabra*, but distinct in the smaller size of every part, and in the absence of spines on the spirals of the elaters. In colour resembling *T. chrysosperma*.

Trichia nana, Mass. (n. sp.)., fig. 12.

Sporangia scattered or aggregated, rarely crowded, sessile on a broad base, smooth, pale bright ochre, opaque, wall very thin; mass of elaters and spores pale primrose yellow; *elaters cylindrical*, 3–4 μ *thick, spirals irregular, very distant and prominent, tips abrupt*, the spirals usually running quite to the end; spores globose, *minutely verruculose*, 6–8 μ diameter.

(Type in Herb. Kew.)

On wood. Westbrook, Maine; U.S. !

Sporangia rarely exceeding ·5 mm. diameter, hemispherical or sausage-shaped and curved. By far the smallest of all known species, resembling superficially *Trichia minima*, from which it differs in the distant and prominent spirals of the elaters; in the latter character it agrees with *T. varia*, but differs in the spirals not being markedly more prominent on the convex side of bent elaters, the abrupt tips, and smaller size of every part. The elaters are rarely more than 200 μ long.

Trichia reniformis, Peck.

Sporangia gregarious or clustered, sessile, *subglobose or reniform, small, brown*; flocci few, short, sparingly branched; spores globose, *minutely echinulate*, yellow-ochre, sometimes tinged with green, ·0005 in. in diameter (= 12–13 μ).

Peck, Twenty-sixth Report of the State Museum, New York, p. 76; Sacc., Syll., n. 1510.

Owing to the scanty information respecting the elaters, the affinities of the present species are doubtful; may possibly be allied to *Trichia inconspicua*.

Trichia contorta, Rost.

Plasmodiocarp creeping, flexuous, subcompressed, umber or bay-brown; mass of elaters and spores yellow; elaters 2·5–3·5 μ, cylindrical, *tips usually swollen* and terminated by a long slender spine, there is sometimes an interstitial swelling; *spirals indistinct*; spores globose, *minutely warted*, 12–15 μ diameter.

Trichia contorta Rost., Mon., p. 259, fig. 229; Schroeter, p. 113; Sacc., Syll., v. 7, pt. i. n. 1503; Cooke, Myx. Brit., fig. 229; Raunk., Myx. Dan., p. 68, t. 3, f. 13.

On rotten wood. Britain; Germany; France; Denmark; Sweden; Australia.

The peculiar cylindrico-compressed, flexuous plasmodiocarp of a dark brown colour, and the elaters with long spine-like tips and indistinct spirals mark the present species.

(Rostafinski's Synonyms.)

Lycogala contortum, Dit., in Sturm. Deut. Cr. Fl., t. 5 (1817).
Trichia reticulata, *b*, Grev., Sc. Cr. Fl., t. 266 (1827).
Perichæna contorta, Fr., S. M., iii. 192 (1829).
Licea contorta, Wallr., Fl. Cr. Ger., n. 2110 (1833).
Hemitrichia contorta, Rost., ap. Fuckel Syn. 2, Nach. p. 75 (1873).

§ § *Spirals spinulose.*

Trichia scabra, Rost., fig. 13.

Sporangia rarely scattered, typically gregarious, sessile on a broad base, seated on a hypothallus, circular or polygonal from mutual pressure, varying from yellow through orange to pale brown; mass of elaters and spores orange; *elaters cylindrical*, 6–8 μ thick, ending in smooth, acute, straight or slightly bent tips 7–10 μ long, spirals not very prominent, rather distant, *bearing numerous short acute spines*; spores globose, *epispore warted*, warts rather large, numerous, 8–12 μ diameter.

Rost., Mon., p. 258, figs. 214–217 and 239; Cooke, Myx. Brit., figs. 214–217 and 239; Schroeter, p. 113; Sacc., Syll., n. 1500; Raunk., Myx. Dan., p. 68, t. 4, f. 2.

Trichia scabra, v. *aurea*, Cooke, Myx. U. States, in Ann. Lyceum Nat. Hist. N. York, vol. xi. No. 12, p. 403.

Exsicc.—Ellis and Everh., N. Amer. Fung., 2100! Roumeg., Fung. Gall. Exs., 1005!

On wood, moss, &c. Britain (Queen's Cottage Wood, Kew! Birmingham! Taunton, Notts! Scarboro'!)! France! Germany! Denmark! United States! Ceylon!

Spores resembling those of *T. nitens*, but the latter is separated by the polished sporangia and absence of spines on the spirals of the elaters. The last character also separates *T. varia* from the present species.

Var. *analogia*, Cooke. Elaters with the spirals furnished with only rudimentary spinules, or in some instances entirely absent.

Cooke, Myx. U. States, in Ann. Lyc. Nat. Hist. N. York, vol. xi. n. 12, p. 403.

On rotten wood. New York!

Trichia Decaisneana, De Bary.

Sporangia pyriform, brownish flesh-colour, shining, *stipitate*; stem red then blackish brown, very much plicate, equal; mass of capillitium and spores yellowish flesh-colour, *inclosed in an inner membrane connate with the outer wall of the sporangium*; elaters *cylindrical, inflated near the tips and ending in smooth, tapering, curved spines* 3–6 times as long as diameter of elater, spirals 5–6, *flexuous, spinulose*, in some cases parts of the elaters have the spirals in the form of distant ridges or wrinkles; spores *delicately warted*, 10–11 μ diameter.

De Bary in Rost., Mon., p. 250, figs. 219, 220; Schroet., p. 112; Cooke, Brit. Myx., figs. 219, 220.

On *Jungermannia*. Germany.

According to Schroeter the spores measure from 11–13 μ, the elaters have four spirals, and are 4–5 μ thick. As these measurements differ from those given by the author of the species, the question that naturally suggests itself is, has Schroeter had the true species of De Bary in view? In Rostafinski's monograph, fig. 220, the spirals of the elaters are represented as broad and *flat*, no spines are shown in the figure.

Trichia persimilis, Karst.

Sporangia aggregated, sessile, spherical or nearly so, yellowish-brown, shining; elaters cylindrical, yellow, 4–6 μ thick, tips smooth, commonly curved, twice the length of the diameter of the elater, spirals 3–4, prominent, rather distant, *with scattered, spreading, curved, hyaline spines* 8–10 μ *long, and* 4–6 μ *thick*; spores spherical, *warted*, ochraceous, 13–14 μ diameter.

Karsten, in Not. Sällsk. pro Faun. et Flor. Fenn. Förh., 1868, ix. p. 353; Karst., Myx. Fenn., p. 139; Sacc., Syll., n. 1506.

On birch-wood. Finland.

Karsten describes the colour of the sporangia as "subargillaceo-castaneis."

I have not had an opportunity of examining the present species, the elaters—unless some inaccuracy has crept into the description—being very remarkable in being furnished with spines as thick as themselves, and 8–10 μ long, a character which alone stamps the species.

C. *Spores with elongated, raised, flat bands not combined to form a network.*

* *Bands plain.*

Trichia sulphurea, Mass. (n. sp.), fig. 3.

Sporangia densely crowded, sessile on a broad base, circular, subangular or reniform in outline, pale yellow, smooth; mass of elaters and spores pale lemon-yellow; *elaters cylindrical*, simple, or frequently branched, especially near the tips, 9–10 μ *thick, spirals crowded*, not very prominent, tips not thickened, smooth, acute, straight or slightly curved, 10–14 μ long; spores globose, *with numerous short, slightly raised, straight or crescent-shaped flat bands*, 10–14 μ diameter.

(Type in Herb. Berk. Kew, n. 10,906.)

On wood. Ceylon!

A very fine large species, sporangia ·5–1 mm. diameter. The distinguishing features are the thick cylindrical elaters with crowded spirals, and the numerous short flat bands on the spores, which under a low power look like warts. From 15–20 bands are present on a hemisphere of a spore. Most nearly related to *Tr. nitens*, but in the latter the markings on the spores are true rounded warts, and the spirals on the elaters are much wider apart.

Trichia Balfourii, Mass. (n. sp.), fig. 4.

Sporangia sessile, base broad or narrowed, crowded, hemispherical or angular from mutual pressure, clear primrose-yellow; mass of elaters and spores deeper and duller yellow; elaters cylindrical, 9–10 μ thick, sometimes swollen near the apex, which is *abruptly narrowed into from one to three short, smooth spines*, generally more or less bent, spirals thin, rather distant, not prominent, *furnished with scattered rudimentary spines;* spores globose, with a few broad, slightly raised, *flat bands, not punctate, nor combined in a reticulate manner*, 16–18 μ diameter.

With *Trichia Jackii*, in Herb. Kew, marked "*Trichia Jackii*, spores not typical," by Professor I. Bayley Balfour. (Type in Herb. Kew.)

On wood. Cape of Good Hope!

Closely related to *T. Jackii*, but readily known by the absence of punctiform markings on the raised bands of the spores. In *T. verrucosa*, the bands on the spores are much shorter and more numerous, looking under a 1/4 objective, like warts, the elaters are also very different, having simple stouter tips and crowded spirals, which are not spinulose.

* * *Bands with minute depressions.*

Trichia abrupta, Cooke, fig. 2.

Sporangia densely gregarious on a well-developed hypothallus, sessile on a broad base, generally more or less polygonal from mutual pressure, clear pale yellow; mass of elaters and spores orange; *elaters cylindrical*, 8–11 μ diameter, spirals rather distant, not prominent, with scattered rudimentary spinules, tips smooth and equal in thickness to elater for a length of 8–10 μ, then *abruptly terminating in two or three thin, tapering, straight or curved spines* 8–10 μ long; spores globose, with *numerous slightly raised, straight or curved flat bands furnished with minute depressions in a single row*, or rarely irregularly scattered, 10–16 μ diameter.

Cooke, Ann. Lyc. Nat. Hist. N. York, v. xi. No. 12, p. 404; Cooke, Myx. Brit., fig. 256 (without description); Sacc., Syll., n. 1511. (Type in Herb. Kew.)

On wood. Britain (Ken Wood, Hampstead! Scarborough!) Westbrooke, Maine, U.S.!

A very distinct and beautiful species, most nearly related to *T. Jackii* in the spores but distinguished by the more numerous and shorter bands, and by the branched tips of the elaters In the last named character it agrees with *T. Balfourii*, but in the latter the bands on the spores are not punctate. *T. intermedia* is distinguished by the presence of ridges on the elaters running parallel to their long axes between the spirals.

Trichia Jackii, Rost., fig. 5.

Sporangia generally crowded, sessile on a broad or narrow base, hypothallus well developed; circular, polygonal, or elliptical in shape, dull yellow; mass of elaters and spores yellow; *elaters cylindrical*, 5–7 μ thick, tips smooth, acute, straight or a little bent, spirals not very prominent, distant, smooth or with rudimentary spinules; spores globose, with a few slightly elevated, broad, *flat bands, which are slightly sinuous, sometimes branched, but not combined to form a network, surface of bands with a central row of minute depressions*, 12–15 μ diameter.

Rost., Mon., p. 258, f. 242; Cooke, Myx. Brit., f. 242; Balf., Grev., v. 10, p. 117; Schroeter, p. 113; Sac., Syll., n. 1500; Raunk., Myx. Dan., p. 69, t. 4, f. 5.

On wood, &c., Britain (Hassock's Gate, Brighton! Bishop's Wood, Highgate! Castle Howard, Yorkshire! Glamis, N.B.!). Germany! Italy! Switzerland! Denmark!

Most nearly related to *T. abrupta*, from which it is at once distinguished by the comparatively longer bands on the spores, which are also fewer in number, the undivided tips of the elaters, and the absence, or rudimentary nature of the spinules on the spirals.

Trichia intermedia, Mass. (n. sp.), fig. 1.

Sporangia subglobose, sessile on a broad base, crowded, often irregular from mutual pressure, smooth, shining, bright ochre; mass of capillitium and spores, clear pale chrome yellow; threads simple, cylindrical, about 10 μ thick, ending in a short smooth apiculus, spirals close, not prominent, sometimes branched, with a few short spines here and there, *connected by thinner raised bands* running parallel to the long axis of the thread; spores globose, with distant raised flat bands that rarely anastomose irregularly, *surface of bands with minute depressions*, usually arranged in a single row, 9–11 μ diameter. (Type in Herb. Kew.)

On trunks, Scarborough!

The spores closely resemble those of *Trichia Jackii*, but the spirals of the capillitium threads are connected by raised bands as in *Trichia chrysosperma*, and the spines are rare and rudimentary. Known from *T. affinis* by the bands on the spore not being uniformly combined with a network, and the presence of ridges connecting the spirals of the elaters.

D. *Spores with raised flat bands combined to form a network.*

* *Bands plain.*

Trichia chrysosperma, Rost., fig. 10.

Sporangia crowded, rarely scattered, sessile on a broad or narrow base, circular or irregular in form from mutual pressure, varying in colour from clear pale yellow to ochraceous cinnamon; mass of elaters and spores yellow; elaters cylindrical, 5–9 μ thick, tips smooth, acute, straight or slightly bent, not longer than diameter of elater, spirals not very prominent, rather distant, sometimes with a few scattered rudimentary spinules, *connected by thin ridges running parallel to the long axis of the elater;* spores globose, with *rather deep, narrow, raised bands, combined into an irregular polygonal network, bands not punctate*, 12–15 μ diameter.

Rost., Mon., p. 255, figs. 209, 213, 240; Cooke, Myx. Brit., p. 64, figs. 209, 213, 240; Schroeter, p. 113; Sacc., Syll. n. 1498; Raunk, Myx. Dan., p. 69, t. 4, f. 1.

Exsicc.—Rab., Fung. Eur., 567, 2137! (called *Trichia varia*, Pers.); Jack, Leiner u. Sitzenberger Krypt. Badens, 622! Ellis, N. Amer. Fung., 1112!

On wood, bark, moss, &c. Britain (Highgate! Castle Howard, Yorks! specimen in "Dawson—Turner's Herb." at Kew, without locality!) Germany! France! Belgium! Denmark. United States! According to Rostafinski the present species occurs in Finland, but Karsten's plant, called *Trichia chrysosperma* in Karst., Fung. Fenn., n. 699, is *Trichia varia* in the Kew copy.

Respecting the synonymy of the present species Professor Bayley Balfour writes as follows:—"Under *Tr. chrysosperma*, Rostafinski quotes a very extensive synonymy. I have devoted some time to the study of the synonyms quoted, but I am not satisfied from the descriptions and figures by the several authors that the identification in all cases is correct. Indeed, I do not see how, by such descriptions and figures as are given, one can determine which of the sessile aggregated species—*Tr. chrysosperma*, *Tr. scabra*, Rtfki., *Tr. Jackii*, and *Tr. affinis*, De Bary, all having a general likeness in habit—is referred to by the older authors. A correct estimate would only be possible after examination of the type specimens. How many of these Rostafinski was enabled to study I do not know. As I have not yet had the opportunity of seeing a sufficient number of these, I shall not at present criticize in detail the synonymy, but that great confusion has occurred in the identification of the several species of sessile, aggregate Trichias, an examination of the specimens in the Kew Herbarium has convinced me.

. . . But first let me say a word as to the name *Trichia chrysosperma*, as adopted by Rostafinski. As I have stated, he ascribes it to Bulliard ('Hist. des Champign.,' T. (1791) 131, t. 417, f. 4), who describes a form, *Sphærocarpus chrysospermus*, presenting three varieties, the first of which is taken by Rostafinski as the type of the species *Trichia chrysosperma*, Bull. Now, in Bulliard's description and figures there is nothing regarding the elaters and spores to show that his species really conforms with the definition of the species given by Rostafinski, and is not such another form as *Tr. affinis*, De By. Indeed, as I have mentioned already, Fuckel quotes the species as being in part De Bary's *Tr. affinis*, though I do not know the ground for his identification. But, supposing Rostafinski's identification to be correct, there is no warranty for affixing Bulliard's name to the species, as he describes it under another genus. The real authors of the name, it would appear, are Lamarck and De Candolle, who ('Synops. Plant.,' No. 673, and again, 'Flor. Franc.,' ii. 250) describe under this name what they take as identical with Bulliard's *Sphærocarpus chrysospermus*, which they quote as a synonym. Bulliard has no claim to the name. Rostafinski having adopted the name for the form he so carefully describes, there need be now no longer any difficulty or confusion in the determination of the species, as it is preserved in herbaria or gathered at the present day, whatever decision be come to as regards synonyms." *

So much for the synonymy. From the above it appears that it is more than doubtful as to whether the variety of Bulliard's plant was the same as the species described by Rostafinski, a doubt not cleared up by the description given by Lamarck and De Candolle; and further, as types, so far as I have been able to ascertain, do not exist, it

* Grev., x. p. 118.

will be wise to consider Rostafinski as the author of the species in question.

Agreeing more especially in spore sculpture with *Tr. dictyospora* and *Tr. Archeri*, for distinctive features, see under these species.

The specimen in Rabenh., Fung. Eur., n. 567, has the spirals of the elaters furnished with scattered minute spinules.

(Rostafinski's Synonyms.)

Lycoperdon gregarium, Retz., Obs. 1, 33 (1769).
Lycoperdon favogineum, Batsch., f. 173 (1786).
Stemonitis pyriformis, Roth., Fl. Germ., 1, 548 (1788).
Sphærocarpus chrysospermus, Bull., t. 417, f. 4 (1791).
Stemonitis favoginea, Gmel., Syst., 1470 (1791).
Trichia nitens, Pers., Obs. 1, 62 (1796).
Trichia favoginea, Pers., Disp., 10 (1797).
Trichia chrysosperma, D. C., Fl. Fr., 673 (1805); Eng. Fl., v. 320; Cooke, Hdbk., No. 1187; Fungi Britt., ii. 524, 527.
Trichia turbinata, Purt., Brit., ii. 1115 (1817).
Clathroides flavescens, Hall., t 1, f. 7 (1742).
Trichia, Hall, 2168, t. 48, f. 7 (1768).
Lycoperdon aggregatum, Retz., Fl. Scan., 1627 (1769).
Lycoperdon epiphyllum, Light, Fl. Sc., 1069 (1777).
Clathrus turbinatus, Huds., Fl. Angl., 632 (1778); Bolt., t. 94, f. 3.
Trichia pyriformis, Vill., Fl. Dauph., 1060 (1789).
Stemonitis pyriformis, Pers., in Gmel., Syst., 1468 (1791).
Trichia turbinata, With., Arr., iv. 480 (1792); Sow., t. 85; Eng. Fl., v. 320; Cke., Hdbk., n. 1186.
Trichia pyriformis, Pers., Disp. 10 (1797).
Trichia olivacea, Pers., Obs. I., 62 (1796) in part.
Trichia ovata, Pers., Obs. II., 35 (1796); Schum., Saell., 1454; Fl. Dan., t. 1313, f. 1.
Trichia vulgaris, Pers., Obs. II., 32 (1799).
Physarum contextum, Spr., Syst., ix. 20 (1817).

Trichia verrucosa, Berk., fig. 9.

Sporangia pyriform, brown or chestnut, shining, passing downwards into *a long slender stem*, simple or botryoid, scattered, *springing from a thick, broadly effused hypothallus;* mass of capillitium and spores ochraceous; threads of capillitium simple, *cylindrical*, 8–10 μ thick, with smooth tapering ends of variable length and straight or curved, spirals close, thin, not prominent; spores globose, with narrow, *raised flat bands combined into a few large irregular polygonal* meshes, 14–16 μ diam.

Berkeley, in Flora Tasm., p. 269.

(Type in Herb. Berk., n. 10,906.)

On wood. Tasmania! (Archer). Differs from *Trichia chrysosperma* and *T. dictyospora* in the scattered stipitate sporangia springing from a stout hypothallus, and also in the characters of the capillitium threads and spores. Plants 2–3 mm. high. Usually not more than one complete polygon is present on a hemisphere of the spore.

Trichia Kalbreyeri, Mass. (n. sp.), fig. 8.

Sporangia crowded, sessile, often irregular from mutual pressure, pale yellow, smooth; mass of capillitium and spores pale primrose-yellow; threads of capillitium *cylindrical*, 9–10 μ thick, with short, smooth, tapering ends, *spirals not prominent, thin, close;* spores globose, with raised *narrow flat bands forming an irregular polygonal network*, 11–14 μ diam.

(Type in Herb. Kew.)

On wood and living leaves. New Granada! (W. Kalbreyer).

Externally resembling *Trichia chrysosperma*, but readily distinguished by the absence of the ridges between the spirals on the capillitium threads, and the narrow bands forming more numerous polygons, from two to three complete ones being present on a hemisphere of the spore.

** *Bands with minute depressions on the surface.*

Trichia affinis, De Bary, fig. 7.

Sporangia sessile on a broad base, crowded, circular or elliptical, often seated on a well-developed hypothallus, clear pale yellow; mass of elaters and spores pale yellow; *elaters cylindrical*, 4–7 μ thick, ending in short, tapering, smooth tips, *spirals thin, rather close, not prominent*, sometimes furnished with scattered rudimentary spinules; spores globose, with broad, slightly raised, flat bands *combined into a few irregular polygons, surface of bands with a central row of minute pits*, 10–14 μ diameter.

De Bary, MS., in Rost., Mon., p. 257, fig. 241; Cooke, Myx. Brit., fig. 241; Schroet., p. 113; Sacc., Syll., n. 1499?

Exsicc.—Cooke, Fung. Brit. 614! (as *T. chrysosperma*); Cooke, Brit. Fung., ed. 2, 527! (as *T. chrysosperma*); Thum., Myc. Univ., 2000! Fuckel, Fung. Rhen., 1432!

On wood, twigs, moss, &c. Britain (Epping! Scarborough! Brandon! Castle Howard, Yorks.! Lillieshall! Weybridge! Appin, N.B.! Chislehurst! Carlisle!). Europe! United States! Cuba! Tasmania!

Superficially resembling *T. chrysosperma*, from which it is known by the row of pits on the raised bands of the spores. The bands are united into very few polygons, rarely more than one being complete on a hemisphere of the spore. Rarely there is a free end to the band. For distinctions from *T. intermedia* and *T. superba*, see under these species. It is doubtful what species is intended in Sacc. Syll., as the spirals of the elaters are said to form a network, and the punctæ on the bands are not mentioned.

Trichia superba, Mass. (n. sp.), fig. 6.

Botryoid, rarely simple. *Sporangia broadly obovate*, pale yellow, common stem more or less wrinkled longitudinally, often twisted, colour of the sporangium above becoming orange downwards, springing from a well-developed hypothallus; mass of capillitium and spores deep yellow; elaters simple, *cylindrical*, 9–11 μ thick, with abruptly tapering, smooth, short ends, often more or less bent, spirals close, thin, but little prominent; spores globose, *with raised flat bands combined into a polygonal network; bands with a row of minute depressions*, 17–20 *μ diameter.*

(Type in Herb. Kew.)

On mosses and logs. New Zealand!

Allied to *Trichia affinis*, but known by the much larger spores with smaller and more numerous reticulations, and the obovate sporangia arranged in a botryoid manner, and supported on a long stem.

Plants scattered, 3–4 mm. high, stem about equal in length to the sporangium, thin and weak, so that the sporangia are often drooping. From three to four polygons present on a hemisphere of the spore.

Trichia Kickxii, Rost.

Sporangia spherical, sessile, *in several crowded strata forming cakes some mm. high, and sometimes several cm. long and broad*; walls of single sporangia rigid, *flesh-colour, polished and shining*; elaters simple, either flexuous or curved into circles, 4·2 μ thick, spirals two, not very prominent; tips obtuse; spores *with an irregular network*, 14–15 μ diameter.

Rost., Mon. App., p. 40; Sacc., Syll., n. 1504.

Trichia pusilla, Schroeter.

Sporangia subglobose, *very small*, 0·3–0·5 mm. diameter, gregarious, scattered or collected in clusters, golden or brownish-yellow, smooth, shining, fragile; hypothallus absent; *elaters very short, about* 100 *μ long*, 4–5 *μ thick, here and there thickened, apices rounded, often mucronate and curved*, 4–5 μ long; spirals 2–3, slightly prominent, *here and there inconspicuous;* spores globose, unequally *costulato-reticulate*, 11–12 μ diameter.

Schroeter, p. 114; Sacc., Syll., 1509.

On bark. Germany.

Oligonema, Rost.

Wall of sporangium single, dehiscing irregularly; capillitium composed of free, simple, or branched elaters, furnished with ring-like thickenings, or rudimentary spirals, tips obtuse; spores globose.

Rost., Mon., p. 291; Cooke, Myx. Brit., p. 77; Sacc., Syll., p. 436.

Agreeing with *Trichia* in the free elaters, but distinguished by the rudimentary markings on their walls, never having more than a single, indistinct, very open spiral, which may be present on one part of an elater, and absent on another part, or not unfrequently altogether absent from the elaters of one sporangium, and present on some of those in another sporangium taken from the same group. A type of ornamentation on the walls of the elaters in the present genus consists of annular or ring-like thickenings, which present the appearance of thin, flat, circular, perforated discs, rather larger than the diameter of the elater, and placed at right angles to its long axis. These annular ridges are not peculiar to the present genus, but occur in *Cornuvia*, and also in *Didymium Hookeri*, Berk., where they are coloured. In rare instances, the two ends of an elater coalesce and form a closed ring, as figured by Rostafinski in *Oligonema nitens*, Rost., Mon., fig. 198.

Five species known; three European, one North America, one N. Africa.

A. Spores warted.

Oligonema Broomei, Mass. (n. sp.), fig. 22.

Sporangia *scattered*, or aggregated in small clusters, depressed, circular or elongated and irregular, *dark brown, dull;* mass of capillitium and spores reddish ochre; elaters cylindrical, 3–4 μ thick, *irregularly branched, dull orange, furnished with narrow thickenings in the form of rings*, which are either scattered or 3–4 close together, tips obtuse; spores *rather coarsely warted*, globose, 13–14 μ diameter.

Type in Broome Herb. in Brit. Mus., marked "*Trichia serpula?*"

On bark. England (Warleigh!).

Sporangia 1–2 mm. across. Possessing several characters in common with *O. æneum*, but distinguished by the scattered, dark brown dull sporangia, branched elaters, and larger spores.

Oligonema æneum, Karst.

Sporangia *densely crowded*, often confluent and venulose, rarely scattered, orbicular or angular from mutual pressure, depressed, *shining, with copper, green, or olive metallic tints;* threads of the capillitium free, 2–3 μ *thick, with scattered thickenings in the form of circles;* spores globose, *warted*, rather ferruginous or pale reddish ochre, 12 μ diameter.

Karsten, Myc. Fenn., iv. p. 125; Sacc., Syll., n. 1487.

Finland.

Oligonema brevifilum, Peck.

Sporangia crowded in effused heaps, bright ochraceous-yellow; elaters few, short, *cylindrical or subfusiform;* spores globose, *rugose*, 11 μ diameter. Peck in 31st Rep. State Agric. Mus., p. 42; Sacc., Syll., n. 1489.

On mosses. Oneida, U.S.

In the diagnosis, Peck states that the elaters are "not septate," which probably means that the walls have no ring-like thickenings. The description is too imperfect to indicate its affinities and possibly also to insure its future identification.

B. Spores with raised bands combined into a network.

Oligonema nitens, Rost., fig. 29.

Sporangia densely crowded, often several layers superposed, sessile on a broad or slightly contracted base, *clear primrose-yellow, very smooth and shining*; mass of capillitium and spores yellow; elaters scanty, variable, 4-5 μ, thick, *simple or branched, perfectly smooth, or with scattered narrow rings, sometimes with an indistinct, very open spiral on the whole or portion only of an elater*, tips usually abrupt, rarely ending in a short apiculus; spores globose, *with narrow raised ridges of varying thickness, forming an irregular network*, 11–13 μ diameter.

Rost., Mon., p. 291; Schroet., p. 108; Sacc., Syll., n. 1488 (the colour of the sporangium described as "gilvo" by mistake).

Exsicc.—Lib., Pl. Crypt. Ard., fasc. iii. n. 227! (as *Trichia nitens*); Klotzsch, Herb. Myc. (Rabenh.) 137! (as *Tr. circumscissa*); Fuckel, Fung. Rhen., 2198! (as *Tr. nitens*).

On wood, bark, &c. France! Bavaria! Germany!

Sporangia ·5–1 mm. diameter, clear yellow, polished and shining. The elaters are very variable, in some sporangia simple and without a trace of spiral or ring-like thickening, in others the simple smooth elaters are mixed with others that are branched and ornamented as described above.

Var. *bavarica*, fig. 25, *elaters short, tips more or less acute, generally with a more or less distinct diffuse spiral*, 5–7 μ *thick*.

Oligonema bavarica, Balf. and Berl., Sacc., Syll., n. 1490.

Exsicc.—Thum., Myc. Univ., n. 399 and 1497!

On wood. Bavaria!

Professor Bayley Balfour in some notes on British Myxomycetes, 'Grevillea,' x. p. 119, writes as follows respecting the above variety:—"*Trichia bavarica*, Thum., Myc. Univers., No. 1497, is no Trichia. It is an Oligonema. Typical *Oligonema nitens* has few elaters without any pattern on the walls. In the De Thumen's specimens I find that the walls have a tendency to become spirally thickened, and the elaters sometimes are slightly pointed, and it, therefore, shows an approach to Trichia. But still the elaters are very few, and the whole plant is essentially an Oligonema, but I am not convinced as to its being *Olig. nitens*. De Thumen has sent out the same plant as *Trichia chrysosperma*, D.C., under No. 399, Mycoth. Univ."

Dr. Berlese, on the strength of the above statement, established the species *O. bavarica*, in Saccardo's Sylloge, as quoted above. In the Kew copy of Madame Libert's Exs., examined by Professor

Balfour, the elaters are mostly without ornamentation, but in Dr. Cooke's copy, now in the Kew Herbarium, and also in the British Museum copy, I find along with unornamented elaters, others presenting the markings described above. The variety differs in having thicker elaters with a more evident and constant spiral.

(Rostafinski's Synonyms.)

Trichia nitens, Libert, non Pers. ! in Lib., Plant. Arden. Collec., fasc. iii. No. 277 (1834).

Oligonema minutula, Mass., fig. 20.

Sporangia scattered, rarely aggregated, sessile on a narrow base, *lemon-yellow, dull*, mass of capillitium very scanty, elaters simple, short, cylindrical, 5–6 μ thick, *rugulose, and with a very open indistinct spiral*, tips obtuse, rounded; spores globose, with slightly raised, flattened bands forming a *network of numerous almost regular and equal-sized polygons*, 12–14 μ diameter.

Type in Herb. Berk., Kew, n. 10,902, marked "*Trichia minutula*, D.R. et Montag., Algiers."

On wood. Algiers!

Related to *O. nitens*, but known by the scattered, dull sporangia, and the very few short elaters having thick rugulose walls with an indistinct spiral. In rare instances a swollen portion 15–20 μ long and 8–12 μ thick is present near the middle of an elater, but there is no indication of the narrow, ring-like thickenings as in *O. nitens*. From 7–9 complete polygons present on a hemisphere of a spore.

Alwisia, B. and Br.

Sporangia fasciculate on a common stem, wall single, dehiscing irregularly; capillitium scanty, elaters attached to the wall at the base of the sporangium, tips free, abrupt or attenuated and occasionally bifid, walls thin, spirals and spinules rudimentary; spores globose.

B. and Br., Journ. Linn. Soc., xiv. p. 87, t. 2, f. 6, and xv. t. 2, f. 1.

Trichia, Rost., Mon., p. 246 (in part); Sacc., Syll., vii. pt. i., n. 1494 (in part).

In the generic diagnosis given by Berkeley and Broome, the sporangia are described as subcoriaceous, but examination of the type specimens shows this to be only when the specimens are not quite mature, when, as in most *Myxogastres*, they become more or less cartilaginous on drying. The cavity of the sporangium is continuous with the hollow stem. The present genus is most nearly allied to *Prototrichia*, with which it agrees in having the elaters attached to the base of the sporangium, and the tips free; but in *Alwisia* the markings on the walls of the elaters are rudimentary, and the habit is very different. The fasciculate form is the only one at present known, but judging from what occurs in allied genera, the simple form may be supposed to exist.

Only one species, from Ceylon.

Alwisia bombarda, B. and Br., fig. 19.

Sporangia broadly fusiform or elliptical, several seated on the apex of an elongated stem, smooth, dark brown, sometimes with a purple tinge; stem same colour, hollow, springing from a well-developed hypothallus; mass of elaters and spores brown; elaters cylindrical, 6–7 μ thick, sometimes furnished with one or two swollen portions, walls thin, collapsing when dry, with a few scattered, very rudimentary spinules and a very indistinct open spiral, free ends obtuse, rarely attenuated and bifid; spores globose, smooth, 5–6 μ diameter.

Jour. Linn. Soc., xiv. p. 87, t. 2, f. 6, and xv. t. 2, f. 1.

Trichia fragilis, Rost., Mon., p. 246 (in part); Cooke, Brit. Myx., p. 63 (in part); Sacc., Syll., n. 1494 (in part).

On decayed wood. Gongolla forest; Ceylon! (Type in Herb. Berk., Kew, n. 10,921.)

Plant 2–3 mm. high, scattered. The fasciculate sporangia are in some specimens connate except at the tips, and then present the appearance of a single sporangium with several subacute apical lobes.

The stem is somewhat contracted and wrinkled longitudinally when dry. The present plant resembles to a certain extent, when examined with a pocket-lens, fasciculate forms of *Trichia fragilis*, and from such superficial examination Rostafinski gave it as a synonym of the last-mentioned species. It it had been properly examined this mistake would not have been made.

Prototrichia, Rost.

Sporangia stipitate or sessile; dehiscing irregularly; wall single; elaters with one end grown to the lower part of the sporangium, the other end free and terminating in a tuft of thin, smooth threads; spores globose.

Rost., Mon. Appendix, p. 38; Cooke, Myx. Brit., p. 65; Sacc., Syll., vii., pt. i. p. 437.

Trichia, B. and Br. (in part).

A well-marked genus, differing from *Trichia* in having the elaters grown at one end to the wall of the sporangium near its base. In the last character it agrees with *Alwisia*. For remarks on this point of agreement, see under last-named genus.

The species are scattered in habit, sessile, or shortly stipitate, but up to the present no fasciculate forms are known.

Three species, all occurring in Europe (Britain and Sweden), one extending to Tasmania.

A. *Spores smooth.*

Prototrichia flagellifer, Rost., fig. 23.

Sporangia scattered, globose, *sessile*, attached by a very narrow base, wall thin, smooth, copper colour and reflecting metallic tints; mass of capillitium and spores flesh-colour; *elaters broad at the base, 7–9 μ, and tapering to the apex, branching at some distance from the base into two or three arms*, each of which is sometimes divided near the apex, spirals thin, not prominent, sometimes crowded, at others distant, disappearing below the ultimate branchlets, brown, becoming colourless towards the tips; spores globose, *smooth*, 10–13 μ diameter.

Rost., Mon., Supp. p. 38 (in part); Cooke, Myx. Brit., p. 65; Sacc., Syll., n. 1492 (in part).

Trichia flagellifer, B. and Br., Ann. Nat. Hist., ser. 3, xviii. p. 56, No. 1143, pl. 2, f. 4.

Dermatricha flagellifer, Cooke, MS. (Type in Herb. Berk., n. 10,905.)

On spruce fir. Britain (Badminton, Glo'ster!); Sweden! Scattered, or rarely 2–3 in a cluster, but not crowded together, ·5 mm. or a little more in diameter. Very distinct from *Prototrichia metallica* with which it has been confused by Rostafinski, probably from want of microscopic examination. In the present species the elaters are widest at the fixed base and taper gradually to the free tips, and are divided into two or three main branches, whereas in *T. metallica* the main branch of the elater is undivided and very thin at the fixed base, and terminates at the apex in several long, smooth spines. The spiral markings are also very different in the two species.

Prototrichia metallica, Mass., fig. 26.

Sporangia scattered, *stipitate* or sessile on a broad base, spherical or depressed and lenticular, smooth, shining, copper colour with metallic tints; stem very short, rather thick, darker in colour than the sporangium; mass of capillitium and spores pale flesh-colour or yellowish; *elaters elongato-fusiform*, 6–7 μ at thickest part, 300–400 μ long, *terminating at the apex in a pencil of simple or branched, cylindrical, smooth, sometimes nodulose filaments*, 2 μ thick, and 40–60 μ long; spirals broad, flat, close; spores globose, *smooth*, 9–11 μ diameter.

Trichia metallica, B. and Br., Fl. Tasm., p. 268.

Prototrichia flagellifera, Rost., Mon., Appendix, p. 38 (in part); Sacc., Syll., n. 1492 (in part).

Prototrichia elegantula, Rost., Mon., Appendix, p. 39, fig. 246; Sacc., Syll., n. 1491.

(Type in Herb. Berk., Kew, n. 10,905*a*).

On wood. Tasmania! Sweden!

Sporangia ·5 to nearly 1 mm. diameter.

Rostafinski founded his *Prototrichia elegantula* on a specimen in the Berkeley herbarium at Kew, which was sent by Fries, and marked "(Perichæna ?) nova species, in Betula. Lindblad." This specimen on examination proves to be identical with *Trichia metallica*, B. The last-named species is given as a synonym of *P. flagellifer*, B. and Br., by Rostafinski—evidently the outcome of pocket-lens examination.

B. *Spores minutely warted.*

Prototrichia cuprea, Mass. (n. sp.), fig. 24.

Sporangia scattered or crowded, subglobose, sessile on a broad base, or attenuated below, or with a very short distinct stem, bright copper-colour, shining, sometimes iridescent; mass of capillitium and spores reddish flesh-colour; capillitium copious, threads attached at one end to the base of the peridium, *basal part of thread* 6–8 μ thick, 60–80 μ long, *then branching once or twice in a dichotomous manner*, branches tapering upwards 150–200 μ long or more, *each ending in a more or less corymbose tuft of slender, smooth, colourless filaments* of variable length, and 1–2 μ thick, main trunk and branches brownish, with rather close, not prominent, spirals; spores globose, *minutely verruculose*, 10–13 μ diameter.

(Type in Herb. Kew.)

On dead thorn. Scarborough!

Sporangia ·5–1 mm. diameter, bright copper-colour, polished, and often iridescent, especially when old and empty. Characterized by the warted spores. When I first collected the present species, some years ago, I concluded that it was identical with Berkeley's *Prototrichia flagellifer*, and, noticing that the spores were warted, had the presumption to think that a mistake had been made by Berkeley in describing the spores as smooth, an idea which I expressed in Roy. Micr. Soc. Journal, v. p. 757. Having since had an opportunity of examining Berkeley's type-specimen, I find that the mistake was on my own part, and that the spores were smooth as described.

Hemiarcyria, Rost.

Sporangium consisting of a single wall, dehiscing irregularly; threads of the capillitium with ridges arranged in a spiral, forming a net with usually free ends; spores globose, epispore smooth or variously ornamented.

Rost., Mon., p. 261; Cooke, Myx. Brit., p. 67; Sacc., Syll., vii. part i., p. 446.

The only genus belonging to the *Trichiaceæ* having the threads of the capillitium combined into a net. Most nearly related to *Arcyria*, in fact the only point of difference consists in the ornamentation of the capillitium threads. In *Hemiarcyria* spiral bands are always present, and may be supplemented by spines or warts, whereas in *Arcyria* the threads may be smooth, warted, spinulose, or with half-rings; but *ridges* spirally arranged are never present. It is more than doubtful whether the above distinction is of generic value, as the spiral arrangement is very evident in many species of *Arcyria* where the spines or half-rings are arranged in a very open spiral, while in *Hemiarcyria melanopeziza* the spirals are very rudimentary, but yet present, whereas the threads bristle all over with long slender spines.

The thirteen known species are distributed as follows:—Europe, seven; United States, two; South America, three; Java, one. Some of the European species extend to Africa, Ceylon, Australia, and New Zealand.

A. *Spores smooth.*

Hemiarcyria Karsteni, Rost., fig. 36.

Sporangia effused, vermiform, sinuous, sometimes forming irregular reticulations, or hemispherical, scattered, and sessile on a broad base, varying from dirty ochraceous brown to dark chestnut; mass of capillitium and spores dingy ochre; threads often irregularly branched and forming a very loose net, 3–4 μ thick, *with scattered inflated portions* 12–15 *μ thick and* 30–50 *μ long, spirals very indistinct*, a few scattered rudimentary spines now and then present, free tips not distinctly attenuated, usually abrupt or clavate; spores globose, *smooth*, 10–12 μ diameter.

Rost., Mon. Suppl., p. 41; Karst., Myx. Fenn., iv. p. 142; Schroeter, p. 115; Sacc., Syll., n. 1516. (Specimen from Ceylon in Herb. Berk., n. 10,893, named by Rostafinski.)

On wood. Finland, Silesia, Ceylon!

Recognized by the threads of the scanty capillitium being considerably swollen at intervals, and by the indistinct spirals.

Hemiarcyria pusilla, Berlese.

Sporangia rather closely gregarious, subcylindrico-elliptical, 0·4–0·5 mm. high, 0·15–0·25 mm. diameter, rather obtuse above, abruptly subtruncate below with only a trace of a stem or altogether without; at first *blood-red with an amber tinge, afterwards rose-colour*; capillitium rather dense, forming a *rose-coloured network, threads round*, 3–4 μ thick, spirals three or four, furnished with minute spinules; spores rose or flesh-colour, globose, *smooth*, 7–9 μ diameter.

Berlese in Sacc., Syll., n. 1521.

Hemitrichia pusilla, Speg., Fung. Argent., Pug. IV., n. 269.

On bark. Argentine Republic.

Hemiarcyria leiocarpa, Cooke, fig. 33.

Sporangia scattered or aggregated, obovate or pyriform, rarely almost globose, pallid, *stem same colour, as long as diameter of sporangia*; mass of spores and capillitium concolorous, or with a slight ochraceous tint; *capillitium sparse, forming a loose net*, threads 5–6 μ thick, *spirals thin, rather close*, slightly prominent on the convex side of the bent threads, usually furnished with scattered rudimentary spinules, *free tips very rare or absent;* spores globose, *smooth,* 12–14 μ diameter.

Cooke, Myx. U. States, in Ann. Lyc. Nat. Hist. New York, xi. n. 12, p. 405; Cooke, Myx. Brit., figs. 252, 255; Sacc., Syll., n. 1519.

On decaying vegetable débris. Portland, Maine, U.S.!

In Saccardo's Sylloge, vii. part i. p. 440, n. 1519, Rostafinski is quoted as the author of the present species, and furthermore the reader is referred to "Rost., Mon., p. 267," for the description, whereas the species is not included at all in Rostafinski's work. The above is but one of the numerous inexplicable complications so common in those portions of Saccardo's Sylloge compiled by incompetent assistants.

* *Hemiarcyria rubiformis,* Rost., fig. 31.

Sporangia *usually fasciculate springing from a short common stem,* or sessile on a hypothallus, rarely an irregular plasmodiocarp, brown or almost black, polished and with a metallic lustre, or opaque; mass of capillitium and spores *orange-brown;* threads of capillitium brown, 5–6 μ thick, combined into an elastic net which at maturity elongates considerably, carrying the apical portion of the sporangium at its apex, where it remains in the form of a cap, free tips usually terminated by from one to three short, smooth spines, rarely obtuse, *spirals flat, distant, furnished with numerous slender spines;* spores globose, *smooth,* 10–12 μ diameter,

a. genuina. Sporangia cylindrico-turbinate, dark brown, opaque, or with a steel lustre, seated on a common fasciculate stem.

β. sessilis. Sporangia sessile, cylindrical or subangular from mutual pressure.

γ. plasmodiocarpia. Plasmodiocarp irregular with a broad base attached to a hypothallus.

Rost., Mon., p. 262, figs. 201, 230, 231; Cooke, Myx. Brit., p. 67, figs. 201, 230, 231; Schroeter, p. 114; Sacc., Syll, vii. n. 1512; Raunk., Myx. Dan., p. 63, t. 3, f. 15, t. 4, f. 6.

Exsicc.—Roum., Fung. Gall., 1686! Fuckel, Fung. Rhen., 1438! (as *Trichia rubiformis*); Cooke, Fung. Brit., 612! (as *Trichia Neesiana*); Jack, Leiner u. Sitzenb. Krypt. Bad., 421! (as *Trichia rubiformis*); Sacc., Myc. Ven., 962! (as *Trichia pyriformis,* Hoffm.); Karst., Fung. Fenn., 700!

A very beautiful and distinct species characterized by the cylindric dark-brown fasciculate sporangia, usually with metallic tints, the dense capillitium of orange-brown spinulose threads, and smooth spores. *Hemiarcyria Ellisii* closely resembles the present species in colour and habit, but is sharply separated by the warted spores.

On rotten wood, mosses, &c. Britain (Apethorpe! Weybridge! Twycross! Bulmer, N. Yorks! Orton Wood, Leicester! Wothorpe! Scarborough!) France! Germany! Switzerland! Italy! Belgium! Denmark; Hungary; Finland; Bohemia; United States! Cuba! Venezuela! Ceylon! Australia!

(Rostafinski's Synonyms.)

Clathroides pyriforme, Hall., t. 1, f. 5 (1742).
Trichia, Hall, t. 48, f. 5, No. 2167 (1798).
Lycoperdon vesparium, Batsch, t. 30, f. 172 (1786).
Stemonitis cinnabarina, Roth, Fl. Germ. 347 (1788).
Lycoperdon favaceum, Schr., Fl. Bav., ii. 667 (1789).
Trichia pyriformis, Hoffm., V. Cr., t. 1, f. 1 (1790).
Stemonitis fasciculata, Pers. in Gmel., Sys. 1468 (1791).
Trichia rubiformis, Pers., Disp., t. i. f. 3, t. iv. f. 3 (1797); Berk., Ann. Nat. Hist., No. 218; Cooke, Hdbk., n. 1177.
Trichia rubiformis, *β minor*, Pers., Disp., 54 (1797).
Lycoperdon ferrugineum, Hedw., t. x. f. 1–4 (1802).
Trichia chalybea, Chev., Fl. Par., t. 9, f. 24 (1827).
Trichia Neesiana, Corda, Ic., i. f. 288 C. (1837).
Trichia Ayresii, B. & Br., Ann. Nat. Hist., No. 390; Cooke, Hdbk., No. 1179.

B. Spores with minute warts.

Hemiarcyria Ellisii, Mass. (n. sp.) fig. 30.

Sporangia *fasciculate, from three to seven on a common twisted or wrinkled stem*, or sessile, smooth, rather shining, dark chestnut; mass of capillitium and spores dingy *brownish-orange*, capillitium elastic, rupturing the peridium in a circumscissile manner near the apex and carrying up the apical portion like a cap, threads 6–7 μ thick, rarely branched, *spirals thin*, not prominent, rather distant, furnished with numerous, short, acute spines, tips short, acute, smooth; spores globose, rather *coarsely warted*, 10–12 μ diameter.

Type, Ellis, N. Amer. Fung. exs., n. 1113! (called *Hemiarcyria rubiformis* (Pers.)) (Kew copy).

a. genuina. Sporangia cylindrico-turbinate, from 3–7 on a stout, twisted or wrinkled stem about equal in length to the sporangia.

β. sessilis. Sporangia in small clusters, sessile on a broad base.

On wood. United States.

Externally indistinguishable from *Hemiarcyria rubiformis*, but quite distinct in the warted spores.

Hemiarcyria stipitata, Mass. (n. sp.) fig. 32.

Sporangia pyriform, from two to five on a common stem, or solitary, pale lemon-yellow, opaque; *stem elongated, equal, dark brown or black*, longitudinally rugulose; mass of capillitium and spores dingy ochre; *capillitium dense, much branched and forming a net without free tips*, 4–5 μ thick, *spirals very open*, rather distant, thin, not prominent; spores globose, *minutely warted*, 7–8 μ diameter.

a. genuina. Sporangia single on an elongated stem.

β. fasciculata. Sporangia fasciculate on a common stem.

On palm stems. Java!

(Type in Herb. Berk., Kew, n. 10,892*a*).

Scattered or aggregated, 3–4 mm. high, stem about 2 mm. high, thin, hollow. Capillitium elastic, protruding after dehiscence. Allied to *Hemiarcyria clavata*, but distinct in the dense capillitium without free tips, and the loose spirals, and in the long, thin, black stem.

* *Hemiarcyria clavata*, Rost.

Sporangia simple, *stipitate, varying from clavate to subglobose, yellow, polished,* stem rather thin, yellow, often becoming reddish at the base, mass of capillitium and spores clear yellow, ochraceous-orange, or tinged with olive; threads of capillitium 4–5 μ *thick, forked, free ends not numerous, obtuse or sometimes slightly swollen,* spirals thin, not prominent, distant; spores globose, *minutely warted,* 8–10 μ diameter.

Rost., Mon., p. 264, figs. 205, 207, 210, 235; Cooke, Myx. Brit., p. 68, figs. 205, 207, 210, 238; Sacc., Syll., vii., 1513. Raunk., Myx. Dan., p. 64; Schroeter, p. 114. Exsicc. Fckl., Fung. Rhen. 1434 (as *Trichia clavata*)! Jack, Leiner u. Sitzenb. Krypt. Badens, 621 (as *Trichia clavata*)! Ellis, N. Amer. Fung., 523!

On decayed wood. Britain (King's Cliffe! Apethorpe! Carlisle!) France! Germany! Denmark! United States! Cuba! Brazil! Ceylon! Bonin Island!

A neat species, scattered or gregarious, 1·5–2 mm. high; stem slender, often attenuated downwards and longitudinally wrinkled, resembling in form *Hemiarcyria leiocarpa*, Cke., but known by the warted spores, and absence of spines on the elaters.

(Rostafinski's Synonyms.)

Clathrus pedatus, Schm., Ic., t. 33, f. 1, 17 (1776).
Sphærocarpus pyriformis, Bull., t. 417, f. 2 (1791).
Stemonitis pyriformis, Gmel., Syst., 1469 (1791).
Trichia pyriformis, Sibth., Fl. Ox., 406 (1794); Sow., 400, f. 6.
Trichia clavata, Pers., Disp., p. 11 (1797); Eng. Fl., v. p. 320; Cooke, Hdbk., 1183.
Trichia citrina, Schum., Saell., 1460 (1803).
Arcyria trichioides, Rudolph, Linn., p. 120 (1829).
Trichia erythropus, Borszczow (1856).
Trichia obtusa, Wigand, p. 30, t. 11, f. 4 (1863).
Trichia Thwaitesii, B. & Br., Ceylon Fungi, No. 776 (1873).

Hemiarcyria melanopeziza, Berl.

Sporangia sessile, *creeping, subterete, generally forming rings,* 1–2 mm. long, *very black,* scarcely or not at all shining, very smooth; wall black, opaque, subcellulose, rather coriaceous; splitting longitudinally and dehiscing in a valvate manner; capillitium yellow, protruded elastically, threads round, 4–5 μ thick, combined into a loose net, everywhere *covered with erect spines*, 5–6 × 1 μ, *spirals almost* *obsolete*; spores *elliptico-globose, papilloso-scabrid,* 10–12 × 10 μ, yellow.

Berlese in Sacc., Syll., n. 1520.

Hemitrichia melanopeziza, Spegazzini, Fung. Arg., Pug. iv. n. 268.

On bark. Brazil. Looking exactly like some black *Peziza.*

Hemiarcyria calyculata, Speg.

Sporangia simple, gregarious, stipitate, globose or elliptical, dirty foxy-brown, 1–2 mm. diameter, stem 3–5 mm. long, 200–250 μ thick, round, glabrous, rather tough, *apex dilated into a little dimidiate cup equal to the peridium, base dilated, fibrillose,* colour of the sporangium; spores and capillitium dingy yellowish-fulvous; elaters 7–8 μ thick, cylindrical, yellowish, sparsely branched, free tips acute; spirals 3–5, flat, not very conspicuous, separated by interspaces their own width, spinulose; *spores discoideo-lenticular, concavo-convex, margin muriculate,* 10 × 3 μ. Spegazzini, Fung. Argent., Pug. iii. n. 92; Sacc., Syll., 1518.

On rotten willow trunk. Argentine Republic.

A most remarkable species if the spores as described above are the normal condition. Many species of *Myxogastres* have the spores *concavo-convex* when dry, and it is more than probable that the spores in the above species had not been soaked sufficiently long before examination.

Hemiarcyria Wigandii, Rost.

Sporangia clavate, discoid, or irregularly subrotund, very small, almost sessile; mass of spores and capillitium *bay or flesh-colour* verging on yellow; elaters rarely branching, *spirals one or two, flexuous, either separated by interspaces from three to four times their own width or crowded and almost forming rings,* tips scarcely narrowed, truncate or inflated; spores minutely *verruculose,* 10–11 μ diameter.

Rost., Mon., p. 267, fig. 232; Sacc., Syll., 1517; Cooke, Myx. Brit., fig. 232.

Germany.

(Rostafinski's Synonym.)

Trichia abietina, Wgd., l. c., p. 33, t. ii. f. 11 (1863).

* *Hemiarcyria paradoxa*, Mass. (n. sp.) fig. 35.

Sporangia scattered or aggregated, sessile on a broad base, hemispherical or irregularly elongated and subvermiform, smooth, rather shining, dirty ochre, *inner surface of the wall with a thick layer of amorphous particles of lime;* mass of capillitium and spores pale lemon-yellow; capillitium scanty, threads 4–5 μ thick, *much contorted and forming a loose net,* with but few abrupt free tips, *spirals very* *much crowded*, not prominent; spores globose, *minutely warted*, 8–10 μ diameter.

(Type in Herb. Currey, Kew.)

On wood. Britain (Weybridge, Surrey !).

Sporangia when hemispherical, from ·5–1 mm. diameter, sometimes vermiform. Distinguished amongst the species with warted spores by the densely crowded spirals of the elaters. A note by Currey accompanying the specimen says, "The spores of this specimen sown in water produced de Bary's zoospores in 24 hours."

Remarkable in having the inner surface of the wall of the sporangium covered with large amorphous lumps of lime, differing in this respect from any known member of the *Tricheæ*.

C. *Spores with raised flat bands combined to form a network.*

* *Hemiarcyria chrysospora*, Lister, fig. 37.

Sporangia sessile on a broad base, generally closely aggregated, bright ochraceous yellow; mass of capillitium and spores yellow; threads 5 μ thick, forming a loose net with many free ends, which generally terminate in slightly expanded, smooth, bent or straight, conical apices, *spirals four, rather close, not prominent, connected by less prominent ridges running parallel to the long axis of the thread;* spores globose, *with raised flat bands forming a polygonal network*, 16 μ diameter.

'Grevillea,' v. p. 126.

(Authentic specimen from author in Herb. Kew.)

On twigs of larch lying on the ground, and on the surrounding herbage. Britain (Lyme Regis !).

A fine species with the sporangia 1 mm. diameter, well marked by the reticulated spores, and the parallel bands connecting the spirals on the elaters. From three to five complete polygons on a hemisphere of the spore.

* *Hemiarcyria serpula*, Rost., fig. 34.

Plasmodiocarp vein-like, creeping, usually anastomosing to form a net, wall thin, fragile, yellow, sometimes tinged with brown; mass of capillitium and spores yellow; threads of capillitium 5–6 μ thick, forming a net with numerous free ends terminating in a smooth, tapering spine 8–10 μ long, *spirals thin, not prominent, distant, furnished with numerous long, slender spinules;* spores globose, *with raised flat bands forming an irregular network*, 10–12 μ diameter.

Rost., Mon., p. 267, figs. 200, 227, 228; Cooke, Myx. Brit., p. 68, figs. 200, 227, 228; Schroeter, p. 115; Sacc., Syll., vii. part i. No. 1514; Raunk., Myx. Dan., p. 64, t. 3, f. 16.

Exsicc.—Fuckel, Fung. Rhen., 2692! (as *Hemitrichia contorta* (Ditm.) Rost.).

On rotten wood, branches, leaves, &c. Britain (Carlisle ! specimen in Herb. Berkeley, from Sowerby's herbarium, no locality, named "*Trichia reticulata*," undoubtedly British!); Germany! Sweden! Belgium; Italy; United States! Cuba! St. Vincent! Bombay! N.W. Australia! New Zealand! Ceylon!

Readily known by the vein-like plasmodiocarp forming a net-like pattern.

(Rostafinski's Synonyms.)

Mucor serpula, Scop., Fl. Carn., t. 65 (1772).
Lycoperdon lumbricata, Batsch, f. 174 (1786).
Trichia spongioides, Vill., Fl. Dauph., 1061 (1789).
Stemonitis lumbricalis, Gmel., Sys., 1470 (1791).
Trichia reticulata, Pers., Disp., 10 (1797); Ic. et Desc., t. 12, f. 1.
Trichia serpula, Pers., Disp., 10 (1797); Eng. Fl., v. 320; Cooke, Hdbk., 1189.
Trichia serpula, *β spongioides*, Pers., Syn., 181 (1801).
Trichia venosa, Schum., Saell., 1456 (1803).
Hyporhamma reticulatum, Corda, Ic., v. 34 (1842).
Trichia retiformis, Payer, Crypt., f. 574 (1850).

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Balf., Grev.—Remarks on British Myxomycetes, Grevillea, x., p. 117. Professor Bayley Balfour.

B. & Br., Ann. Nat. Hist.—Berkeley and Broome in Annals and Magazine of Natural History.

B. & Br., Journ. Linn. Soc.—Berkeley and Broome in Journal of the Linnean Society.

Cooke, Myx. Brit.—Myxomycetes of Great Britain. M. C. Cooke.

Cooke, Myx. U.S.—Myxomycetes of United States, in Annals of Lyceum of New York. M. C. Cooke.

Grev.—Grevillea; a quarterly record of Cryptogamic Botany. M. C. Cooke.

Haller, Helv.—Enumeratio Methodica Stirpium Helvetiæ indigenarum, D. Alberti Haller.

Karst., Myx. Fenn.—P. A. Karsten.

Karst., in Not. Sällsk.—Karsten in Notiser ur Sällskapets pro Fauna et Flora Fennica.

Lév., Ann. Sci. Nat.—J. H. Léveillé in Annales des Sciences Naturelles.

Nyl. in Not. Sällsk.—Nylander in Notiser ur Sällskapets pro Fauna et Flora Fennica.

Peck, Rep. St. Agr. Mus.—Report on the State Agricultural Museum. Chas. H. Peck.

Peck, Rep. St. Mus.—Report on the State Museum of Natural History. Chas. H. Peck.

Rost., Mon.—Monografia Sluzowce (Mycetozoa). J. T. Rostafinski.

Rost., Mon. App. (or Suppl).—Supplement to above.

Raunk., Myx. Dan.—Myxomycetes Danicæ; C. Raunkiær, in Botanisk Tidsskrift, 17 Bind, 1–2 Hæfte (Journal de Botanique, publié par la Société Botanique de Copenhague).

Sacc., Syll.—Sylloge Fungorum. P. A. Saccardo.

Schroet.—Flora von Schlesien, Pilze. Dr. J. Schroeter.

Sow.—English Fungi. James Sowerby.

Speg., Fung. Arg., or Speg., Fung. Guar.—Fungi Guaranitici. Carolo Spegazzini, in Annales de la Sociedad Cientifica Argentina, 1886.

EXSICCATI QUOTED.

Cooke, Fung. Brit.—Fungi Britannici Exsiccati. M. C. Cooke.
Cooke, Fung. Brit., Ed. 2.—Fungi Britannici Exsiccati, Ser. II. M. C. Cooke.
Ellis, N. Amer Fung.—North American Fungi. J. B. Ellis.
Ellis & Everhart, N. Amer. Fung.—Ellis & Everhart, North American Fungi. Second series.
Erbar. Crittogam. Ital.—Erbario Crittogamico Italiano.
Fuckel, Fung. Rhen.—L. Fuckel's Fungi Rhenani Exsiccati.
Herb. Berk., Kew.—Herbarium of the late Rev. M. J. Berkeley, now deposited at Kew.
Herb. Broome, Brit. Mus.—Herbarium of the late C. E. Broome, now in the British Museum.
Jack, Leiner u. Sitzenb.—Jack, Leiner u. Sitzenberger, Kryptogamen Badens.
Karst., Fung. Fenn.—Fungi Fenniæ Exsiccati. P. A. Karsten.
Klotzsch (Rabenh.) Herb. Myc.—Herbarium vivum Mycologicum. J. F. Klotzsch. Continued by Rabenhorst.
Lib., Pl. Crypt. Ard.—Plantes Cryptogames des Ardennes. Madame Libert.
Moug. & Nest.—Stirpibus Cryptogamis Vogeso-Rhenanis. J. B. Mougeot, C. Nestler et W. P. Schimper.
Rab., Fung. Eur.—Rabenhorst's Fungorum Europæorum Exsiccatorum.
Roum., Fung. Gall. or Roum., Fung. Sel. Gall.—Fungi Selecti Gallici Exsiccati. M. C. Roumeguère.
Sacc., Myc. Ven.—Mycotheca Veneta. P. A. Saccardo.
Syd., Myc. March.—Mycotheca Marchica. Sydow & Zopf.
Thum. de Myc. Univ.—Mycotheca Universalis. F. de Thumen.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Origin of Nervous System of Vertebrates.‡—Dr. W. H. Gaskell, after a discussion of the relation between the structure, function, distribution, and origin of the cranial nerves, propounds a new theory of the origin of the nervous system of Vertebrates; any theory that shall be satisfactory must take into account not only its segmental arrangement but also its tubular formation. If we fix our attention exclusively upon the nervous elements of the central nervous system we can describe it as a system composed of a bilateral chain of ganglia connected together by means of longitudinal and transverse commissures, which gives origin to a series of segmental nerves, and is connected by means of well-defined commissural tracts with another nervous system of higher function, which gives origin to no outgoing nerves, except such nerves of special sense as the optic and olfactory. In addition, however, to its nervous elements the spinal cord contains an elaborate system of non-nervous structures, viz. the supporting structures of the cord, and the folding over of the medullary plates gives origin not merely to nervous material but also to a tube of supporting tissue, which was originally formed of compact layers of epithelial cells arranged symmetrically around the central canal. Dr. Gaskell thinks that, in the embryological development of the central nervous system, we are observing the simultaneous development of two different organs, the one the nervous system, and the other the tube of supporting tissue, the formation of which is not necessarily involved with that of the nervous system. In certain parts of the central nervous system the sole structure formed by the folding over of the medullary plate is the supporting tube which is not and never was nervous, while in other parts the simultaneous formation of nervous material with that of the supporting tube has so compli-

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Journ. of Physiol., x. (1889) pp. 153–211 (5 pls.).

cated the problem that it is difficult to decide which of the embryonic cells form supporting structure and which nervous material. Both ontogenetical and phylogenetical evidence appears to lead to the conclusion that the central nervous system of the higher Vertebrates has been formed by the spreading and increase of nervous material over the walls of an original non-nervous tube, the cellular elements of which tube, whatever its original function, have been utilized as supporting structures for the nervous elements in those parts where the latter have invaded its walls; while in other parts, where no such invasion has taken place, the walls of the tube have retained their simple cellular structure, or have undergone gelatinous degeneration.

If a comparison be made of the brain of *Petromyzon* and that of Mammals we are led to the view that the nervous material of the Vertebrate central nervous system is situated in definite places outside but in close contact with the walls of a pre-existing non-nervous tube, and that the elements of this non-nervous tube, which is formed by the folding over of the medullary plate, become utilized as the supporting tissue or myelospongium, wherever the nervous matter comes into contact with it.

With regard to the embryological evidence, the difficulty lies in deciding which of the elements of the original embryonic tube will form nervous material, and which will form supporting structure; though there has been much discussion on this point, Dr. Gaskell does not think that we can yet go much further than the observations of His—(1) all the cells of the embryonic tube do not form nervous material; (2) all the motor nerve-fibres arise as prolongations of the motor nerve-cells; and (3) the motor nerve-cells, as soon as they can be recognized, are always situated in a perfectly definite place in the embryonic tube, viz. in the outer and not in the inner part.

As a possible explanation of the ancestral history of the spinal cord, it is suggested that it was originally composed of a bilateral chain of ganglia, situated ventrally to a non-nervous tube, the parts of each chain being connected together by commissures also situated ventrally to this tube. By the increase and spreading round of the nerve-cells and nerve-fibres to the dorsal side, the original tube was so invaded with nervous elements that it lost its original character and became the supporting structure of the spinal cord; as most marked indications of its original character are the epithelial lining of the central canal and the peculiar structure of the *substantia gelatinosa centralis.*

This definition does not, however, apply to the more anterior portion of the central nervous system; in it the ventral chain of ganglia, instead of spreading round to the dorsal side of the tube, is connected by means of strong encircling commissures, which form a commissural collar around the tube, with a series of ganglia lying on the dorsal side of the tube, whose function is of a higher character than that of the ventral chain, and which give rise to no outgoing nerves, except those of such special senses as sight and smell.

Clearly this description would apply as well to an invertebrate central nervous system, and, if it be true, it follows that the tube of supporting tissue around and within which the nervous system is formed, with its extraordinary continuation by the neurenteric canal into the present alimentary canal, was originally the whole or part of the alimentary canal of the invertebrate from which the vertebrate ancestor arose. Further, this tube must have had an anterior as well as a posterior opening. Examination of the infundibular region (or that where the notochord and the nervous tissue which corresponds to the infra-œsophageal ganglia terminate) of an adult sheep has led Dr. Gaskell to the discovery of what he believes to be the remains of the terminal œsophageal tube. Sections revealed the existence of a canal leading from the cavity of the infundibulum towards the corpus mamillare; this canal lies quite on the surface of the brain, and occupies the greater portion of the length of the tuber cinereum; it is lined with epithelium continuous with that of the third ventricle and of the infundibulum; its walls are composed of substance similar to the *substantia centralis gelatinosa*; the further away it is from the infundibulum the more is its cavity closed by the approximation of its walls, and it vanishes at the very surface, completely closed. Its appearance is exactly that of an open tube which has been bent down on the surface of the brain, so that its open extremity became obliterated by the coming together of its walls. The skate, the dogfish, and the lamprey have been all found to have this tube. Dr. Gaskell suggests that the terminal part of the œsophagus has been obliterated by being folded down on the infra-œsophageal ganglia, while the next portion of the œsophagus has been dilated to form the infundibulum with the glands of the pituitary body lying on the anterior lip of the original mouth or œsophagus. Dohrn's picture of the nervous system of a young *Limulus* is given to illustrate the author's meaning.

This view brings the vertebrate nervous system into complete harmony with that of Invertebrata, and supports the views of Owen, Balfour, Dohrn, and others. For the present the author says nothing as to the origin of the present alimentary canal of Vertebrates, but he promises to discuss the question shortly.

Protovertebræ and the Segmentation of the Vertebral Column.*—Prof. V. v. Ebner discusses the developmental relations of the protovertebræ and the vertebral column. The material worked with consisted mainly of embryos of the ringed snake. Remak, it will be remembered, derived the vertebræ from the protovertebræ by secondary segmentation; according to His the protovertebræ are "archiblastic," giving origin to muscles, &c., but without any share in forming the "parablastic" skeleton. Both views have had their supporters. Von Ebner corroborates the view of Remak, and describes how his sections will only admit of this interpretation. Remak's conclusion is to be corrected in this point, "that the segmentation of the vertebral column does not arise from a uniform blasteme of the protovertebræ, but appears at a time when the latter are still independent complexes of embryonic cells." He gives several interesting figures of the intervertebral cleft in the protovertebræ, which "being very delicate, and often hardly demonstrable, appears to have been hitherto overlooked."

Study of a Human Embryo.†—Dr. C. Phisalix has had the opportunity of making a study of a human embryo, 10 mm. long. He has discovered a certain number of new facts with regard to the cranial nerves and the central nervous system, the arrangement of the valves and septa of the heart, the origin of the pancreas and the Wolffian body. Additions and corrections have been made to many of the statements of

* SB. K. Akad. Wiss. Wien, xcvii. (1889) pp. 194-206 (2 pls.).
† Arch. Zool. Expér. et Gen., vi. (1888) pp. 279-350 (6 pls.).

His. The most remarkable point in the embryo was that, although there was no reason for supposing that the condition was due to pathological causes, there was a certain want of symmetry in the development of the two sides of the body. The left side was, for several organs, and especially for the cerebral vesicles, in advance of the right. The author cannot say whether this asymmetry is peculiar to man, and asks if it has any relation to the functional predominance of the right side of the body in the adult. He asks if it is a result of a habit or the consequence of anatomical peculiarity of the embryo. But he is unable to answer these questions.

Development of Bony Fishes.*—M. F. Henneguy gives a detailed account of his observations on the development of Bony fishes; the chief object of his investigations has been the trout From his studies, as from those of his predecessors, it is obvious that the embryology of the Teleostei is particularly interesting as introducing us to a special mode of development which sharply separates these animals from other fishes; such are the constitution of the egg, the formation of the gastrula, the presence of a rudimentary primitive line, the primordial constitution of the nervous system and of some other organs; and these characters indicate that the Teleostei form a divergent branch of the piscine phylum. The facts of Embryology corroborate those of Comparative Anatomy, and show us that, even if in certain points the Teleostei are a degraded type of fish, we find in them the earliest indications of the distinctive characters of the higher Vertebrata.

Structure of Amphioxus lanceolatus.†—Prof. E. Ray Lankester has a contribution to the knowledge of this interesting animal, which is illustrated by, *inter alias*, figures which represent, in semi-diagrammatic form, the structure of *Amphioxus*, not merely as seen in sections or dissections, with all the imperfections necessarily arising from the action of preservative media, but as reconstructed and corrected from numerous specimens, so as to give as nearly as may be a true view of the undistorted organism.

After some account of the external marks and numerical characteristics, in which the numbers of the myotomes, of the dorsal and ventral fin-rays, and of the preoral cirri are considered, attention is drawn to the size and importance of the post-oral tentacles or tentacles of the sphincter oris, and to the fact that there are no "ventral canals" beneath the plaited ventral wall of the atrium. There are three distinct kinds of spaces containing liquid in the living state; these are the atrial cavity, the enteric cavity, and hæmo-lymph cavities. The last break up into numerous groups, such as the vascular system which is in open continuity with the suprapharyngeal and perienteric portions of the cœlom; the perivascular spaces of the dorsal aortæ; the perigonadial cœlom; various lymph spaces and canals; the neuraxial canal; the myocœlomic pouches or intra-muscular lymph-spaces of the head; and the series of intra-skeletal lymph-spaces of the myotomes. The distorting action of the reagents used for hardening specimens causes the correct conclusion as to the existence of spaces in the body of *Amphioxus* to be a very difficult matter.

The vascular system appears to be in a condition of degeneration, as

* Journ. Anat. et Physiol. (Robin), xxv. (1888) pp. 413–502, 525–617 (4 pls.).
† Quart. Journ. Micr. Sci., xxix. (1889) pp. 365–408 (5 pls.).

the vascular trunks which are developed do not, in their present relations, appear to have a physiological significance. It is important to note that the vascular trunks and lymphatic spaces are continuous; the author gives some notes descriptive of several of the blood-vessels. The question how, and indeed whether, the blood circulates has not yet been satisfactorily answered. It is probable that the present branchial apparatus has been modified, as compared with an earlier stage in which the blood-vessels played a more important part.

Below the epithelium of the endostyle, or median ventral tract of the pharynx, there is a chitinous plate which has never yet been described: it consists of right and left halves, and is segmented. Prof. Lankester doubts the existence of the muscular tissue which has been described by Schneider in the region of the endostyle.

The atrio-cœlomic funnels or brown canals discovered by the author fifteen years ago have not been described or discussed by any other subsequent writer, with the exception of Mr. Bateson. It is impossible at present to assign definite physiological characters to these tubes; their morphological marks are that they are paired short tubes which put the cœlom in continuity with the exterior; so far they resemble the abdominal pores of certain craniate Vertebrates; Bateson has shown that they correspond in some points to the collar-pores of *Balanoglossus*. Whether all these three structures are modified nephridia remains to be seen; at the present moment our conceptions of the nephridium are themselves undergoing development and extension. Further observations are needed on the later development of *Amphioxus*.

In conclusion, the author has some remarks on the connective tissues, which, like other tissues of this animal, differ very greatly from the corresponding placed tissues in other Vertebrates, and do not closely resemble those of any other animal. The structural varieties of the connective tissue are lamellar, gelatinous, and cartilaginoid.

Spermatogenesis.*—Signor E. Verson finds that *Bombyx mori* offers excellent material for a study of spermatogenesis. In each division of the gonad there is but one large germinal cell, from which all the organized structures, of which the contents of the division consist, gradually take their origin. Its gigantic protoplasmic body gives off peripheral rays in the form of finely branched arms, and contains, in addition to its large vesicular nucleus, with nucleoli, well-characterized granules which are imbedded in the protoplasm of the radiating arms, and are always more numerous near the centre. Later on the granules separate themselves from the radial processes of the germinal cell, and appear to be independent and surrounded by a thin area of protoplasm. They are succeeded by rounded or more irregular protoplasmic masses which contain a number of nuclei. There are also larger almost spherical masses which are much clearer and are definitely limited at their periphery by a circular contour; their nuclei are also clear, become vesicular, and inclose highly refractive, sharply limited corpuscles, which, in profile, have the form of a comma or a horse-shoe. In addition to these there are still larger vesicles in which an enveloping layer can be distinguished from the contents; the latter contains a large number of nuclei, while here and there a delicate surrounding layer of protoplasm can be made out; the central space appears to be free from

* Zool. Anzeig., xii. (1889) pp. 100–2.

formed elements. Other vesicles have the same appearance as these last, but have a longer diameter. Others, again, have their contents altered; the epithelial layer found in the others has disappeared, the cells are smaller and fill up irregularly the whole cavity of the vesicle. The vesicles next extend irregularly and the spherical form may gradually yield to the pyriform or tubular; the investing layer becomes thinner and the contained cells begin to break up in such a way that the nucleoli become free, while the protoplasm breaks up into elongated droplets. The tubes elongate, the nucleoli and their derivates collect together, and the other contents form varicose filaments.

Spermatogenesis in Man.*—Herr D. Biondi describes the development of spermatozoa in Man. Before puberty the canals contain only one kind of cell, round in shape, lying in a single or double row on their wall, or sparsely and irregularly imbedded in a matrix towards the lumen. After maturity the round cells are arranged in pillars, in the three zones which Biondi has elsewhere distinguished—primitive cells, mother-cells, and, most centrally, daughter-cells. The spermatozoon is developed from the nucleus of the last, and the cell-substance forms imbedding débris. The next zone of cells also become transformed into spermatozoa, and the peripheral cells may form mother- and daughter-cells. The daughter-cells in their development into spermatozoa exhibit five stages—(1) movement of the nucleus to the peripheral pole, (2) formation of the middle portion, (3) formation of the head, (4) formation of the tail, (5) liberation. The spermatozoa are expelled, along with the basal cell, by the expansion of neighbouring cells. The epithelial cells of Sertoli, the supporting cells of Merkel, the spermatoblasts of von Ebner, are artificial products, resulting from the collocation of spermatozoa, protoplasmic débris, and basal cells.

Import of Polar Globules.†—Herr G. Platner notes an important histological fact, which must be considered in the interpretation of polar globules. In ordinary cell-division, the nucleus after dividing returns from aster to coil, and thence to reticulum and rest. There are, however, two exceptions. It is well known that in the formation of the second polar globule the resting-stage is skipped. The second polar spindle arises directly from the internal daughter-plate of the first polar spindle. The half of the nucleus which goes off in the first polar body frequently behaves like the half which remains. The second exception seems to be less known; it occurs in the last division of the sperm-forming cells. Here again the resting-stage is skipped; from the daughter-plate of the second last division the final division-spindle arises directly. The overleaping of the resting-stage in spermatogenesis was studied by Platner in Lepidoptera and Pulmonata. He correlates the two parallel and exceptional facts; in both cases there is a reduction by division of the nuclear mass previous to the final differentiation of female pronucleus in the one case, of spermatozoon nucleus in the other.

In the testes of Lepidoptera there are at first only small cells, which divide frequently and regularly. Suddenly large cells appear, which Platner compares to ova. These divide twice as ova do in forming polar globules. This fact adds a new precision to the comparison between the male and female elements. Furthermore, if the fact

* JB. Schles. Ges., lxv. (1888) pp. 35–8.
† Biol. Centralbl., viii. (1889) pp. 718–20.

observed be of general occurrence, it will follow that "just as the products of the division of sperm-forming cells are equivalent, so also the nuclei arising from the division of the directive spindle will contain equivalent material." Herr Platner does not discuss the relation of the homology which he emphasizes to the various theories of polar globules, but such application will doubtless be forthcoming.

Segmentation in Double Organisms.*—Prof. G. Born has been investigating the conditions of segmentation in ova which give rise to double monsters. Starting from the conclusion of Roux and Pflüger, that the first segmentation of the frog's ovum divides the material into symmetrical halves which correspond to the future right and left sides, Born first supposed that a duplicity would be evident from the beginning in cases where double monsters arose. He sought for material, but the monstrosities were too rare in frogs, and the eggs of Salmonidæ were too opaque. Pike ova, however, suited his purpose. With different females the percentage of double monsters varies greatly from 3 to 0·2 or 0·5 per cent. His first year's experiments have not led him very far, but it appears certain that "those ova which give rise to double monsters form a first segmentation cleft single and regular, as in those from which ordinary embryos develope." Born believes, however, that when the double eggs, as we may call them, divide first into two, and then into six portions, there must have been to start with two primary segmentation nuclei and two germinal vesicles. In such cases a double fertilization must also occur. In ordinary segmentation he maintains that the nuclei which divide to form right and left, or anterior and posterior centres, are not congruent, but at most symmetrical. In double monsters, he supposes that the first division is entirely congruent, that the two nuclei are absolutely equivalent, that the differentiation into right and left or fore and hind portions is only effected in the second division. The appearances are the same as in the normal segmentation, but their import is different. As to ova which at once divide into three and four, they always perish, and probably illustrate the result of polyspermy.

β. Histology.†

Structure of the Cell and Phenomena of its Division.‡—Herr G. Platner commences his essay with an account of his observations on cell-division and spermatogenesis in the hermaphrodite gland of *Limax agrestis*. The secondary nucleus, first observed by la Vallette St. George, is not the peculiar body it has hitherto been supposed to be, but must be ranked with the "sphères attractives" described by van Beneden in the cleavage-cells of *Ascaris megalocephala*, with the "archoplasm" of Boveri, and the "periplasts" of Vejdovsky. The author agrees with van Beneden in thinking that similar elements will be found in all cells.

Spermatogenesis and cell-division in *Paludina vivipara* and *Helix pomatia* is next considered. All the constituents of the sperm-producing cells are oriented towards the centrosoma, which is contained in the secondary nucleus. In cell-division the achromatic spindle, and then the centrosomata with the primary rays of the polar radiate figures, are

* JB. Schles. Ges., lxv. (1888) pp. 79–90.
† This section is limited to papers relating to Cells and Fibres.
‡ Arch. f. Mikr. Anat., xxxiii. (1889) pp. 125–52 (2 pls.).

given off from the secondary nucleus. The primary rays of the polaster have a definite numerical relation to the chromosomata, the number of the latter being twice as large as that of the former. After division the secondary nucleus is formed from the polar elements, that is, the centrosoma and the primary rays, and into it the substance of the spindle-fibres seems again to pass. The tip of the head of the spermatozoon is formed from the centrosoma. The secondary nucleus formed from the spindle-fibres after the last division of the spermatocytes takes a direct or indirect share in the formation of the covering of the axial filament. The last division of the spermatocytes is of a reducing nature, as it follows directly on the one which precedes it without the intercalation of a resting-stage; it corresponds to the division of the second polar globule, and the number of chromatic elements is reduced by one-half.

Herr Platner concludes with some notes on direct nuclear division in the Malpighian vessels of Insects, which are particularly suitable objects for such investigations. Division was found to be not mere elongation and constriction, but a more complicated process; this is explained by supposing that there are in the nucleus chromatic elements of different characters; the more highly differentiated are as nearly as possible divided into two, while those that are less so are more coarsely divided.

Process of Ossification.*—Dr. Drogoul has investigated the much discussed process of normal ossification in mammals. He emphasizes the observation that the osseous cells do not multiply, but that the reproductive activity is exhibited by the cartilaginous elements, periosteal and medullary. His object has been to investigate the cell-divisions in those structures which afford the new tissue. The ossification does not occur in the same way in the epiphysis and in the extremity of the diaphysis; the former is wholly neoplastic, the latter to some extent metaplastic. The articular cartilages are distinguished from the cartilages destined to become ossified in the character and behaviour of their component elements, since only the transitional elements which give rise to the capsule, the ligaments, and the periosteum multiply, never those of the body of the cartilage. The perichondrium is equivalent to the external stratum of the periosteum, and its functions are limited to the protection of the cartilage, in the growth of which it has no share.

γ. General.

Fresh-water Fauna of Greenland.†—MM. J. de Guerne and J. Richard report on the result of M. Ch. Rabot's exploration of some fresh-water basins in different parts of Greenland. Two Phyllopods, *Branchinecta paludosa* O. F. Müller and *Lepidurus glacialis* Kröyer, previously reported from Greenland, were found abundantly. Cladocera were represented by twelve species, of which the most widely distributed seemed to be *Bosmina arctica*. It was interesting to find *Holopedium gibberum*, which is characteristic of the pelagic zone of great mountain lakes, occurring in Greenland in small shallow basins, at the level of the sea. Copepods were represented by *Cyclops viridis* Fisch., of rare occurrence, and *Diaptomus minutus* in great abundance. The

* Atti R. Accad. Sci. Torino, xxiv. (1888-9) pp. 264-8 (1 pl.).

† Comptes Rendus, cviii. (1889) pp. 630-2.

following rotifers were abundant in the lake of Egedesminde:—*Triarthra longiseta* Ehr., *Asplanchna helvetica* Im., *Anuræa cochlearis* Gosse, *A. longispina* Kell., *Conochilus volvox* (?). These are new additions to the Greenland fauna. The fauna of the Greenland fresh-water basins resembles in several ways that of Europe, but differs in the presence of special types.

B. INVERTEBRATA.

Excretory Organs.*—Prof. A. Kowalevsky has made an investigation into the structure of excretory organs of animals, which he has fed or injected with various colouring matters; the organs were then examined fresh, or treated with alcohol and cut into sections.

Beginning with the Crustacea he injected into a crayfish a 1 per cent. solution of carmine and ammonia; after some hours he found that the terminal saccules of the antennary gland began to colour, and gradually become more and more red; in the course of two or three days the coloration reached its maximum. The nuclei of the cells remained quite normal and white, as only the granules took up the red colouring matter; at the ends of the cells which were directed towards the lumen of the gland the granules became collected into small masses; these separated from the cell-substance and fell into the lumen of the gland. Different results were attained when indigo-carmine was used. It was, in effect, found that Weismann and Grobben are right in comparing the terminal saccules with the Malpighian capsules, while the urinary canaliculi of *Astacus* and of the Vertebrate kidney correspond to one another in relation to indigo-carmine. From these experiments and from others with other colouring matters, it may be concluded that in the antennary gland of the crayfish there are three divisions which are physiologically distinct:—the terminal saccules with acid reaction, the commencement of the urinary canaliculi where indigo-carmine is excreted and the reaction is alkaline, and a third portion, the white loop, which for a long time remains indifferent to the staining materials; where large quantities are used for some time small quantities of indigo carmine are deposited in it. Various other Crustacea were experimented with, and it was found that in the shell-gland of the lower forms the terminal saccules and the urinary canaliculi have the same functions as in the antennary gland.

A number of observations were made on Insects and it was found that, in comparison with Crustacea, the function of the antennary or shell-gland is so far separated that that of the urinary canaliculi is performed by the Malpighian vessels, while there is no organ corresponding to the terminal vesicles; their function is performed by the pericardial cells. The author has already shown that these have the office of purifying the blood and extracting from it foreign or dangerous bodies; the action of these cells may be compared to that of phagocytes, as they have no efferent ducts.

Numerous representatives of the Mollusca were examined, and it was found that the indigo-carmine was secreted by the same elements as those which secrete the renal salts, for the colouring matter was deposited not only in the same renal cell, but in the same vacuole as the urinary concretions. We may conclude, therefore, that in the Mollusca there

* Biol. Centralbl., ix. (1889) pp. 33–47, 65–76.

are organs which play the part of the Malpighian corpuscles and the tubuli contorti of Vertebrate kidneys.

Among the Vermes, Chætopods, Gephyreans, and Leeches were alone examined; small examples of *Nereis cultrifera* were found to be very suitable objects for examination, and fuller information than is here afforded us is promised shortly. Carmine is got rid of by the nephridium of the earthworm, but it is only a small part of the organ that is engaged in so doing; the chloragogue cells also take up indigo-carmine. In the Hirudinea the relations are very complicated, and are not as yet completely understood.

In the Echinodermata, Tiedemann's bodies appear to be the excretory organs of the water-vascular system, while the so-called heart or ovoid gland is the excretory organ of the body-cavity; both of these organs appear to have the same reaction as the segmental organs of most Annelids, that is, they excrete carmine and have a slight acid reaction. Prof. Kowalevsky observed distinct contractions of the ovoid glands in Echinoids; though these were not regular pulsations, yet there were repeated contractions of the whole organ.

The arrangements of some Ascidians are very remarkable, for in *Phallusia mentula* all the organs are imbedded in a stroma which consists of a number of vesicles in which lie rounded concretions. If indigo-carmine be injected into *Ascidia mentula*, crystals are found in the secreting vesicles around the concretions already there, just as in the case of the organ of Bojanus in Molluscs. The author concludes that the Ascidians have organs which correspond to the renal canaliculi of the Vertebrate kidney.

In an additional note,* in which some further information is given, the most interesting point is, perhaps, the discovery that if a dog containing *Echinococcus* vesicles be fed for three weeks with carmine and ammonia, the water-vascular system, and especially the larger lateral trunks of *Tænia echinococcus*, become coloured red.

Mollusca.

Anatomy of Deep-sea Mollusca.†—Prof. P. Pelseneer, who had to make a somewhat hasty examination of the deep-sea Mollusca collected by H.M.S. 'Challenger,' arrives at three general conclusions:—

(1) An organ of special sense, the organ of vision, may atrophy and disappear in consequence of the absence of sufficient light in the great depths.

(2) Correlatively, the organs of general sense may multiply and acquire a high degree of development, as the labial palps of *Trochus infundibulum*, and the siphonal tentacles of varied structure found in the deep-sea Anatinacea and in *Malletia*.

(3) The respiratory activity may diminish, and the gills become rudimentary in various ways or may retain great simplicity of structure.

α. Cephalopoda.

Structure of Silurian Cephalopods.‡—Dr. H. Dewitz calls attention to the fact that in 1878 he demonstrated that the horizontal walls found inside the air-chambers of Silurian Cephalopoda were of organic origin,

* Biol. Centralbl., ix. (1889) p. 127.

† Reports of the voyage of H.M.S. 'Challenger,' Zoology, xxvii., part lxxiv. (1888) 42 pp. (4 pls.).

‡ Zool. Anzeig., xii. (1889) pp. 147-52.

secreted by the animal itself. He gave to these structures the name *Hilfskammerwände*. He writes against the change of this term into pseudoseptum, and against sundry misrepresentations both of his discovery and of the facts of the case.

Development of Sepia.*—M. L. Vialleton has a memoir on the early stages in the development of this Cephalopod. The egg is at first a simple nucleated cell, surrounded by a few flattened cells which form a rudimentary follicle. This follicle soon becomes complicated, and presents an inner epithelial layer, and an outer connective and lamellar one. The former becomes folded, and begins to secrete the nutrient yolk which does not mix with the protoplasm of the egg. The follicular cells do not emigrate into the interior of the egg to serve as food, but simply furnish it with their secretion. As the egg grows, the germinal vesicle does the same, and undergoes considerable modifications; its contents, which at first consisted chiefly of chromatic material in different stages of division, contain, later on, only a few chromatic grains distributed in a large mass of finely granular protoplasm. When the follicular cells have secreted all the nutrient yolk necessary for the egg, they provide it with a chorion. The germinal vesicle disappears. The egg, now ripe, drops into the peritoneal cavity, but it is not fecundated till it leaves the oviduct.

The egg is expelled by the funnel, seized by the ventral arms and buccal membrane, and fertilized by sperm from the copulatory pouches; it is then enveloped in its capsule, and fixed to submerged bodies. The formation of polar globules takes place, no doubt, at the moment when the egg is expelled. The two pronuclei are identical in structure, have no proper separable membrane, but a very fine pellicle of chromatin; they fuse in the ordinary way. As they pass over the formative yolk the protoplasmic granulations which inclose it group themselves around the pronuclei so as to form the germinal disc. The formative yolk at the periphery of the disc is a very delicate hyaline lamella, which gradually fuses with the nutrient yolk. The first segmentation-nucleus is near, but not exactly at the centre of the germinal disc.

The first segmentation-groove is meridian, and divides the germinal disc into two equal parts; the next two grooves are likewise meridian, and give rise to eight unequal segments which are arranged symmetrically in relation to the first groove, which becomes the axis of the blastoderm; though unequal, these eight segments are all macromeres. The six upper and lateral segments are next divided by a meridian groove, but the two lower by an equatorial one; the uppermost of the latter set occupies the centre of the blastoderm, and its cells correspond to the micromeres. Segmentation becomes more irregular. At the end of segmentation the blastomeres (micromeres) are very numerous, as there are more than three hundred present; they form a circular plate limited externally by the zone of blastocones.

As development proceeds the differences between these two sets of cells becomes more and more marked, till at last the blastomeres form a multistriated cellular disc (blastoderm), while the blastocones have scattered their nuclei throughout the whole extent of a hyaline layer, which they thus transform into a multinucleated true plasmodium, the perivitelline membrane. The blastoderm gradually covers this membrane,

* Ann. Sci. Nat., vi. (1888) pp. 165–280 (8 pls.).

which forms a specialized independent layer, and which we may, at a later stage, regard as the primitive endoderm; the blastoderm becomes differentiated into an ectoderm, which forms a rounded plate one layer thick in its centre, and formed of several rows of cells at the periphery; these cells are formed by delamination; the deeper layers of the edge of the blastoderm form part of the mesoderm.

The author concludes with carrying further the modifications of the germinal layers, and takes the opportunity of discussing the views of those who have preceded him. Other parts of the mesoderm are formed by the ectoderm in different parts of the body; as at the periphery of the eye, the region of the siphon, where it gives rise, by proliferation, to a mass in which the muscles of the siphon and the visceral ganglion are, later on, differentiated, the cephalic lobes, and the extremity of the brachial folds. It will be seen that the character of these secondary delaminations is to be isolated and partial, and this secondary proliferation of the ectoderm produces very different tissues, for the masses to which it gives rise are sometimes muscular and sometimes nervous. The author does not think there can be any doubt as to the justice of regarding the perivitelline membrane as the primitive endoderm.

γ. Gastropoda.

Double Forms of Spermatozoa.*—Dr. R. Koehler gives a description of the two forms of spermatozoa found in *Murex brandaris* and *M. trunculus*. It is pointed out that in the Pulmonate Gastropods (*Arion*, *Helix*) the mother-cells of the spermatic products, or spermatogonia, arise from nuclei which are scattered irregularly in a layer of protoplasm which lines the inner surface of the testicular tubes. These nuclei with the protoplasm correspond to the regular embryonic epithelium of these tubes, and represent the primordial sexual cells. It is probable that these nuclei also give rise directly to the special elements which have been called basal cells.

In *Murex*, the nuclei, which are arranged in a similar manner, give rise to two very distinct categories of elements; some are large cells with definite contours which are the mother-cells of the vermiform spermatozoa, while others are smaller, have no membrane, and give rise to the filiform spermatozoa; these last undergo the changes usual in spermatogenesis. The mother-cells of the vermiform spermatozoa inclose only a single nucleus which will, later on, break up to form the large multinucleated cells; they do not undergo the repeated divisions which characterize the development of ordinary spermatozoa. The substance of one of the nuclei is converted into a bundle of fibrils, one end of which will give rise to a tuft of cilia, while the other will form the cephalic extremity of the vermiform spermatozoon. During its development the nuclei largely disappear in the cellular protoplasm, but their remains will form the colourable granulations which the protoplasm of their spermatozoa contains in their adult state. These have no distinct central filament, except in the cephalic region. Although the organization of the spermatozoa is similar in the two species, those of *Murex brandaris* are immobile, and of *M. trunculus* very active. The vermiform spermatozoa of the Prosobranch Molluscs are not adapted to any definite function; as their early history shows, they have the

* Rec. Zool. Suisse, v. (1888) pp. 101–50 (2 pls.).

morphological value of ova, and they give to the gonad which produces them the appearance of a hermaphrodite organ. It may be that, in the testes of the higher Prosobranchs, they represent the ova produced by the gonad of the hermaphrodite types which were separated from the Prosobranch stock at the same time as that at which the higher or Monotocardate Prosobranchs made their appearance.

Fertilization in Helix aspersa and Arion empiricorum.*—Dr. P. Garnault has been led by his researches to recognize two distinct actions in the process of fertilization in these two molluscs. One consists in the impulsion given to segmentation which is, indeed, produced by the spermatozoon, but which may be caused by an external and mechanical excitation, as has been shown by the experiments of Tichomiroff on the ovum of *Bombyx mori*. The other consists in the assurance of the transmission of characters; this may, in organisms with a diffused nucleus, merely consist of the fusion of two bodies. In higher organisms, where there is a vesicular nucleus, the fecundating individual, the spermatozoon, fuses with the yolk by its protoplasmic part, but its nucleus (head) is the point of departure of a nuclear formation (male pronucleus) which becomes relatively enormous by borrowing its materials from the ovum.

In fact, if in the parthenogenetic ovum a single nucleus is developed, evidently at the expense of the egg, two are developed in the fecundated egg, and they are equivalent in mass to the single nucleus; they are both developed at the expense of the egg, but one of them has arisen from the head of the spermatozoon. They elaborate in common substances destined to fuse later with the protoplasm; from the point of division they behave as in the parthenogenetic egg, but the nuclear substance has received the influence of the male. It is impossible to say what is the precise moment of fertilization; all the phenomena which occur are of the nature of cellular actions, the morphological manifestations of which are simple in the lower organisms which have no nuclei, and are more complicated in those which possess one. In the latter case one can only admit that the nuclear phenomena which are produced at the moment of fertilization, constitute the essential part of the phenomenon, while the nucleus is the sole substratum of the essential characters of the individual.

Neurology of Prosobranchiata.†—Dr. J. Brock has made an investigation of the nervous system of a number of Prosobranch Molluscs. He comes to the conclusion that the great majority of Prosobranchiata are, so far as the development of the terminal plexus of the anterior margin of the foot is concerned, higher than the Rhipidoglossa. There appears to be a definite connection between the delimitation of an anterior portion of the foot as propodium and the better development of the ganglionic plexus which is so characteristic of the anterior margin of the foot. This is the more remarkable as the whole formation of the propodium in the few families that are provided with it is so different that its appearance must, in many cases at least, have been independent of the rest. Although the author does not propose to rehabilitate Huxley's division of the Gastropod foot into pro-, meso-, and metapodium, which has, indeed, been shown by

* Zool. Anzeig., xi. (1888) pp. 731–6; xii. (1889) pp. 10–15 and 33–8.
† Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 67–83 (2 pls.).

Grenacher's embryological investigations to have no certain basis, yet he perceives that there is at least a possibility of characterizing a propodium by anatomical characters.

The physiological significance of the nervous plexus is very difficult to explain. Where it is highly developed, as in *Harpa*, *Natica*, &c., the portion of the foot which contains it is provided with a wealth of nerves such as there is not the like of among the Mollusca. The tendency of nerves, especially in their terminal branches, to break up into a plexus is very great in the Mollusca; they have been described in the gastric and enteric walls of various Proso- and Opisthobranchiata, and Pulmonata, in the branchiæ, pericardium, wall of the heart, mantle, lips and kidney of Prosobranchs, and elsewhere.

An account is given of the central nervous system and the visceral commissure of *Pteroceras*, which present some abnormal characters. Instead of a ganglionic mass above and below the enteric canal, there is one to the right and another to the left of it. The commissure which generally goes from the right pleural ganglion to the supraintestinal ganglion appears to be wanting, and instead of it a strong nerve passes from the left pleural to the subintestinal ganglion. The difficulties raised by these peculiar arrangements are explained when an examination is made of the ganglia of the œsophageal ring, which has been twisted through a right angle in the direction opposite to that of the hands of a watch. A similar alteration has been observed in *Strombus luhuanus*.

We now know of three ways in which the simple, typical, visceral commissures of Prosobranchs may be made more complicated. The first consists in a fusion of the parts of the hinder loop, together with a marked shortening of the anterior. This very peculiar differentiation leads to the apparently orthoneural visceral commissure of the Neritina and Helicina. If Pelseneer's views are correct, the Heteropoda would form a kind of intermediate stage. The second mode of differentiation is that here described; it ends in the anterior loop of the visceral commissure, being placed to the left of the intestine, and this is seen in the Cyprææ and Alata. A third method is the approximation and fusion of the supra- and subintestinal ganglia with the pleural ganglia of their proper side; this may be seen in all stages in many of the higher Prosobranchiata. It generally happens that the subintestinal ganglion first fuses with the right pleural ganglion, while the supraintestinal long remains independent. The final result is the extreme shortening of the anterior loop of the visceral commissure.

Hermaphroditism of Aplysiæ.*—M. E. Robert has some observations on the recent paper of M. Rémy Saint-Loup.† He does not for a moment doubt that *Aplysia fasciata* or *A. depilans* have the sexes united, and the information which can be got by examining the hermaphrodite gland may be supplemented by a study of the conformation of the accessory reproductive organs, which are altogether on the hermaphrodite type. No difference can be observed between the individuals in copulation.

M. Saint-Loup's error appears to have arisen from his taking for males younger animals than those which he calls females; the latter are adults perfectly hermaphrodite. In young forms spermatoblasts and

* Comptes Rendus, cviii. (1889) pp. 198-201.
† See this Journal, *ante*, p. 195.

spermatozoa are more abundant than are ova. The pouch which Cuvier took for a bladder appears to be not a spermatic reservoir, but a store-place for reserve elements which do not escape at the same time as the ejaculated mass of spermatozoa.

In answer to these remarks M. R. Saint-Loup * urges that at one period the hermaphrodite gland elaborates male elements, and that such individuals may, for the time, be regarded as males; at other times it produces both male and female elements without either predominating, and lastly the female elements distinctly predominate. In all these stages the individuals are fit for copulation.

Genera of Æolidiidæ.†—Dr. R. Bergh continues his investigations on Nudibranchs in a systematic account of the Æolidiidæ, accompanied by five plates. The genus *Æolidiella*, with *Æ. orientalis* sp. n.; *Glaucus*, with *Gl. atlanticus* Forst.; *Hervia*, with *H. rosea* sp. n.; *Moridilla* g. n., with *M. brockii* sp. n.; *Cerberilla*, with *C. annulata* (Quoy et Gaim.) var., *affinis* Bgh.; *Melibe* Rang, with *M. ocellata* sp. n.; *Doto*, with *Doto fragilis* Forbes; *Hero* Lovén, with *H. formosa* Lovén, are described and figured.

The new genus *Moridilla* is thus diagnosed:—Body slender, elongated, subcompressed; rhinophoria somewhat mulberry-like; tentacles long; dorsal papillæ not readily caducous, elongated, disposed in oblique rows, anteriorly in groups; foot rather narrow, with the anterior angles produced like tentacles; mandibles moderately long; masticatory process not curved, with a single series of coarse denticles; lingual teeth in a single row, almost as in Facellinæ; penis unarmed.

New Genus of Parasitic Mollusca.‡—Mr. E. A. Smith forms the new genus *Robillardia* on a single specimen of a shell which was stated to have been found living on an Echinus. In the absence of the animal it is impossible to assign this new form to any definite systematic position, but the delicate shell is stated to have the glassy texture of *Carinaria*, and somewhat the form of a certain species of *Hyalina*; it appears to be viviparous. The shell of *R. cernica* has a longer diameter of 8, and a shorter diameter of 6·5 mm., with a height of 5 mm. Mr. Smith takes the opportunity of collecting in a very convenient form the names and habitats of most of the already described parasitic genera of Mollusca.

δ. Lamellibranchiata.

Abdominal Sensory Organs in Lamellibranchiata.§—Dr. J. Thiele gives a full account of the sensory organs discovered by him in certain Lamellibranchs, the preliminary account of which we have already noticed.‖ It is now noted that in several genera the sensory body on the left side is degenerate, or, as in *Pecten* and *Ostrea*, wanting. The search for these organs in the siphoniate forms has remained vain. The only organs in other Molluscs which can in any way be compared to them are the sensory structures found near the gill of *Nautilus*, but this even is doubtful.

The extraordinary resemblance between the epithelium of these

* Comptes Rendus, cviii. (1889) pp. 364–5.
† Verh. K. K. Zool.-Bot. Gesell., xxxviii. (1888) pp. 673–706 (5 pls.).
‡ Ann. and Mag. Nat. Hist., iii. (1889) pp. 270–1.
§ Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 47–59 (1 pl.).
‖ This Journal, 1888, p. 942.

organs and of the lateral organs of the abdomen of the Capitellidæ was noticed in the preliminary communication; since then the author has had the opportunity of examining preparations of the latter, and finds that the likeness is very great. A detailed account is now given of the histological characters of these bodies in Lamellibranchs, and it is shown that in them, as in the Capitellidæ, only one kind of cell is in contact with the surface, and that the nuclei thereof are spindles. The character of the epithelium and its connection with the nervous system justifies the conclusion that the papillæ found in the region of the anus are sensory organs; as they are provided with a number of long hairs, which are set in motion by every current of water, their function would appear to be that of perceiving movements in the surrounding medium. They are, in other words, organs of the sixth sense. It is, indeed, possible that they have also some power of olfactory perception, but it cannot be that they have any tactile power. Their absence in the Siphoniata seems to show that their chief duty is the perception of movements in the water; in siphoniate forms sensory organs for the perception of water-movements are placed at the end of the in-current siphon.

Turgescence in Lamellibranchs.*—M. A. Ménégaux has made a somewhat extended examination of the phenomena of the turgescence of the foot in Lamellibranchs. He comes to the conclusion that, in all those in which this organ is well developed, there is an orifice provided with a sphincter muscle, and that this is wanting in the rest; the intervention of water is, therefore, not necessary to explain the enlargement. A post-ventricular and muscular dilatation aid the heart in driving the blood into the siphons, while two successive valves oppose the direct return of the blood into the heart during the rapid contraction of the siphons.

Development of Oyster and Allied Genera.†—Mr. R. T. Jackson has a preliminary paper on the later development of the oyster, with studies of allied genera. He considers that the two valves of an adult oyster are altogether homologous with the single valve of adult cephalous Mollusca, for both originate from the preconchylian gland. As the adult shell of the latter is termed a conch, the name dissoconch (double shell) is suggested for that of adult Lamellibranchs. The form and structure of the shell in the stages recognized by Ryder—prodissoconch, silphologic (spat), and adult, are considered in detail. Mr. Jackson directs attention to a striking peculiarity in the Ostreidæ which he thinks has escaped notice; the two valves are as dissimilar as if they belonged to distinct species. This is regarded as evidently a case of inherited or acquired characteristics.

Byssus of young of common Clam.‡—Mr. J. A. Ryder has made some observations on the byssus of the young of *Mya arenaria*. Sections were prepared to determine if there was a byssus-gland in the foot; these were obtained by treatment with 1/2 per cent. chromic acid solution, which was afterwards acidulated with nitric acid. In the sections of the median region at the apex of the foot a median saccular depression, which was undoubtedly the byssal gland, was detected. The presence of this

* Comptes Rendus, cviii. (1889) pp. 361–4.
† Proc. Boston Soc. Nat. Hist., xxiii. (1888) pp. 531–56 (4 pls.).
‡ Amer. Natural., xxiii. (1889) pp. 65–7.

byssal attachment reopens the question of the life-history of this important shell-fish; other forms may also have an unknown byssal stage, and if that be the case the methods hitherto proposed to be adopted in order to secure the young for purposes of transplanting will have to be greatly modified. To obtain the early stages of the young it will be necessary to resort to some forms of "collector," such as is used in oyster-culture, to allow the fry to affix itself.

Distribution of Unio margaritifer.*—Herr K. Fischer reports the presence of the pearl-bearing *Unio* in the district of Trier. Where the water is limy it is not found.

Molluscoida.

α. Tunicata.

Tunicata of the Voyage of the 'Challenger.'†—With his third part Prof. W. A. Herdman completes his description of the Tunicates collected by H.M.S. 'Challenger.' He here gives accounts of the Ascidiæ salpiformes, the Thaliacea, and the *Larvacea*, and discusses the affinities and classification of the Tunicata and their probable phylogeny. Altogether twenty-six species of pelagic Tunicata, mostly belonging to the genus *Salpa*, were collected, and of these nine are new to science. The remarkable deep-sea genus *Octacnemus* of Moseley is made the subject of a new family, the Octacnemidæ. *Pyrosoma*, although now a free-swimming organism, is, in the author's opinion, derived from the fixed compound Ascidians, to the most typical of which it is, through *Cœlocormus huxleyi*, directly related. The Synascidiæ are polyphyletic forms, derived from the simple Ascidiæ at three distinct points; they form, therefore, three groups:—(1) the Polystelidæ, (2) the Botryllidæ, and (3) the remainder, which are more nearly related to particular groups of simple Ascidians than they are to one another.

Branchial Homologies of Salpa.‡—Sig. F. Todaro compares the anatomy and development of *Salpa* with that of other Tunicata, and comes to the general conclusion "that the two large branchial clefts of *Salpæ* are homologous with the two branchial clefts in *Appendicularia*, and with the two primary branchial clefts in the Ascidiæ, while the numerous stigmata or secondary branchial clefts of the Ascidiæ are homologous with those of *Salpæ*."

Relation of Tunicata to Vertebrata.§—M. F. Lahille summarizes his objections to the view that the Tunicata are the ancestors of the Vertebrata. He thinks that the two groups are very distinct from one another, and cites a number of facts to support his contention.

β. Bryozoa.

Phoronis Buskii.‖—Prof. W. C. M'Intosh reports on a new species of *Phoronis* dredged by H.M.S. 'Challenger.' He gives a detailed description of its anatomy, but is unable yet to definitely assert the

* Verh. Nat. Ver. Preuss. Rheinl., xlv. (1888) pp. 292-4.

† Reports of the Voyage of H.M.S. 'Challenger,' xxvii. part lxxvi. (1888) 163 pp. (11 pls.).

‡ Atti R. Accad. Lincei (Rend.), iv. (1888) pp. 437-44 (2 figs.).

§ Bull. Soc. d'Hist. Nat. Toulouse, xxii. (1888) pp. xcii.-vi.

‖ Reports of the Voyage of H.M.S. 'Challenger,' Zoology, xxvii., part lxxv., 27 pp. (3 pls.).

relationship of this genus to other known groups. It seems to be most closely allied to the aspidophorous group of the Polyzoa; and, for the present, must be regarded as an aberrant Polyzoon.

Ovicells of Cyclostomatous Bryozoa.*—Mr. A. W. Waters thinks that the ovicells of cyclostomatous Bryozoa are important characters, so that it is to be regretted that so little is known about them. He now describes and figures those of three of the species found by the 'Challenger'; the result of the examination of *Idmonea fissurata* Busk is to remove it to the genus *Hornera*. In addition to *I. irregularis* and *I. milneana*, Mr. Waters has some notes on *I. Meneghini*.

Ovicells of Lichenoporæ.†—The same author has notes on the ovicells of some *Lichenoporæ;* this contribution is of importance, as in the third part of Mr. Busk's British Museum Catalogue, and in the same author's 'Challenger' Report, no notice is taken of these structures.

Formation of Statoblasts in Plumatella.‡—Herr F. Braem, in the continuation of his researches,§ has been able to detect the passage of ectodermal cells into the funiculus to aid in the formation of the statoblasts of *Plumatella*. In consequence of this immigration, the funiculus swells up at its point of origin and represents a multicellular germinal stock from which the first statoblast begins to be constricted off. In later stages the connection of the ectodermal material of the germ-stock with the integument becomes lost. As the immigration is effected rapidly, it is not easy to demonstrate the passage of the cells, and, further, the mode of development of the colonies appears to vary with the period of the year.

Delagia Chætopteri. ‖—From notes of Prof. J. Joyeux-Laffuie and Prof. E. Ehlers it seems clear that the Bryozoon described by the former under the above name ¶ was named *Hypophorella expansa* by the latter in 1876.

Arthropoda.

α. Insecta.

Embryology of Insects.**—The first subject dealt with by Herr N. Cholodkovsky is the development of the external form in the embryos of *Blatta germanica*. The species recommended itself as appearing to be one which was very suitable for the determination of some unsolved problems in the embryology of the Hexapoda. The cocoon offered considerable technical difficulties, which were got over by placing cocoons, opened at either end, for from eight to twenty-four hours in Perenyi's fluid, then in 70 per cent., and then in 90 per cent. alcohol. The chitinous capsule of the cocoon could then be removed with needles, and the eggs, as a rule, be isolated without injury. The egg has the form of an elongated plate, near the straight margin of which lies the germinal band, while the other surface is covered by undifferentiated blastoderm. The latter is not at first continuous, but consists of separate flat cells, which are, later, used to form the serous investment.

* Journ. Linn. Soc. Lond., xx. (1889) pp. 275-80 (1 pl.).
† T. c., pp. 280-5 (1 pl.).
‡ Zool. Anzeig., xii. (1889) pp. 64-5. § See this Journal, 1888, p. 937.
‖ Arch. Zool. Expér. et Gén., vi. (1888) pp. xliv.-vi.
¶ See this Journal, 1888, p. 936.
** Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 89-100 (1 pl.).

The germinal band forms a narrow elongated layer of low cylindrical cells, which broadens out at the future head-end into two large lateral lobes. Segmentation of this band does not take place till a relatively late period, though it is, at a very early stage, remarkable for the centralization of its cells around certain points which are the centres of the formation of the future extremities.

In an early stage of development all the rudiments of the extremities have a similar structure; they form simple outpushings of the ectoderm, the cavities of which are invested by rounded mesodermal cells. The antennæ are pretty long; the mandibles are very small; the proportionately very long thoracic feet begin very early to exhibit signs of segmentation. The first pair of ventral appendages are considerably longer than the others, though they have exactly the same structure.

The succeeding changes in the form of the embryo, in addition to its general growth and the development of the lateral parts of the body, chiefly consist in a change in the form and internal structure of the first abdominal appendage; instead of becoming longer they become broader, while the base narrows; the mesodermal cells appear to wander into the body-cavity of the embryo; at any rate, the number in the first abdominal appendage gradually decreases. This becomes pyriform in shape, and is only attached to the body by means of a thin and small stalk. The greater part consists of very long and narrow, almost spindle-shaped, ectodermal cells, which form, by their diverging distal ends, the surface of their appendage, while their proximal ends converge towards the stalk. They lie very close to one another, and there is no internal cavity in this part of the altered extremity, while in the axis of the stalk there is only a canal leading into the body-cavity. In the later stages of development the organ disappears in a manner which has not yet been worked out.

Patten is not correct in saying that all the other abdominal appendages disappear rapidly; while the second to the ninth disappear as changes occur in the hinder part of the body, the tenth and eleventh undergo further development; the eleventh form the future cerci, and the tenth pair forms small appendages which persist throughout life in the male, but become lost in the female. The cerci do not become jointed till the embryo leaves the egg.

The development of the dorsal region is next briefly described, and it is stated that the tracheæ do not begin to be formed as invaginations of the ectoderm until it is completed. It is in consequence of this late appearance of the tracheæ that the embryo of *Blatta* is so especially adapted for the study of the rudimentary appendages, for in other insects the stumps of these organs may be easily confused with the ridges of the stigmata.

In the next place the author advances some general considerations. He first insists on the fact that the embryo described by him had eighteen pairs of well-developed appendages, nine of which in the male, and eight in the female persist throughout life. All these appendages have at first an altogether similar structure, and their cavities communicate with the corresponding cavities of the somites. He is led to believe that the insects are derived from ancestors that were polypodous and homopodous, and probably like *Scolopendrella;* that these ancestors did not live in water, but led, at most, an amphibious life, and that, in any case, they had nothing to do with the Crustacea. There does not appear to be any ground for regarding the "pedes spurii" of caterpillars as secondary structures; they are, rather, true embryonic appendages, which were retained in the postembryonic development, and the last pair of which persists through life in the male as the appendices copulatorii. Furthermore, the apparently truly secondary abdominal appendages of the complete insect are of the same morphological significance, and must be regarded as true homologues of the other extremities.

In conclusion, the author refers to the morphology of the larval forms of Insects. The theory of Brauer as to the so-called *Campodea*-like larvæ being the most primitive must be somewhat modified in the light of other researches. The development of *Blatta* leaves no room for doubt that the insect-embryo is essentially polypodous, and that, consequently, the ancestor of Insects is to be sought for in Myriopod-like forms. Balfour rightly called attention to the similarity between the structure of *Peripatus* and the organization of lepidopterous larvæ.

Incidental Observations in Pedigree Moth-breeding.*—Mr. F. Merrifield has some interesting notes on the breeding of Moths. The usual difference in size between the spring and the summer emergences appears to be due to the fact that the larva of the former is much longer in feeding up than the latter. The author thinks he has observed that, when there is no stunting or retarding from unhealthy conditions, those larvæ of a brood which are longest in feeding up are the largest. Variety in markings and colours, and also in size, is much greater in the summer than in the spring emergence; some successful experiments have been made in increasing these differences by selection. The application of cold in the earlier stages has a tendency, operating possibly by retardation, to produce or develope a darker hue in the perfect insect; this may throw some light on the melanism which is so often remarked in north-country examples of widely distributed moths.

Changes of Internal Organs in Pupa of Milkweed Butterfly.†—Mr. J. H. Emerton has some notes which may be regarded as supplementary to the memoirs of Burgess and Scudder on the life-histories of Butterflies. He describes chiefly the earlier pupæ from the time the larval skin is thrown off till the seventh or eighth day.

Chermes and Phylloxera.‡—Herr L. Dreyfus confirms Blochmann's recent account of the bisexual generation of *Chermes abietis*, but the general results of his observations do not agree with those of that author, for he finds that the course of development is much more complicated than has been supposed; indeed it is probable that the cycle is not completed in a single year. He thinks it probable that *C. abietis*, *C. laricis*, and *C. obtectus* are all forms in the developmental cycle of one species. The course of development seems to be as follows:—in the first year *C. abietis*, having survived the winter, lays eggs; in the gall on the pine a generation is developed which has wings, and this flies out; some members of this generation migrate to the larch, where they lay eggs as *C. laricis;* the third generation passes the winter on the larch as *C. laricis*. At the end of April of the second year there is a fourth generation which escapes at the end of May as *C. laricis;* the greater number of these return to the pine, where they lay eggs as *C. obtectus;*

* Trans. Entomol. Soc. Lond., 1889, pp. 79–97.
† Proc. Boston Soc. Nat. Hist., xxiii. (1888) pp. 457–61 (1 pl.).
‡ Zool. Anzeig., xii. (1889) pp. 65–73, 91–9.

the fifth generation developed therefrom is bisexual; from the fertilized egg the animal which is to live over the winter is slowly developed, and it gives rise to the first generation of the cycle. Further details are given as to other species of the genus.

The developmental history of *Phylloxera* is also incompletely known and is more complicated than is generally supposed; in many points there is a resemblance to what obtains in *Chermes*, and it is probable that forms which are generally regarded as specifically distinct belong to different periods in one developmental cycle. There are, also, reasons for supposing that external conditions may affect the rotation in which the various stages follow one another. In *P. coccinea* there are two and not only one winged sexupara during the year, for there is one at the end of June and another at the end of August; in addition to the wingless sexupara of September, described by Balbiani, there are others in July which produce a number of males or females. The author has brought together numerous facts relating to the life-history of these insects, and concludes that, in the natural development of *Phylloxera vastatrix*, the gall-generation never follows directly on the parthenogenetic root-generation; the first young form (stem-mother) which arises from the fertilized winter egg and its direct descendents, sometimes for several generations, begins the cycle with the formation of galls.

Dr. Dreyfus has also published a small treatise * on these insects which may be considered as a monograph of the group. He regards the Phylloxerina as forming the intermediate stage between the Coccinæ and Aphidinæ, and as constituting a distinct family of the suborder Phytophthires. The group is pretty widely distributed; the most important fact in their developmental history is that, in certain generations, the ova of one and the same mother give rise to completely different animals which pass, simultaneously, through quite different courses of development; there is, in other words, a division of the developmental series. The author thinks that these "parallel series" will be found in other Insects, and that a knowledge of them will afford the key to the difficulties now associated with their developmental history.

Chermes.†—Herr N. Cholodkovsky has two communications on this insect, in the second of which he points out how his observations control those of Blochman and Dreyfus; he finds that the yellow males and females described by the former do not belong to the developmental cycle of *Chermes strobilobius* but to that of *C. viridis*, while the black sexual animals which he has himself found are those of *C. strobilobius*. There are similar criticisms of other points of detail into which we cannot enter here.

δ. Arachnida.

Ecdysis of Spiders.‡—M. W. Wagner has made a close study of the phenomena of ecdysis in Spiders. He considers that the casting of the old integument only forms part of the process, and that a secondary one. Some of the phenomena begin at a comparatively long period antecedent to the casting of the skin, and these are partly due to the fact that for a time the animal is deprived of some of its faculties—of sight, hearing, touch, movement, and, for a short time, of respiration. Some of the

* 'Ueber Phylloxerinen,' 8vo, Wiesbaden, 1889, 88 pp.
† Zool. Anzeig., xii. (1889) pp. 60-4, 218-23.
‡ Ann. Sci. Nat., vi. (1888) pp. 281-393 (4 pls.).

ectodermal products and such of the mesodermal as are subjected to the chitinizing activity of the ectoderm undergo ecdysis. The blood-corpuscles, which, in Spiders, are formed at the expense of the endoderm, are subjected to periodic modifications at every ecdysis, the result of which is the proliferation of a large number of them. Besides these there are other changes which occur principally about the time of ecdysis, and are more or less closely connected with it; they are by no means confined to changes in size or to the complete development of the genital organs. At the period of ecdysis Spiders are able to regenerate organs which they have lost, and at that time they lose, more or less early, certain provisional organs.

ε. Crustacea.

Ancestral Development of Respiratory Organs of Decapodous Crustacea.*—Miss F. Buchanan attempts to answer the question how the gills of Decapodous Crustaceans came to be situated in the different positions in which they are found.

The Chætopod-like ancestor probably had no special respiratory organs; when the vascular surface became concentrated it would naturally happen that the concentration would be in such parts of the body as are most brought into contact with water; and so, when certain limbs became modified for swimming, the parts behind those limbs would first become especially vascular and branchial. As it would be an advantage to have the surface increased the surface became folded; and a simple respiratory plate is found in the nearest living representatives of the Crustacean ancestor—the Phyllopoda. The typical thoracic appendage of *Apus* consists of a basal or axial portion, six endites, and two exites, viz. a flabellum and a bract. The fifth endite probably represents the endopodite of the crayfish's limb, the sixth the exopodite, the flabellum the epipodite, and the folded stem or bract is probably homologous with the branchiæ of the Decapod.

This primitive position of the respiratory behind the swimming organ is retained in Schizopods, Stomapods, and in the higher group of Isopods. The Archimalacostraca probably had not a settled respiratory organ, for *Nebalia* has no special branchial organs. The next or archischizopod form probably had a fixed number of segments, and differed from the Archimalacostraca by its different manner of swimming, the exopodite and not the epipodite being the branch used; the respiratory organs would, as usual, be developed on the swimming appendages. Of living Schizopods, the Euphausiidæ are the most nearly related to the Archischizopoda, and they all have branchiæ attached to the bases of their thoracic appendages, which are called podobranchiæ. In these forms the gills have a very simple structure, for they merely consist of branching lobes with no secondary branches. In the higher Lophogastridæ the gill is more complex, the primary lobes of the stem being themselves lobed, and the attachment of the gill is not to the limb itself, but to the arthrodial membrane near the base of the gill. In both these groups the epipodites are reduced or absent on all the appendages on which there are gills.

In the Decapoda the thoracic feet have no longer a swimming function, and the exopodite has become vestigial or is altogether wanting;

* Quart. Journ. Micr. Sci., xxix. (1889) pp. 451–67 (1 pl.).

but this change in function does not affect the gills, which became fixed to the thoracic region in the Schizopod stage, which is gone through both phylogenetically and ontogenetically by the Decapoda. In consequence of the raising of the pleura the epimeral walls, and probably also the arthrodial membrane at the base of the appendages, have become stretched, and the gills are no longer situated close together, but are separated. This stretching of the arthrodial membrane and the time at which it took place, the need of protection to the branchiæ, the condition of the larva when hatched, and probably also the condition of the tissues of the creature, will probably serve to explain all the various positions in which branchiæ are found.

In Stomapods the mid-body is developed before the hind-body, and here there are abdominal swimming appendages and branchial tufts attached to the epipodite. The degenerate Cumacea have only one gill remaining. The Arthrostraca are probably to be derived from the Archischizopod, but have from the beginning taken a different line of descent to the true Schizopoda.

Development of Compound Eye of Alpheus.*—Dr. F. H. Herrick, who has for some time past devoted himself to the embryology of this crustacean, has a short account of the mode of development of the eye. He draws attention to some leading points; the optic disc is at first a unicellular layer of ectoderm; this disc becomes thickened by migration of cells from the surface, by delamination, and, probably also, by the addition of cells from the yolk. The optic lobe thus formed becomes differentiated into two parts, which are separated by a structureless membrane. From the outer portion or retinogen, which is at first a single layer, the retina is developed; the rest of the lobe (gangliogen) gives rise to the ganglia and parts of the eye below the basement membrane. The retinulæ, retinophoræ, and corneal cells are differentiated ectodermal elements belonging to the retinogen. The retinophoræ are not prolonged far inwards and do not enter the retinular bundle. There is no swollen pedicle, and nothing answering to pedicle, rhabdom, or spindle has been detected. No invagination or formation of cavities of any kind occur in the development of this eye. The ommatidium consists of thirteen cells disposed in three layers, as follows: (*a*) corneal layer—2 cells; (*b*) retinophoral layer—4 cells; and (*c*) retinular layer—7 cells. No nerve-fibres were detected in the crystalline cones.

The author is of opinion that there is a tendency to exaggerate the significance of an invagination of ectoderm, for he thinks it improbable that, at the time when most of these infoldings occur, a cell has any true upside or downside, or that an included cell is differentiated from one next it, which does not share in the invagination. He suggests as a temporary working hypothesis that all invaginations of ectoderm, wherever they occur in the Animal Kingdom, are primarily of no morphological importance, but simply mechanical expedients for introducing rapidly a large number of ectoderm cells below the surface; where there is any significance it is secondary.

Anomura of the 'Challenger.'†—Prof. J. R. Henderson states that the collection of anomurous Crustacea made by H.M.S. 'Challenger' is

* Zool. Anzeig., xii. (1889) pp. 164–9.

† Reports of the Voyage of H.M.S. 'Challenger,' Zoology, xxvii., No. lxix. (1888) 221 pp. (21 pls.).

one of the most valuable which has ever been brought together in a single voyage; before its arrival we had little or no knowledge of the bathymetrical distribution of the group. Species of *Munida* are prevalent, and there are here described fifteen new species. In most of the deep-water Galatheids the eggs carried by the female are few in number and very large in size, whence we may infer that in the deep sea enemies are fewer. In *Ptychogaster* and *Uroptychus* the abdomen is twice folded on itself; these seem to lead a sedentary life in the branches of Gorgonids. In all, 161 species belonging to 52 genera are described; of these, 7 genera and 86 species are new to science.

Amphipoda of the 'Challenger'.*—The Rev. T. R. R. Stebbing has published an enormous report on the Amphipoda collected by the 'Challenger,' 640 pp. of which are bibliography. The ordinary division of the Amphipoda into three groups, the Gammarina, Caprellina, and Hyperina is adopted. All the waters of the world are found to contain them, and they are pushing out advanced guards in a sort of tentative manner on to the land, where they may have a great future before them; they are readily able to adapt themselves to many varying circumstances. From below 300 fathoms the 'Challenger' possibly dredged thirty-one specimens of Gammarina, which represent twenty-five genera, of which ten are new, and twenty-eight species, of which twenty-six are new. In all, thirty-one genera and one hundred and eighty species are described as new.

Argulus foliaceus.†—Prof. F. Leydig has some fresh observations to record on a creature whose anatomy he first described nearly forty years ago. Among the subjects discussed as parts of the integument are the dermal glands; these have a nucleus proportionately small to the size of the body of the gland; after the use of reagents a body may be seen projecting from the orifice of the efferent duct; it appears to be the secretion of the gland hardened into the form of a cylinder. In the living animal the body of the gland exhibits such modifications of form that one is inclined to ascribe to it a proper power of contractility. In a few cases the glands are compound and not unicellular. The musculature of the body is not highly developed. With regard to the histology of the nerve-centres it is stated that the cortex of the brain and cord, below the cuticular neurilemma, is formed of ganglionic spheres which hardly ever exhibit anything more than the character of small naked cells. Dotted substance is found within the ganglionic swellings. On the inner portion of the lateral commissure going from the upper to the lower portion of the brain the most internal bands of these fibres form a completely closed ring. As there is a similar arrangement in the brain of the Lumbricina, it is probable that we have here a structure of general distribution. Some of the bands which compose the commissures radiate out towards the optic nerves and cross from one side to the other. In the enlargements of the ventral cord there are fibres in addition to the small-celled cortex and the internal dotted substance. The nerves arising from the cord have a dorsal and a ventral root which lie close together; this would seem to be a general arrangement in Arthropods and Annelids. The tubular character of the nerve-fibres of *Argulus* is

* Reports of the Voyage of H.M.S. 'Challenger,' Zoology, xxix., No. lxvii. (1888). Text in two halves, pp. xxiv. and 1737, and Atlas of 210 pls.
† Arch. f. Mikr. Anat., xxxiii. (1889) pp. 1–51 (5 pls.).

very well marked, and in some of the tubes there are indications of septa or of a meshwork. Two nerves enter the carapace; the anterior is directed towards the head, and the other, which is thicker, is distributed to the hinder portion. With repeated divisions these nerves become smaller and smaller and very difficult to follow out; they lose themselves in the cellular matrix-layer of the integument. The mode of termination of the nerves in the setæ is not what has been ordinarily supposed. In the setæ at the edge of the carapace the inner filament appears as a hard line or looks as if it were cuticularized; at its root, in *Argulus phoxini*, a small corpuscle with similar optical characters may be seen. Prof. Leydig formerly regarded these structures as being nervous in nature, but he is now convinced that they are connected with the supporting or skeletal tissue which is distributed between the two plates of the shield. The nerves lose themselves in the cellular substance of the matrix layer. A connection between the internal filament of the seta and the nerves is only to be regarded as due to the fact that the hyaloplasm of the nerves may pass into the substance of the layer and thence flow over into the setæ.

In the frontal eye the most striking character is the pigment; there are scattered, yellow, fat drops, a diffused blue pigment, a pigment consisting of molecular granules, and a brownish pigment which is so arranged as to form cup-like divisions; of these last there are four. In the paired eye there is a homogeneous matrix-layer which gives rise to the cuticle; the membrane is a continuation of the neurilemma of the optic ganglion, and corresponds to the connective tissue which surrounds the eye of higher animals. The crystalline cone is surrounded by a special envelope which clearly corresponds to the tube which incloses every cone and its nerve-rod in the compound eye of other Arthropods. There is a quadrangular area at the hinder part of the lens, and with this there is connected a nerve-rod, which is likewise four-sided. The crystalline cones exhibit a distinct and remarkable dimorphism; there are smaller cones which form a special compact group near the hinder margin of the eye; they are not only distinctly four-lobed but surrounded by a darker margin than the rest; there are about a dozen of them. The pigment of the eye is dark-violet in parts, and elsewhere brown.

The body-cavity is stated to be at first a blood or lymph-space; canal-like constrictions and ramifying prolongations become blood-lymph vessels; the spaces and canals are bounded by matrix-cells of the cuticular and connective tissue which secrete on the inner surface a homogeneous fringe; there is as close a connection between connective tissue and blood-spaces as between hill and valley; the final processes of the cavitary systems are the ducts in the clefts of the connective tissue and the pore-ducts of the cuticular.

There is a fluctuation rather than a circulation of the blood. The heart is a median cylindrical tube which is, primitively, a longitudinal cleft between the muscles of the back, and so completely resembles other blood-spaces found between muscles. Even in the adult stage the anterior end of the heart has no definite limits. Its histological structure is difficult to make out; the inner bounding line is not perfectly regular, but appears to be alternately thickened and narrowed. In animals which have been for a long time without food the blood-corpuscles become rounded, and one large or several smaller vacuoles appear in their interior.

The sac connected with the ovary seems to be the body-cavity; some further remarks are made concerning the seminal pouch, but the author notes that many points, both histological and physiological, still remain obscure. The groups of large, sometimes very large, cells which are found in the body of *Argulus* appear to belong to the category of fat-bodies; the author has recently discussed the structure of these giant cells.

The justice of Claus's criticisms on the author's earlier views as to the segmentation of the body is acknowledged, and the characters of some of the appendages are discussed in detail, and descriptions of larval characters are given.

It has been remarked by Claus that the males of *Argulus* are much less numerous than the females. When, in July, Prof. Leydig noticed a number in the basin at the Botanic Garden at Bonn, the number of males was easily seen to be greater than that of the females. Later on, however, this proportion changed; in the new swarms, about the middle of August, the females, which were full of ripe eggs, were more numerous. It would appear then that the males die off towards the beginning of autumn.

Formation and Number of Polar Globules in Cirripedes.*—Prof. M. Nussbaum states that in Cirripedes, and particularly in *Pollicipes*, there are two polar globules in the egg. One arises in the ovary, and the other after fertilization. The first lies without, the other within the vitelline envelope.

Vermes.

a. Annelida.

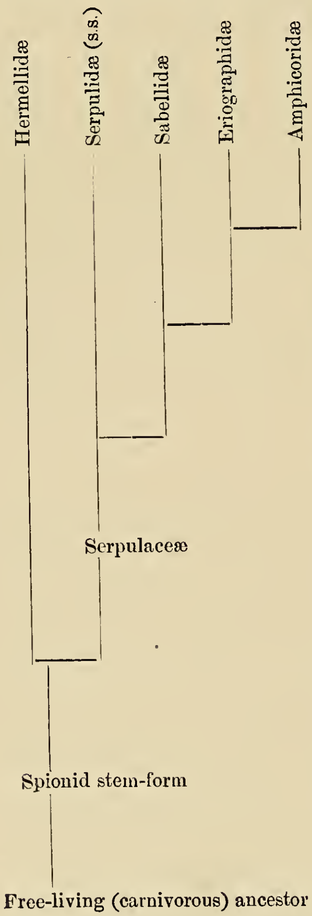
Morphology of Annelids.†—In the fourth of his memoirs on this subject, Dr. E. Meyer treats of the Serpulaceæ and the Hermellidæ. The first point dealt with is the development of the thoracic excretory system; the larval nephridia of these forms are most like those which Hatschek described in a larva from Faro, but differs in that they have apparently no direct contact with the secondary mesodermal bands; both are completely closed internally. The earliest rudiments of the definite thoracic nephridia are next considered under several heads. In the complete development of these organs it is important to notice that the lumen of the duct has a quite independent external pore, and that its communication with the secondary cœlom is only effected by the ciliated infundibulum. The two distal ends of the nephridial tubes fuse in the middle line after the closure of the hæmal longitudinal groove.

The supports of the cephalic gills of the Serpulaceæ and the paleæ of the Hermellidæ are next discussed; this is followed by an account of the lateral neck-lobes of the Serpulaceæ and the neural parapodia of the first somite of the Hermellidæ. The neural neck-lobes, which are next described, are stated to be formed by a fold of the ventral integument, and they are independent of the lateral lobes. The succeeding chapter deals with the thoracic membrane of the true Serpulidæ and the trunk-cirri of the Hermellidæ; all the parapodial cirri of the latter are hollow processes, and are, therefore, lined internally by the peritoneum.

The hæmal and neural chætopodia form the subject of the sixth chapter; it appears to be characteristic of the larvæ of the Serpulaceæ that three

* Zool. Anzeig., xii. (1889) p. 122.
† MT. Zool. Stat. Neapel, viii. (1888) pp. 462–662 (3 pls.).

pairs of hæmal bundles of setæ, and as many neural hooklets are developed very early; there is then a pause before the other chætopodia appear. The author discusses the results of earlier observers, and is largely in agreement with Claparède and Eisig. We have as yet no observations on the permanent chætopodia of the Hermellidæ. The term of thoracic or ventral shields is applied to the more or less distinctly bounded integumentary thickenings, which appear on the lower surface of these worms, between the lateral rows of parapodia. They are characterized by their intimate connection with a large number of unicellular glandular tubes which open to the exterior between their cells and project for a variable distance into the cœlom; the arrangement, form, and structure of these are somewhat fully discussed, as is also their development.



The eighth chapter is occupied by an account of the cephalic gills of the Serpulaceæ, and the oral tentacles of the Hermellidæ; the ninth deals with the mouth, which, in both these groups, is terminal in position; the changes undergone during the larval stages are described. The frontal tentacles form the subject of the tenth chapter; they are paired, are often greatly reduced, or may be altogether wanting; so hidden are they that no observer but Pruvot has as yet detected them; they are hollow filaments, which are provided externally on their median upper surface with a special ciliated epithelium; they have a proper muscular layer, and are lined internally by the peritoneum; below the ciliated longitudinal grooves there runs, in the hypodermis, a nerve which comes from the brain; and in the axial cavity is a much coiled contractile vessel which ends blindly in front.

The central nervous system is very fully described; the ventral medulla of the two groups under consideration is characterized by consisting of two separate halves or cords; in each segment there are two pairs of ganglia connected by two pairs of transverse commissures; with these two pairs of primary nerves correspond. The development of this system is also discussed very fully.

The vascular system forms the subject of the twelfth chapter, and the peritoneal glands that of the thirteenth; the latter are the gonads, the sites of origin of the lymphoid cells, and the pigmented lymph-glands or chloragogue-glands.

In the second half of this memoir, the more general questions and conclusions to which a study of some of the described organs lead, are discussed in great detail; one of the most interesting of these is the phylogeny of the nephridial system; here we have only space to say that this question is considered under the heads of the significance of the ectodermal terminal portion of the unpaired efferent ducts of the thoracic nephridia, the origin of the variations in the form of these organs, and the genital tubes.

In conclusion the author discusses the affinities of the Hermellidæ and Serpulidæ, and his views are given in the adjoining tabular form.

Abnormal Earthworm.*—Mr. R. Broom reports on another earthworm with bifid hinder ends, several of which have been noticed during the last few years. Reminding us of Kleinenberg's discovery that, in *Lumbricus trapezoides*, two complete individuals are normally developed from one ovum, he suggests that this sometimes happens in *L. terrestris;* in support of this view he states that the two posterior parts of the worm examined by him are attached by their sides, the ventral surface of each part being continuous with that of the front part of the body. Although in some of the already published cases the posterior ends were unequal, Mr. Broom thinks it probable that they were equal at an early stage, but for some reason or other developed unequally, as is known to be frequently the case with double monsters of the higher animals; these last may, indeed, owe their origin to a change in the ovum similar to that which normally happens in *L. trapezoides.*

Development of Cœlom in Enchytroeides Marioni.†—M. L. Roule has studied the development of the cœlom in this marine Oligochæte. He finds that it appears in the form of irregular cavities hollowed out in the mass of mesoendoblastic cells; some of these cells become free in the cœlomic cavities, and have a complete resemblance to the typical mesenchymatous elements. As the cœlom of *Polygordius* is formed on the epithelial plan, it follows that the mode of appearance of the mesoblast and of the cœlom is only of secondary importance, and the Hertwigs' division of the Metazoa into Enterocœlia and Pseudocœlia cannot be considered natural.

Structure of Clitellio.‡—Mr. F. E. Beddard is able to make some additions to Claparède's account of the anatomy of this oligochæte. Like many other writers, he confounded the testes with the vesiculæ seminales, and did not describe the true testes at all. They lie in the tenth segment, and each organ is long and narrow. The presence of oviducts is recorded, and as Stolc has already seen them in *Ilyodrilus* and *Psammoryctes*, it is probable that they will be found to be invariably present in the Tubificidæ. As in that group generally, the mature ova of *Clitellio* are of very large size (half the diameter of the body), and are loaded with yolk-spherules; they are inclosed in independent ovisacs. The author points out the more important differences between *Clitellio arenarius* and *C. ater*, and shows that the two are not congeneric; the latter will be better placed in Eisen's genus *Hemitubifex.* Mr. Beddard takes the opportunity of making a few remarks on some other marine species of Tubificidæ.

* Trans. Nat. Hist. Soc. Glasgow, 1889, pp. 203–6.
† Bull. Soc. d'Hist. Nat. Toulouse, xxii. (1888) pp. lviii. and lix.
‡ Proc. Zool. Soc. Lond., 1888 (1889) pp. 485–94 (1 pl.).

β. Nemathelminthes.

Hypodermis and Peripheral Nervous System of Gordiidæ.*—M. A. Villot considers that M. Michel † has incorrectly interpreted his observations. He considers that the hypodermis of *Gordius* represents, in the cellular stage, a layer of embryonic tissue which belongs to the ectodermal layer; the embryonic cells produce, at first by secretion, the different layers of the cuticle, but this is not the only part which they play in organogenesis. The cells which invest the inner wall of the cloaca of adult females are converted into unicellular glands; beneath the integument they ramify and anastomose, and so form an absorbent and perhaps excretory apparatus. The peripheral nervous system is connected with the hypodermis by its origin and by the relations of its constituent elements. It is formed of a plexus of ganglionic cells, placed between the subcutaneous layer and the perimysium. The ganglionic cells, which are remarkable for their small size, give off, independently of their anastomoses, two kinds of prolongations. Some of these are directed towards the muscular fibres, and penetrate the perimysium; others pass into cuticular papillæ, which are true tactile organs.

Circum-intestinal Cavity of Gordii.‡—M. A. Villot has a brief note on the histological significance, mode of formation, and use of this cavity. He regards it as the last phase in the development of these round worms. It is formed by the destruction and forcing back of the parenchymal cells which are found in the neighbourhood of the intestine and ventral cord. These cells undergo fatty degeneration and become resolved into a granular substance of yellowish colour, which lines the cavity around the intestine, and fills it completely at either end. The fatty matter thus produced serves as food for adult individuals living a free life. After leaving their host *Gordii* become in a way parasitic on themselves, and absorb, under the form of degenerate embryonic elements, that part of their mesoderm which has not been utilized by organogenesis.

γ. Platyhelminthes.

Asexual Reproduction of Microstoma.§—Dr. F. von Wagner has made a close study of the phenomena of asexual reproduction in *Microstoma*. The first step is usually the formation of a septum between the second and last thirds of the body; this is directed transversely to the long axis of the body. At the same time a fold of the enteron becomes fixed, and this gives the rudiment of the first bud. The size of the animal thus exhibiting gemmation varies considerably. If we make a general survey of the gemmations in an animal we see that the formula of Hallez and Graff is often broken; this is due to the fact that there are temporary alterations in the mode and intensity of budding. The enteron, the integument with its differentiations, the parenchyma and the two lateral nerves pass directly from the mother individual to the child, while the fresh formations of brain, eyes, ciliated pits, mouth, pharynx, and glands are to be regarded as simple phenomena of regeneration.

* Comptes Rendus, cviii. (1889) pp. 304–6. † *Ante*, p. 225.
‡ Comptes Rendus, cviii. (1889) pp. 685–7.
§ Zool. Anzeig., xii. (1889) pp. 191–5.

Embryology of Cestodes.*—Prof. B. Grassi and Dr. G. Rovelli begin by discussing the developmental cycle of Cestodes. They find that *Tænia elliptica* has an intermediate host in the flea of the Dog and of Man, as well as in *Trichodectes.* They do not accept the doctrine of Megnin that *T. serrata* can develope without an intermediate host. On the other hand they are certain that *T. murina* of *Mus decumanus* developes without an intermediate host, though not without a cysticercoid stage; to demonstrate this it is necessary to make use of white mice three to four months old. Moniez and Linstow are correct in supposing that the cysticercoid found in *Tenebrio molitor* is that of *T. microstoma;* it is not that of *T. murina.* As has been already shown, *T. nana* has also a distinct mode of development, and indeed this is only a variety of, even if it be not distinctly the same as *T. murina.* Of the tapeworms of fowls, *T. proglottina* has an intermediate host in *Limax cinereus*, *L. agrestis*, and *L. variegatus; T. infundibuliformis* in the house-fly, and *T. cuneata* in the earthworm *Allolobophora fœtida. T. leptocephala* of the rat has an intermediate host in several insects, of which the most ordinary appear to be the lepidopterous *Asopia.* Parona was right in regarding the perch as the other host of *Bothriocephalus latus.*

The authors have set before themselves three morphological problems:—(1) To determine why the scolex of the cysticercus (and probably also of the cysticercoid) is developed as hollow and invaginated; (2) To see whether the embryology of Cestodes affords new arguments to support the view of an affinity between them and the Trematodes; and (3) To put in a clearer light the development of the organs of Cestodes. The larvæ of Cestodes may be arranged in three chief groups: there are cysticerci with inconstant invagination and no embryonic coverings (*Archigetes*); cysticerci with later invagination (*Tænia elliptica* and *T. murina*); these may be again subdivided, for the invagination may be simple (*T. elliptica*), or it may follow the formation of embryonic coverings (*T. murina*); thirdly, there are cysticerci in which the invagination is early, and is succeeded by the formation of embryonic coverings (cysticerci in the strict sense).

The authors are of opinion that the development of the invaginated and hollow scolex is explicable by cenogeny and the better development of the embryo (as by the formation of special envelopes) in agreement with the great power of regeneration which is possessed by the body of Cestodes.

As to the relationship between the Cestodes and the Trematodes the authors have shown that the cercariæform period, which was believed to be confined to a few forms, is very common, and its significance is very high; in the Tæniidæ there have been found distinct signs of a foregut (oral cavity and pharynx separated from it by a constriction); the primitive cavity is comparable to the mesenteron of Trematodes. It must be remembered that in the Cestodes, in correlation with the disappearance of the sensory organs and mesenteron and the want of a blood-vascular apparatus, development is much abbreviated, and the differentiation of germ-layers is very incomplete; indeed, there is but a single mass of cells (blastema) from which all the organs arise. It is possible that the six-hooked embryo consists only of ectoderm, although against this we must set Lang's discovery of the endodermal origin of the gonads of

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 370–7, 401–10.

Platyhelminthes. The primitive cavity probably represents the space which was once bounded by the cells of the mesenteron.

In conclusion, the authors discuss the colonial nature of the Cestoda, and the possibility of an alternation of generations. They find that the cysticerci, with the exception of the echinococci, &c., undergo a simple metamorphosis, which is often largely wanting. This may be made clearer by a consideration of the case of *T. elliptica*; in it the anterior part of the six-hooked embryo forms the scolex, and the hinder part a rudimentary organ, the tail, which, later, falls off. In other *Tæniæ* this hinder part is converted into a tail, but in them the hinder part of the anterior portion forms an embryonic covering; consequently, only the anterior part of the anterior portion forms the scolex, and it is by the growth and segmentation of the scolex that the adult *Tænia* is formed. The authors do not believe in any asexual generation; such does, of course, obtain in *Echinococci*, but this is a secondary and adaptive phenomenon.

In the development of the organs it is observed that the six-hooked embryo is formed from a blastema, or embryonal tissue which is not differentiated into germinal layers; from this the organs are developed directly, and are at once found, with the exception of the rostellum, in their definite positions. As we pass from without inwards in a young cysticercoid we meet with a peripheral zone of subcuticular cells, a parenchyma in which the cells are closely packed, and a soft parenchyma in which the cells are scanty; and between these three there are no definite boundaries. The authors suppose that the nervous system and the water-vascular apparatus are developed from the closely packed parenchyma, with the exception of the efferent vesicle, which is chiefly formed from the subcuticular zone; this last also gives rise to the subcuticular musculature.

New Cestodes from Lamna cornubica.*—Prof. P. J. Van Beneden describes two new cestodes found in the intestine of this Shark. One, which is called *Dinobothrium septaria*, resembles when contracted in alcohol a shell of the genus *Septaria*, and appears to have no hooks; the other is called *Diplobothrium simile*, on account of the similar suckers which are united in pairs. Both forms have a complete septum between the two pairs of suckers, and this has at its tip four pieces which appear to furnish points of attachment for the muscular layer. The other host of these parasites is not yet known; they both belong to the group of Phyllobothriidæ, all of which are, so far as is yet known, parasitic in plagiostomous fishes.

Echinodermata.

Embryology of Echinoderms.†—In his present paper Mr. H. Bury confines himself to the bilateral symmetrical stage, which is more or less clearly represented in all Echinoderm-larvæ, and to which Semon has recently given the name of *Dipleurula*. He deals, therefore, only with the primary divisions of the cœlom, starting from a stage in which at least two enterocœl-pouches are already present, with the development and connections of the hydrocœl, and with the skeleton so far as it is developed.

* Bull. Acad. R. Sci. Belg., lix. (1889) pp. 68-74 (1 pl.).
† Quart. Journ. Micr. Sci., xxix. (1889) pp. 409-49 (3 pls.).

From the study of larvæ of the various classes, the author concludes that a pair of anterior entercœls was probably originally present in all Echinoderms; the hydrocœl is generally formed distinctly later than the other cavities; as there is no trace of any right hydrocœl, it is probable that this organ was never paired; it varies in its mode of origin, but its normal position seems to be between the anterior and posterior enterocœls. The water-pore always (? Holothurians) arises in connection with the posterior end of the left anterior enterocœl, and only communicates indirectly, if at all, with the hydrocœl. Mr. Bury thinks that the water-pore existed in a very early stage in the history of Echinoderms, and probably before the hydrocœl.

The current passing through the water-pore is exhalent, but not usually very strong; this pore, and the short tube by which it communicates with the enterocœl, are regarded as forming a primitive nephridium.

The hydrocœl always arises on the left side from one or other division of the cœlom, which differs in different groups; this variation may mean that when the hydrocœl originally appeared, the anterior and posterior enterocœls were connected, as they are in *Asterina* and some *Bipinnariæ*; or it is possible that the original mode of development of the hydrocœl was more complicated, and that it has become simplified independently in the different groups. The author has a few observations on the difficult question of the closure of the water-vascular ring.

In the study of the skeleton it was found that many plates are developed in the bilateral larva, and that they bear a definite relation to the body-cavities; it was also found that the terminals lie on the left side, and this discovery enables us to establish a typical bilateral form from which all the conditions found in existing larvæ may have been derived. This is shown in the following table:—

	Right Enterocœl		Left Enterocœl	
Position	Radial	Interradial	Radial	Interradial
Name	Primary Radials	Basals	Terminals	Orals

Mr. Bury thinks it probable that in all groups (except perhaps Holothurians), the radii of the abactinal part of the body (including the regions of the right and left posterior enterocœls) bear a very definite relation to the mouth, anus, and water-pore of the larva; that, in fact, these organs mark out an interradius, which, since it contains both mouth and anus, might be called ventral, or, as it is anterior to the system of radial plates, and contains, when present, the preoral lobes, may be called anterior. The latter term seems preferable, but, if it is used, we must be guided by the situation of the water-pore rather than by the indefinite and variable positions of the mouth and anus, when seeking for an anterior interradius in adult forms.

Rhopalodina lageniformis.*—Prof. H. Ludwig has made a renewed investigation of this interesting Holothurian. Some corrections in the descriptions of previous writers are made. A piece from the middle of the stalk-like portion of the body was cut into a series of fine transverse sections; in these the fine water-vessel and the radial nerve were found lying outside each of the ten muscles; the œsophagus was only attached by the mesentery inclosing the genital duct, while the rectum was fastened by a number of radial bands, in which were found proportionately large round cells. The five muscles seen in section around the rectum were all of the same size, but of the five around the œsophagus the two which lay nearest to the genital duct—and which, therefore, were, in comparison with those of other Holothurians, the two dorsal—were much thicker than the other three. The five circular muscles of the body-wall in the region of the œsophagus were continued to the partition which separates this part from the region of the rectum; this character seems to show that the "stalk" of *Rhopalodina* owes its origin to the fusion of an oral and an anal stalk-like and narrower portion of the body. The connection of the œsophagus with the rectum by radial septa, as described by Semper, does not exist, for the part of the cœlom surrounding the one is separated from that round the other by a partition which traverses the whole length of the stalk-like portion of the body; this partition is clearly the remnant of the median dorsal interambulacrum, by the shortening of which the oral and anal ends of the body have become so closely approximated.

The five pairs of radial papillæ at the anal calcareous ring are really hollow internally, and seem to be nothing more than the anal ends of the radial water-vessels; a single layer of small, branched, and closely packed calcareous corpuscles is found in their walls. The five pairs of radial papillæ form forks of five simple, radially-placed, hollow papillæ, the walls of which present continuous calcifications. The interradial tips of the anal calcareous ring are solid. This ring does not, as Semper thought, consist of five radials and five interradials, but of five calcified, hollow, and bifurcate radial papillæ, which are surrounded by a circlet of interradial and radial calcareous plates.

Monstrous Larvæ of Echinus.†—MM. G. Pouchet and Chabry have made some experiments on the production of monstrous larvæ of Echini effected by deprivation of carbonate of lime. They have started from the doctrine of Chevreul that the morphological characters of living beings are, to a certain extent, the function of their chemical constitution. Their experiments were made by rearing larvæ in water which had been deprived of the greater part of its chalk by oxalate of soda. As they expected, they found that the spicular substance can be totally suppressed by depriving the organism of one of its constituents. Morphological deviation is more marked in proportion as a greater quantity of carbonate of lime is removed from the sea-water.

In water which retained more then one-tenth of its chalk, the larvæ were at the sixtieth hour still in the gastrula-stage, while the control larvæ had ramified spicules and a complete intestine. After ninety hours, the former larvæ, without developing spicules, passed into a true pluteus-stage, characterized by the differentiation of the intestine into

* Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 60–6 (1 pl.).
† Comptes Rendus, cviii. (1889) pp. 196–8.

three regions, but the general form was spherical, there were no prolongations, and death supervened after a few days passed in this condition. When the quantity of chalk was less the larvæ did not pass beyond the gastrula-stage.

Cœlenterata.

New Anthozoon.*—Dr. C. Viguier gives an account of the new Anthozoon of which Prof. Lacaze-Duthiers has spoken as *Paralcyonium edwardsi*, but for which he proposes the new generic term of *Fascicularia*. Dr. Viguier found it in the Bay of Algiers. Though the appearance of the stolons is different, a colony has, especially when its polyps are contracted, considerable resemblance to *Paralcyonium;* when, however, the polyps are protruded, very marked differences become apparent.

The stolons are flattened, and vary in width from two or three to seven or eight mm. They form an irregular plexus which is covered by a light greyish-yellow layer of slime. There are only a few small spicules in the stolons, the walls are essentially constituted of a well-developed connective layer. In well-developed pieces the endodermal investment is reduced to a simple layer of cells, and the same may be said of the true ectoderm.

The groups of polyps are scattered irregularly on the stolons. These groups may be divided into a basal and a free portion. The common basal column has the same appearance as the stolons; it has a lower surface which adheres to the foreign body which serves as its support, and an external surface. On the latter, when the group is well expanded, there are visible longitudinal grooves which correspond to the lines of separation of the polyps. In addition to these there are transverse grooves which obscurely divide the column into segments. The presence of large vertical spicules prevents any flexion in this part of the column, as is the case also in *Paralcyonium*.

Unlike most of the Alcyonaria, *Fasciolaria* has spicules unlike those of the rest of the body in the upper region of the polyp; these are small oval plates, slightly constricted in their middle; they are seen, when highly magnified, to be marked by parallel striæ; the presence of these planes of cleavage causes the spicule to be almost opaque. A siphonoglyph is developed. The author has a few notes on the processes of reproduction.

As to the systematic position of this new genus, M. Viguier believes that it is necessary to institute a new family, which would be characterized by the network of stolons uniting the different groups into one colony, and by the absence of vascular connections between the polyps of one and the same group.

French Pennatulids.†—Dr. C. Fischer has a note on the Pennatulids found on the French coasts, of which there are, at least, eleven species, so that their Pennatulid-fauna appears to be very much richer than that of the British seas is at present known to be.

Agalma Clausi.‡—Dr. M. Bedot describes under this name a new species, which, in the recently published system of Siphonophora by Prof. Haeckel, would be placed in the genus *Crystallodes*. It was found

* Arch. Zool. Expér. et Gén., vi. (1888) pp. 351–73 (2 pls.).
† Bull. Soc. Zool. France, xiv. (1889) pp. 34–8.
‡ Rec. Zool. Suisse, v. (1888) pp. 73–91 (1 pl.).

off Villefranche, and measured in all 24 cm. The nervous system has a close resemblance to that of *Halistemma rubrum*, as described by Korotneff. The most characteristic organs are the bracts, of which there is a considerable number; their peculiar appearance is due to the presence, on their surface, of a large number of small, deep-carmine-red dots, which are small glands which open and expel an intensely yellowish-red colouring matter when the animal is captured. These glands are formed of an aggregate of cells, the protoplasm of which is coarsely granulated. About half of the gland is above the surface of the bract. When the colouring matter has been discharged all trace of the glandular cell disappears, and there is only a small excavation surrounded by a light yellow cloud. The tentacles of this new species have a characteristic appearance which is due to the presence of a terminal orifice and to the site of the point of attachment of the accessory filament. All the characters of this new form are fully discussed.

'Challenger' Siphonophora.*—Prof. E. Haeckel has published a report on the Siphonophora collected by the 'Challenger,' with which he has incorporated notes on other specimens. The generalizations are of interest, but they were made known to our readers at the time of their original publication in Germany.† Two hundred and forty species are enumerated. The plates, as usual in Prof. Haeckel's works, are of great beauty.

Monobrachium parasiticum.‡—Herr J. Wagner has some notes on interesting structural characters in this Hydrozoon. The periphery of the colony is characterized by special structures which the author proposes to call pseudonematophores; they probably represent specialized individuals, and form an intermediate stage between true nutrient polyps and nematophores. The subepithelial layer is wanting in most parts of the organism, and the author was unable to find differentiated ganglionic cells. In the hydrorhiza there are often poorly developed nematocysts with very short threads and vesicular contents. The urticating capsules have no cnidocils; where this is the case the filament is generally looped, but in *Monobrachium* it is spirally coiled. The axial tissue of the single tentacle consists of a number of large cells which are irregularly arranged; it is not separated from the endoderm by the supporting lamella, and the gradual passage of the nutrient into the axial cells may be clearly seen. The gonophore is in the form of an almost completely developed Medusa; its blind gastric cavity has the form of a spadix and contains a small cavity; in some the circular vessel is distinctly developed, but in others it could not be detected. The nerve-ring is formed of filaments of the subepithelial cells. The endoderm of the tentacle of the medusa-form is made up of ordinary cartilaginous cells, and there is no cavity in them.

Unripe ovarian cells and similar amœboid male cells, which only differed in having nuclei which colour more intensely, were often found in the ventral endoderm of the radial vessels. In two cases some maturer cells were found in the genital sacs in their passage from the endoderm of the radial vessels. Smaller cells, which appeared to be younger eggs, were found in the endoderm of the hydrorhiza at the

* Reports of the Voyage of H.M.S. 'Challenger,' Zoology, vol. xxviii., part lxxvii. (1888) 380 pp., 50 pls.

† See this Journal, 1888, p. 741.

‡ Zool. Anzeig., xii. (1889) pp. 116–8.

base of the gonophores. Owing to the want of specimens of a certain age Herr Wagner was unable to determine the layer from which the genital cells were developed, but he does not doubt that they first appear in the endoderm of the hydrorhiza, and that they are matured in the ventral epithelium of the radial canals, whence they pass into the genital sacs which form vertical folds along the radial canals.

Digestion in Hydra.*—Miss M. Greenwood has made a careful study of the process of digestion in *Hydra*. She finds that the ingestion of solid matter is performed by slow advances over the prey of lip-like projections of the substance of the polyp. During this action the tentacles for the most part remain extended, having previously been in contact with the prey or discharged their thread-cells into it. The endodermal cells of the foot are more markedly vacuolated than those of the body; an ingested organism never, apparently, enters its cavity but remains in that of the body, which it often distends greatly. The digestion of inclosed food is effected entirely outside the endoderm cells which line the body-cavity of the *Hydra*, and among these cells two types may be distinguished: (*a*) cells of pyriform shape destitute of large vacuoles; these hold many secretory spherules in hunger, and tend to be emptied during digestive activity; (*b*) ciliated vacuolated cells which at times hold pigment. The water of the digestive secretion is probably, at any rate in part, to be associated with the vacuoles of these ciliated cells, for intracellular fluid is never so conspicuous as in the fasting state, nor so little marked as after abundant nourishment. The pigment, which is often conspicuous in the endoderm, is formed by the activity of the cells, and is probably, as a rule, expelled into the body-cavity during an act of digestion. The formation of secretion by the endoderm and the loss of pigment are made inconspicuous during the later stages of a digestive act, by the onset of absorption; this finds expression in the gathering of proteid matter within the vacuolate endoderm cells. This matter is deposited as a store of reserve substance in the basal part of the cells and eventually takes on the form of spheres; Miss Greenwood believes that it is absorbed as fluid, forms definite vacuoles bounded by the apical protoplasm of the cells, and is by the indirect action of the protoplasm converted into the insoluble form.

It is probable that the excretory pigment takes its rise in some residues of these proteid bodies, and it is possible that they may, at times, be the source of fat. A large proportion of the spheres undergoes final solution, and, when dissolving, they probably constitute the angular particles of some authors. When this solution is effected it takes place towards the apex of the inclosing cell; the little masses of proteid are moved upwards from their resting position, and fluid is secreted around them by the investing layer of protoplasm. The medium in which the digestive activity of a *Hydra* goes on is probably not acid.

In a note a short account is given of the histological characters of the endoderm of *Hydra viridis*. The "chloroplastids" of Lankester lie especially thickly towards the base of the vacuolate endoderm cell, and distally to them, in well-nourished specimens, are the true nutritive spheres. Gland-cells do not form a conspicuous feature in the endoderm of *H. viridis;* this may be because the presence of chlorophyll has

* Journ. of Physiol., ix. (1888) pp. 317–44 (2 pls.).

changed the mode of nutrition, or it may be that the numerous and conspicuous chloroplastids makes the detection of the "glands" difficult.

It will be seen that Miss Greenwood's description does not tally with views generally held; she thinks that lack of continuity in observation has led to the interpretation of what is really a phase of structure as a permanent histological condition.

Porifera.

Chromatology of British Sponges.*—Dr. C. A. MacMunn has found chlorophyll in ten out of twelve species of marine sponges; this may be shown to be of purely animal origin by various tests. It is very probable that it is of use in the constructive metabolism of animals by removing waste carbonic acid, and then by the influcnce of light building up from carbonic acid and water some substances, such as starch, glycogen, sugar, or fat, which are of direct service to the animal. It does not seem likely that the chlorophyll has a respiratory function, for the union between it and oxygen cannot be loose, as it is in the case of hæmoglobin, and a histiohæmatin which is of respiratory use may coexist with chlorophyll in Sponges.

Notes on Sponges.†—Dr. E. Topsent first deals with *Dendoryx Hyndmanni* and the other species of that genus; one new form, *D. luciensis*, is described. He gives reasons for including in this genus a number of species which were placed by Bowerbank with *Halichondria*, *Isodictyon*, and *Hymenacidon*, as well as various species described by other authors. In a second essay he gives an account of the larval stage of *Dysidea fragilis*, which is shown by its embryology, as much as by its anatomy, to be a *Spongelia*.

Sponges from the Gulf of Manaar.‡—Mr. A. Dendy gives an account of a second collection of sponges made by Mr. Thurston; of the twenty-four determinable species fourteen are new to science, and two are represented by new varieties; the great majority are Monaxonids. The characters of *Axinella tubulata* seem to have been misunderstood by the late Dr. Bowerbank; its peculiarities are due to the presence of a commensal tubicolous oligochætous annelid; it is not yet known whether either the worm or the sponge ever live separately; Mr. Dendy points out that Canon Norman's new generic name *Aulospongus* for this species is unnecessary. The genus *Auletta* has not yet been found except in the Atlantic and Arctic oceans; the species discovered by Mr. Thurston is called *A. aurantiaca*. Mr. Dendy, from his own observations and from that of Mr. Bracebridge Wilson, is inclined to believe that the colours of living sponges will be found to be of great service in distinguishing species; the sponges here reported on seem to have had great brilliance and variety of natural colouring.

New British Species of Microciona.§—Messrs. H. J. Carter and R. Hope give an account of *Microciona spinascus* sp. n. from Hastings. Mr. Carter formerly referred it to *M. armata* Bowerbank on the supposition that the spiniferous character of the ends of the tricurvate spicules had been overlooked by Bowerbank, but he is now convinced that he was mistaken in that view.

* Journ. of Physiol., ix. (1888) pp. 1–25 (1 pl.).
† Arch. Zool. Expér. et Gén., vi. (1888) pp. xxxiii.–xliii.
‡ Ann. and Mag. Nat. Hist., iii. (1889) pp. 73–99 (3 pls.).
§ T. c., pp. 99–106 (1 pl.).

List of Mr. Carter's Genera and Species of Sponges.*—Mr. A. Dendy has prepared an alphabetical list of the genera and species of sponges described by Mr. H. J. Carter, together with a number of his more important references to those of other authors, which will doubtless prove a useful guide to students of this group.

Protozoa.

Bütschli's Protozoa.†—Prof. O. Bütschli completes his account of the morphology of the Ciliata, and commences the systematic descriptions. In the former, division, formation of colonies, conjugation and copulation, and encystation are discussed. The systematic part begins with an historical introduction in which the chief earlier classifications are tabulated; of the origin of the group we know but little, and we can almost certainly state that no other gronp of animals is derived from them. There are from 450 to 500 more or less well known species; twenty-seven genera are exclusively marine, and there are from 170 to 200 marine species; twenty-four genera are exclusively parasitic. It cannot be certainly said that *Multicilia* or *Grassia* are true Ciliates. The first order of true Ciliata are the Gymnostomata of Bütschli, which represent part of Stein's Holotricha; the families of this order are Euchelina, Trachelina, Chlamydodonta. The second order is that of the Trichostomata, which is equal to part of the Holotricha plus the Spirotricha; its first suborder is that of the Aspicotricha, which is equivalent to the old family Paramæcina.

Merotomy of Ciliated Infusoria.‡—M. E. G. Balbiani has a contribution to the study of the physiological rôle of the nucleus of the cell. By the term merotomy he means the operation which consists in cutting off from a living organism a more or less considerable portion, with the object of studying the anatomical or physiological modifications of the separated part. The account of the experiments commences with a detailed notice of the structure of *Cyrtostomum leucas*; the study of the effects of merotomy showed that a fragment of an individual, or merozoite, which contains the nucleus is alone capable of regeneration, that is to say, of reconstituting a complete individual which presents all the characters of *Cyrtostomum*. This regeneration is completed in twenty-four or forty-eight hours, at the latest; the regenerated individual only differs from an ordinary one in its smaller size, and this is correlated with the size of the fragment from which it took its origin. The regeneration of the specific form and of the organs is effected under the influence of the nucleus, for such regeneration is never observed in fragments which have no nucleus. This nucleus has even the secretion of the cuticle under its influence; the cicatrization of the parts is effected by the secretion of a new cuticle at the point of denudation. The nucleus also appears to play a part in the trophic phenomena of the protoplasm, for this becomes gradually disorganized and finally dies, when deprived of a nucleus. The disorganization of the protoplasm is manifested by the taking-in of water, formation of vacuoles, disappearance of the stratified structure, absorption of the trichocysts and vibratile cilia, the

* Published by Roy. Soc. Victoria, 8vo, 1888, 26 pp.
† Bronn's Klassen u. Ordnungen, i., Protozoa (1889) pp. 1585-1712.
‡ Rec. Zool. Suisse, x. (1888) pp. 1–72 (2 pls.).

aqueous hypertrophy of the contractile vesicle the pulsations of which become slow and irregular, and, finally, by the destruction of the protoplasm by diffluence. The functions which are not immediately affected by the absence of the nucleus are: ciliary movement, pulsations of the contractile vesicle, prehension and ingestion of food, and defecation. Merozoites without a nucleus live from two to three days, but sometimes for seven or eight; under similar conditions nucleated merozoites may live for nearly a month after regeneration. Essentially similar results were obtained with *Trachelius ovum* and *Prorodon niveus*.

Two Infusorians from the Port of Bastia.*—Prof. P. Gourret and M. P. Roeser give a detailed account of *Strombidium sulcatum*, and of a new generic form, for which they propose the name of *Glossa*; the latter is more or less ovoidal in form, and has on one side a shallow vertical groove, the dorsal edge of which is smooth and entire, while the ventral has, not far from the hinder end, a semilunar depression which corresponds exactly to the mouth. Two triangular membranous layers are inserted by their base along the groove, and fuse with one another at the apex. A kind of endostyle is developed which, with the cilia that border it, aid in forming an alimentary rotatory apparatus. Connected with the mouth is a short cylindrical œsophagus which ends in a nutrient vesicle; this œsophagus can be turned inside out like the finger of a glove, and project to the exterior. The anal orifice is permanent, and near it is the single contractile vesicle. Regularly arranged and parallel striæ extend along the body, and the cilia which they carry are all of the same dimensions. The affinities of this genus are somewhat obscure; it has certain relations to *Ancistrum* and *Ptychostomum*. The new species is called *G. corsica*.

Fresh-water Infusoria.†—Dr. D. S. Kellicott calls attention to some of the species of Infusoria found in the Niagara river and its tributaries. Owing to the constancy of its volume, the temperature of this river is very constant, and it affords consequently excellent infusorial fishing, even in winter. *Enchyleodon pellucidus* sp. n. forms colourless globular cysts, which seem to be only made use of temporarily. *Balantidium gyrans* sp. n. was found in the intestinal cavity of a not identified aquatic worm, where it is abundant; it is very lively. *Pixidium hebes* sp. n. was found on the legs of *Asellus*. *Vorticella rubristigma* sp. n. is characterized by numerous red points, which are attached to the muscle. *Opercularia Niagaræ* sp. n. was found abundantly on *Lernæocera cruciata*, which is parasitic on the Rock Bass; it is rather hardy, living in stale water long after other Vorticellidæ have perished. Three tube-making species of *Stichotricha* were observed, one of which—*S. ampulla*—appears to be new; it was found on *Myriophyllum*, and appears to be most closely allied to *S. secunda*. Among already known species, *Enchyleodon farctus* and *Zoothamnium arbuscula* are described.

New Ciliate Infusoria from Concarneau.‡—M. Fabre-Domergue describes a new genus of Ciliata, which he calls *Spathidiopsis* (*S. socialis*). Its habits are very peculiar; it lives in small colonies of eight to ten

* Journ. Anat. et Physiol., xxiv. (1888) pp. 656–64 (1 pl.).
† Proc. Amer. Soc. Micr., x. (1888) pp. 97–106.
‡ Ann. de Microgr., ii. (1889) pp. 305–9 (1 pl.)

individuals, in a kind of nest hollowed in the detritus which floats on the surface of the water. From time to time an individual goes out, makes a short excursion in the neighbourhood, and returns to its home. Those which remain in the nest are almost immobile, making only a slow rotatory movement, comparable to that of encysted Infusoria. The body is flexible, but not contractile, and its form varies considerably with the state of repletion of the individual. The mouth has the form of a long cleft, which is bordered on either side by a cuticular thickening, and it has a considerable power of comparatively rapid distension. The arrangement of the striæ of cilia is always more or less spiral, but differs a little at either pole.

The author also describes a new species of *Opalina*, which he calls *O. cerebriformis*, on account of the presence on its convex surface of a deep groove, and the arrangement of its striæ of cilia, which give a twisted appearance to the whole mass.

Holotrichous Infusoria parasitic in White Ants.*—Mr. W. J. Simmons finds that the lower portion of the alimentary canal of the white ant teems with parasites. Among these there is a holotrichous infusorian which changes constantly in form. No name is given to the creature, and the author seems to be in doubt as to the morphology of some parts of its organization.

Parasitic Monad.†—Herr W. Zopf gives an account of the development of a new pleosporous fresh-water Monad, which he calls *Polysporella* ‡ *Kützingii*; it was found parasitic in various Algæ. The lasting spores or sporocysts are distinguished from those of other Monads by being pleosporous (4, 8, 16 lasting spores); the form of the cysts is adapted to the cells of their hosts. The investment is simple as compared with that of other Monads. The zoocysts are generally somewhat smaller than the sporocysts, and the zoospores make their way to the exterior, but the direct infection of new algar cells has not yet been observed, but it may be considered as certain that they give rise to Amœbæ; these grow by the ingestion of food. When sufficient has been taken in the Amœbæ draw in their processes, become rounded and encysted. The further development of the contents varies according as the cyst shall give rise to a zoocyst or a sporocyst. The development of either is by successive fission of the protoplasm. These organisms belong to the family Pseudosporeæ.

Dino-Flagellata.§—M. E. Penard treats especially of the structure of the genus *Ceratium*, which he regards as belonging to the vegetable rather than to the animal kingdom. He describes three modes of reproduction, viz.:—(1) By internal embryos. In the summer he found in some individuals from one to four elliptical cells, with nucleus, chlorophyll, and eye-spot. These escape from their inclosing envelope, are either motile or immotile, according to the rigidity of the membrane which envelopes them, become encysted, and pass through a resting

* The Microscope, ix. (1889) pp. 53–5.

† 'Untersuchungen über Parasiten aus der Gruppe der Monadinen,' fol., Halle, 1887, 39 pp., 3 pls. See Bot. Centralbl., xxxvii. (1889) pp. 206–8.

‡ At the end of the abstract the new generic name is said to be *Pleosporella*.

§ 'Contrib. à l'étude des Dino-Flagellés,' Genève, 1888, 43 pp., 3 pls. See Bot. Centralbl., xxxvii. (1889) p. 131.

condition, their contents sometimes segmenting into cysts. (2) By entire cell-rejuvenescence, similar to that described by Schütt in *Peridinium;* the contents escape in the form of two swarm-spores, the further history of which is not followed out. (3) By fission, corresponding to division in the motile state.

Development of Actinosphærium eichhorni.*—Mr. J. M. Stedman remarks that the youngest examples of this species seen by him resembled white blood-corpuscles with a distinct and sharply defined nucleus. Later, a vacuole appears, which attains to a very large size, and at this stage a pseudopodium may be present. Two of these were seen to unite, and in the course of five minutes the two vacuoled forms developed a ray, and the characteristic axis-thread could be seen in its interior. The number of rays in young forms is of no special value, as it varies with different individuals of the same age. The form under observation was, a little later, seen to unite with one which had three vacuoles but no rays, and immediately afterwards a spherical form was assumed. Again a union occurred, and now the characteristics of *A. eichhorni* began to be apparent. The author suggests that in the autumn, at any rate, full-grown Heliozoa become encysted, that the protoplasm divides and subdivides until it is converted into a mass of minute bodies, which, when the cyst is ruptured, make their escape into the surrounding water, and then appear as naked spherical masses of granular protoplasm with a nucleus.

New Type of Astrorhizidæ.†—Mr. H. B. Brady gives an account of an undescribed type of Rhizopod, dredged by Mr. Wood-Mason in the Bay of Bengal. *Masonella* is proposed for the generic name, and two species, *M. planulata* and *M. patelliformis,* are recognized. The general structural features can almost be read by the naked eye, and are easily made out under a low magnifying power. There is a central chamber with a number of radiating tubes which extend, either simple or branched, to the periphery. We have here branched and radiate Astrorhizæ with the sandy investment continued between the arms, so as to produce an even, rounded, peripheral outline. The species appear to be common at the localities in which they were found.

New Gregarines.‡—Prof. J. Leidy describes a new species of *Gregarina,* which he proposes to call *G. philica,* found in the proventriculus of a common American beetle *Nyctobates pennsylvanicus.* It is remarkable and apparently peculiar in its mode of conjugation, for the pairs conjoin with the heads together and the bodies side by side. *G. actinotus* sp. n. is frequent in the common Myriopod *Scolopocryptops sexspinosus;* it looks like a minute *Echinorhynchus* when found adherent by its rostrum to the inner surface of the proventriculus. *G. megacephala* is a new species found in *Cermatia forceps* which appears to be allied to *Dufouria agilis* found in the larva of a *Hydracantharis.* Another new species is called *G. microcephala;* it was found in the tenebrionid beetle *Hoplocephala bicornis,* and bears a close resemblance to *Echinocephalus hispidus* of Schneider, but is without the digitiform processes to the head.

* The Microscope, viii. (1888) pp. 333–61 (1 pl.).
† Ann. and Mag. Nat. Hist., iii. (1889) pp. 293–6.
‡ Proc. Acad. Nat. Sci. Philad., 1889, pp. 9–11.

Eozoon Canadense.*—Mr. G. P. Merrill, in an article on Warren County Ophiolite or Verdantique Marble, remarks that the serpentization of pyroxene is destined to throw some light on the *Eozoon* problem. He suggests that we have in the alteration *in situ* of the pyroxene granules the source of the serpentinous material, and that the mineral pyroxene of the white or colourless variety, which often occurs in the lower layers and fills some of the canals of *Eozoon*, is merely the residual mineral which has escaped alteration.

* Amer. Journ. Sci., xxxvii. (1889) pp. 189–91.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Rotation of Protoplasm.†—Herr J. B. Schnetzler finds the elongated cell in the protoneme resulting from the germination of the oosperm of *Chara fragilis* to be a very favourable object for observing the phenomena connected with the rotation of protoplasm. He believes it to be essentially a function of respiration, that is, of the chemical changes produced by the oxygen of the atmosphere; and compares it to the property of the pollen-grain to emit pollen-tubes, which is equally dependent on the free access of air. If the germinating *Chara* is immersed in irrespirable gases, such as hydrogen, nitrogen, &c., or in pure olive-oil, the movement of the protoplasm rapidly ceases, and the balls of dense protoplasm which float on the surface of the more fluid protoplasm assume a granular appearance, and surround themselves with a delicate pellicle.

Growth of Albuminous Composition of Cell-walls.‡—Dr. F. G. Kohl has examined the structure of the hairs on many species of Borragineæ, Moraceæ, Urticaceæ, and Cucurbitaceæ, which exhibit a very marked thickening at their apex, followed by a partial calcification or silicification. This thickening is effected neither by apposition nor by intussusception, but by the deposition of fresh masses of cellulose in a manner similar to that described by Krabbe § in the bast-fibres of Apocynaceæ and Asclepiadeæ. These masses of cellulose are in the form of caps placed one within another, and between them are masses of protoplasm. This structure is exceedingly well seen in the hairs of *Symphytum officinale*, after the calcium carbonate has been first removed by dilute hydrochloric acid. The multicellular hairs of the Cucurbitaceæ show in addition local thickening of the cell-wall by true apposition. The reaction with Millon's reagent, even after first treating with hydrochloric acid, as proposed by Wiesner,‖ failed to detect the least trace of albuminous substance in the cellulose-caps themselves.

Contents of the Cell.¶—Herr J. H. Wakker states that according to the present state of our knowledge, the cell-protoplasm consists of: (1) the parietal layer or hyaline protoplasm, which chiefly serves merely as a protective organ for the rest, and for this purpose forms also the cell-wall; (2) the granular or streaming protoplasm which is concerned with the transport of nutrient material; (3) the nucleus, the function of which has not been determined experimentally; (4) the amyloplasts, to which belong the chlorophyll-grains; and (5) the tonoplast, from which the turgidity of the cell is derived, but which has also other

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents (including Secretions); (3) Structure of Tissues; and (4) Structure of Organs.

† Arch. Sci. Phys. et Nat., xxi. (1889) pp. 100–7.

‡ Bot. Centralbl., xxxvii. (1889) pp. 1–6 (1 pl.).

§ Cf. this Journal, 1887, p. 272.

‖ This Journal, 1886, p. 818.

¶ Jahrb. f. Wiss. Bot. (Pringsheim), xix. (1888) pp. 423–96 (4 pls.).

functions. Of the mode and place of formation of the fatty oils, the aleurone, the crystalloids, and the crystals, very little is at present definitely known; and the object of the present investigation is to determine some points in connection with this subject. The following are the more important results attained.

Crystals of calcium oxalate which occur within the cell are formed exclusively in the vacuoles; and this theory is not opposed to the fact that they are carried along in the currents of protoplasm. Rosanoff's cellulose sacs are formed by the death of the cell and subsequent passive distension by turgidity. The envelopes of cellulose or protoplasm are deposited on the crystals after their formation.

Aleurone-grains are vacuoles filled up by albuminoids. The albumen dissolved in the vacuole becomes solid by the drying of the ripening seed; in the softening of the seed, on the other hand, which precedes germination, the reverse takes place. During the formation of the seeds, the originally single vacuole of each cell divides, as its contents are being formed, into a very large number of small vacuoles; and the reverse of this takes place again during germination; after germination the empty cells again contain a single central vacuole. The albumen dissolved in the vacuoles of ripening and germinating seeds can be precipitated by several reagents, such as dilute nitric acid, absolute alcohol, saline solutions, &c. By means of these substances the slow disappearance of the albumen on germination in the dark can be followed step by step. Globoids are formed in the vacuoles.

Crystalloids may be formed in the most various parts of the cell, viz.:—in the vacuole (in seeds, in Thallophytes, and in *Pothos scandens*); in the protoplasm (in the potato); and in nuclei and plastids.

The fatty oils are always formed in the protoplasm, and in two different ways, viz. in specially prepared spots, elaioplasts (as in species of *Vanilla*, Hepaticæ, *Vaucheria*, and possibly *Laurencia* and its allies); or distributed uniformly through the protoplasm (as in seeds).

The protoplasm can become perforated during plasmolysis without being thereby killed.

Connection of the Direction of Hygroscopic Tensions with the Structure of the Cell-wall.*—Herr C. Steinbrinck has investigated the causes of the hygroscopic tensions which result in the twistings of organs, such as the involucral scales of Compositæ, the legumes of Leguminosæ, and the awns of *Erodium*, *Pelargonium*, *Stipa*, and *Avena*, which are connected with their dissemination. He attributes the phenomenon to two causes:—the production and the direction of striæ and of pores on the organ in question; and the difference in the capacity for swelling of different cell-walls and layers of cell-walls.

(2) Other Cell-contents (including Secretions).

Spectrum-analysis of the Colours of Flowers.†—Dr. N. J. C. Müller has examined the spectroscopic reactions of the pigments of sixty-five different plants, which he classifies under three heads, viz.:—red (erythrophyll), yellow and orange (xanthophyll), and blue to violet and purple (anthocyan). The following varieties are enumerated, and the characteristics of the spectra given, together with the reaction

* Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 385–98 (1 pl.).
† Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 78–105 (2 pls.).

with sulphuric acid: Erythrophyll α—*Rosa*, *Petunia*, *Dianthus*, raspberry, black currant, beet, radish; β—*Geranium*, *Gladiolus*, *Papaver Rhœas*, *Fuchsia*; γ—*Epilobium angustifolium*; δ—*Diervillea*; ε—*Calycanthus*. Xanthophyll α—*Crepis*, *Hieracium*; β—*Linum campanulaceum*; γ—Cruciferæ; δ—Ranuculaceæ; ε—*Hypericum*; ζ—*Lilium tigrinum*; η—*Zinnia*; θ—*Tropæolum*. Anthocyan α—*Lunaria*, *Malva*, *Viola*; β—*Lobelia*, *Campanula*, *Geranium pratense*; γ—*Gentiana acaulis*; δ—(no example given); ε—*Centaurea Cyanus*; ζ—*Delphinium consolida*.

Change in Colour of Leaves containing Anthocyan.*—According to Herr H. Molisch, the rapid loss of the colour of leaves which are coloured purple by anthocyan, is due to the fact that anthocyan, or the mixture of pigments known under this name, turns blue on the addition of a trace of alkali, green with a larger quantity, then yellow, and finally loses its colour entirely. On the death of the leaf or other organ, this is brought about by the contents of the cells which contained anthocyan mixing with the protoplasm of other cells from which they were previously separated.

Tannin-vacuoles.†—Herr J. E. F. af Klercker has carefully investigated the mode of formation of tannin in a large number of plants, especially in the root. He finds that the tannin of the mature root occurs partly dissolved in the entire cell-sap, partly in special receptacles or tannin-vacuoles, occasionally in the cell-wall, never in the protoplasm. These vacuoles are formed in the protoplasm by the coalescence of small sap-cavities which contain tannin; in the first place vacuoles are formed in the protoplasm of the meristem-cells, some of which contain tannin, others not. If their coalescence is prevented by artificial means, abnormal vacuoles are formed.

An excretion of mucilaginous tannin often takes place in the tannin-vacuoles by plasmolysis. These vacuoles frequently, but not always, contain, besides tannin, substances in appreciable quantities which produce osmose. The tannin of the vacuoles, as well as that of many other cells, shows no, or scarcely any, tendency towards osmose. All the tannin-vacuoles which were examined took up methyl-blue. Albuminoids never occur in solution in these vacuoles.

The tannin-vacuoles are, during the whole of their existence, inclosed in a lamella of protoplasm, and are probably separated from it by a precipitated membrane of iron-tannate. Both in the vacuoles and in many other cases the tannin results from chemical decompositions in the protoplasm of the meristem-cells, and makes its first appearance in the form of solid granules in the protoplasm, which are afterwards dissolved into a vacuole. The tannin of the vacuoles of the bark of the root, as well as that of all root-caps, must be regarded as an excretion. In the epiderm a resorption of these vacuoles frequently takes place in the formation of the root-hairs.

The tests for tannin employed by the author were the staining by methyl-blue, and the precipitation by alkaline carbonates. He also made use of a modification of Moll's reaction, consisting of the substitution of an alcoholic for an aqueous solution of copper acetate, whereby the tannin was stained and the entire cell-contents fixed.

A table is appended of the species in which tannin was observed,

* Bot. Ztg., xlvii. (1889) pp. 17–23.
† Bih. K. Svensk. Vet.-Akad. Handl., xiii. (1888) No. 8, 63 pp. (1 pl.).

whether in vacuoles or dissolved in the sap, the part of the plant examined being in all but one or two cases the root.

Cystoliths in Exostemma.*—M. E. Heckel describes a new type of calcareous concretion which he has found to exist in the genus *Exostemma* (Rubiaceæ). If a tangential section be made of a young branch of *E. floribundum*, two concentric cycles of cystolithic cells will be found in the last layers of the cortical parenchyme. Examined under a sufficiently high power, the cystoliths are seen to be in the form of papillæ terminating in a point, and five or six in number; their apices are all turned towards the interior of the cortex, and their bases towards the exterior. Weak acid causes the dissolution of these calcareous masses, carbonic acid being liberated. It was noticed, however, that after the calcareous mass was gone, a small pedicel composed of cellulose remained on the wall to which it had been affixed; in this respect, therefore, the cystoliths here described differ from those found in Urticaceæ. Although the author found numerous cystoliths to exist in *Exostemma floribundum*, in an allied species *E. caribæum* they were quite absent.

Oil of Bay-leaves.†—Sig. G. A. Barbaglia has distilled the essential oil contained in the leaves of the bay-tree, *Laurus nobilis*, and finds it to have the composition $C_{14}H_{24}O$. This may be a substance belonging to the same series as camphor, $C_{10}H_{16}O$, or it may be a compound with the formula $C_{14}H_{22} + H_2O$, a point which must be determined by further investigation of its chemical reactions.

(3) Structure of Tissues.

Development of Sieve-plates in the Phloem of Angiosperms.‡—M. H. Lecomte states that the principal researches on the development of sieve-tubes have been by Wilhelm, Janczewski, and Russow, and the author criticizes briefly the observations of these three gentlemen. By the help of very sensitive and rapidly acting reagents, he was able to see that the membrane destined to become a sieve is not homogeneous, but is formed of a cellulose network. The substance forming the meshes the author calls callus; this swells when it is traversed by the contents of the tubes, and forms cushions on each side of the septum. If the contents of the tubes are rich in albuminoids, and if the meshes are large, the osmotic action is very active, and the axis of the meshes can be stained by anilin-blue. From the researches of Baranetzki on the thickening of membranes, it appears that in soft parenchyme the transverse walls of the cells possess polygonal punctations. The sieve-tube is therefore only an exaggerated parenchymatous cell.

Development of Cork-wings.§—Miss E. L. Gregory proceeds to discuss the physiology of the development of cork-wings. The earlier researches made on the subject of cork seem to have fixed its use in the plant economy as that of protection, mainly in the way of a substitute for epidermal tissue; we now, however, include as part of its function the repairing of tissues torn or broken by external or internal causes, and aiding in the regulation of gases and transpiration.

* Bull. Soc. Bot. France, xxxv. (1888) pp. 400–3 (3 figs.).
† Atti Soc. Tosc. Sci. Nat., vi. (1888) pp. 181–4.
‡ Bull. Soc. Bot. France, xxxv. (1888) pp. 405–7.
§ Bot. Gazette, xiv. (1889) pp. 5–10, 37–44. Cf. *ante*, p. 242.

The author describes some experiments with *Liquidambar;* and the result may be summed up by stating that the tendency is for the summer growth to form ligneous walls, the plate-cells always cork. In *Quercus* the results were very similar, and the same may be said of *Acer campestre.* In *Acer monspessulanum* the results were the same, excepting that there were ligneous cells along the line of breakage. *Euonymus alatus* differed from the preceding only in that the tendency to ligneous cells in the summer growth was more marked. In the formation of the wings of *Quercus* and *Acer*, and others of a similar type, the first steps in the process are easily explained on the score of purely physical causes. The breaking of the tissues is the result of a strain greater here than in other places on the fresh yielding tissues. The author then says a few words on the function of lenticels.

Various facts in regard to the anatomy of these growths have suggested certain inferences. The most important of these are:—(1) Young stems, which are entirely encircled by cork-wings, are found to lack other means of communication with the outside air. The anatomy of the wing in these cases is such as to enable it to supply this deficiency and to act as lenticels. (2) The wings of the horizontal branches of *Liquidambar*, covering as they do only part of the circumference, perform in part the same function; at the same time they increase the surface sufficiently to allow the growth within, while the remaining part of the surface of the stem retains the character and office of the early periderm. (3) In *Euonymus*, the symmetry of the stem is preserved, the surface is enlarged by the wing, while all the remaining surface of the stem plays the part of assimilation. (4) The characteristics of autumn cork are exactly those of autumn wood, the tracheal element alone excepted. Could it be proved that these changes are due to the same cause, another means of deciding the question as to the cause of the autumnal growth of wood, or annual rings, would be obtained.

Researches on the Periderm.*—M. H. Douliot now describes the periderm of the Hypericaceæ. M. Vesque found a considerable difference in structure to exist between *Hypericum* and *Ancistrolobus pulchellus;* the author, however, states that there is no difference in the origin of the periderm. In the nine genera of true Hypericaceæ belonging to the two tribes Hypericeæ and Vismieæ, the periderm is pericyclic. *Frankenia* differs from the true Hypericaceæ in the two alternate whorls of stamens, and also in the origin of the periderm, which is not pericyclic but hypodermal. The author concludes by some observations on the development of cork in the Hypericaceæ. In *Hypericum calycinum* a folded layer may be observed in the middle of the soft cork, a phenomenon which has already been noticed by Sanio in a species of *Melaleuca*, and which is frequent in Rosaceæ, Œnothereæ, and Myrtaceæ. In *Cratoxylon coccineum* the periderm possesses folded layers and layers of hard cork with thickening cells in the form of a U, the opening being turned inwards. This form of thickening is also met with in the cells of the endoderm.

(4) Structure of Organs.

Pollen of the Convolvulaceæ.†—Dr. A. C. Stokes describes the minute structure of the pollen of several species of this order, especially

* Morot's Journ. de Bot., iii. (1889) pp. 37–9. Cf. this Journal, 1888, p. 987.
† The Microscope, ix. (1889) pp. 33–43 (1 pl.).

of the "moon-flower," *Ipomæa bona-nox*. This is characterized by two features not hitherto recorded: a fine velvety coating consisting apparently of rigid filaments adherent to one another, about 1/4500 of an in. in length, arising directly from the surface of the extine; and two kinds of papillæ. Of these the larger club-shaped processes proceed from the extine; but the smaller conical ones are processes of the intine protruding through the extine, a structure not previously observed in pollen-grains. The velvety covering of the grains was observed in several other species of *Ipomæa* and *Convolvulus*; and the conical intinal processes protruding through the extine also in the pollen-grains of the "morning glory," *Ipomæa purpurea*.

Fruit-scales of Abietineæ.*—From the examination of a number of abnormally developed cones of the larch, Dr. J. Velenovsky draws the conclusion that in the Abietineæ the fertile scale is composed of two leaf-scales, though it does not follow that this is also the case in the other sub-orders of the Coniferæ. The double scale of the cone of Abietineæ can be compared to the double leaf of *Sciadopitys*, this doubling being a very common phenomenon in the vegetative organs of the Coniferæ. Some of the cases were prolonged above into shoots bearing leaves, many of which had ordinary leaf-buds in their axils. In some of these buds all the scales have become fleshy, and each bears on its under side a rudimentary ovule, the whole closely resembling the fructification of a *Cycas*. All intermediate forms are to be met with between these structures and normal buds.

Seeds of Nymphæaceæ.†—Pursuing his investigations on this subject, Prof. G. Arcangeli now describes the structure of the seeds of *Nymphæa alba* and *Nuphar luteum*. In the white water-lily the ripe seeds have a very short funicle, and are surrounded by a copious white aril, within which is a well-differentiated double integument. The seed itself is composed of three parts, the embryo, the albumen (endosperm), and the perisperm. Of these the first and the third occupy by far the largest portion of the seed, the endosperm consisting of a single layer of cells in direct contact with the surface of the embryo. The cells of the embryo and endosperm are full of albuminoid and oily substances, those of the perisperm, on the other hand, of starch. In the yellow water-lily the seeds have a longer funicle, and no true aril, but the integument again consists of two distinct coats. The endosperm is somewhat more developed than in *Euryale* and *Nymphæa*, consisting of from two to four layers of cells. As in the latter genus, the perisperm is by far the largest constituent of the ripe seed, and is the principal reservoir of the amylaceous food-materials, the albuminous and oily substances being stored up in the cotyledons and the endosperm.

Bract in Tilia.‡—Mr. T. Meehan states that the small leaf adherent for some half its length to the common peduncle in the linden tree is known as a wing-bract. The use of the dried bract as a wing to aid in the distribution of the seed can scarcely be its sole purpose. But the lifting power of the growing bract is apparent; and, though it is difficult to understand how the adaptations are of much use to the plant, it will be perhaps more difficult to believe that the adaptations have been made

* Flora, lxxi. (1888) pp. 516–21 (1 pl.).
† Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 122–5, 138–40. Cf. *ante*, p. 250.
‡ Bull. Torrey Bot. Club, xv. (1888) pp. 316–7.

solely in the interest of the insect world; though, so far, the facts barely admit of any other interpretation. The author's view is that nature has not made variety in structure and character solely for the peculiar advantage of the plant itself, but that a variety of purposes are also involved.

Comparative Anatomy of the Bracts of the Involucre in Cichoriaceæ.*—M. L. Daniel describes the structure of the bracts in a number of the Cichoriaceæ. In *Tolpis barbata*, for instance, in a bract from the third row, the two hypodermal bands are formed by sclerenchymatous parenchyme, and unite, completely enveloping the bundles. The structure found in the internal bracts is very different; the lower band is composed of two fibrous portions united by sclerenchymatous parenchyme, beneath one or several bands of aqueous polyhedral parenchyme. The author then goes on to describe numerous other genera belonging to the Cichoriaceæ, and clearly shows that great variation in structure is to be found within that tribe.

Pitchers of Sarracenia.†—From an examination of the anatomical structure of the pitcher of *Sarracenia Drummondii*, M. E. Heckel comes to the conclusion that it represents a hollow petiole, and the opercule the lamina of the leaf. The resemblance in structure is very close to the petiole of *Nymphæa alba*, and the near affinity of the Nymphæaceæ and Sarraceniaceæ cannot be doubted. The structure and arrangement of the vascular bundles are very similar. The parenchyme of the petiole of the water-lily contains large numbers of air-cavities lined with hairs. These appear to be fused in *Sarracenia* into one large central cavity, the cavity of the pitcher, in which we again find the hairs which prevent the escape of the captured insects.

Petiole of Dicotyledons.‡—M. L. Petit describes the anatomy of the petiole of nearly five hundred species of Dicotyledons belonging to three hundred genera and forty-eight families. In form the petiole is always convex below and concave on its upper face; the hairs present unimportant characters for classification, their existence not being constant in the same family or genus. The external membrane of the epiderm is generally 5 μ in thickness; in *Clerodendron fœtidum* and *Cyclanthera pedata* it is 3 μ; while in Ranunculaceæ it is sometimes 10 μ; it is nearly always more or less cuticularized. The form of the epidermal cells is very variable, and their variations are independent of families or genera. The presence of cork has been noticed in several cases, e. g. *Ficus repens*, *Theobroma Cacao*, and *Hoya carnosa*. In the two former it is in contact with the epiderm, but in *Hoya carnosa* it consists of five or six layers, and is separated from the epiderm by four or five layers of parenchyme.

Collenchyme is present in the petiole in two distinct forms; sometimes the walls of the cells are thickened everywhere to the same extent, as in Umbelliferæ and many Rosaceæ, while in other cases the thickening is localized at the angles of the cells, as in Polygonaceæ. These two types of collenchyme are connected by intermediate forms. The conjunctive tissue is formed of round or polygonal cells with either thin or

* Bull. Soc. Bot. France, xxxv. (1888) pp. 432-6.
† Comptes Rendus, cvii. (1888) pp. 1182-4.
‡ Mém. Sci. Phys. et Nat. Bordeaux, iii. (1887) pp. 217-404 (6 pls.). Cf. this Journal, 1888, p. 610.

thick walls. In exceptional cases the cells forming the conjunctive tissue are smaller than the cortical cells (*Mimosa pudica*). Crystals are met with in the petiole in either the cortical parenchyme, the liber, or the pith, and are of some taxonomic importance. They are either (*a*) raphides; (*b*) crystalline granulations; (*c*) isolated crystals; or (*d*) quadrangular in shape. Various forms of secretory tissue may also be found, and thick fibres often exist, especially in Malvaceæ, Cruciferæ, Umbelliferæ, and Compositæ. Sclerenchyme is present either as parenchymatous fibres or as sclerotized cells.

As to the fibrovascular system: in the two peripheral bundles of the petiole the phloem faces outwards, while the central bundles have a variable structure. Bicollateral bundles are to be found in the petiole of Solanaceæ, Convolvulaceæ, Asclepiadeæ, Apocynaceæ, Myrtaceæ, Cucurbitaceæ, and Œnothereæ.

The author then gives a table illustrating the course of the bundles in the petiole of Dicotyledons. The types may primarily be divided into simple and complex, and the simple types are again divided into those which have the bundles distinct both at the apex and base of the petiole, and those where the bundles show the opposite arrangement. Complex types are found in various natural orders, e. g. Rosaceæ, Cupuliferæ, Salicaceæ, &c.

The most important results, however, the author gathers together in a table at the end of the paper, in which he gives a *resumé* of the differential characters of the petiole in the principal families of Dicotyledons. The primary divisions of this table are:— (A) the terminal section in a petiole incloses secretory canals; and (B) the terminal section in a petiole does not inclose secretory canals. In division A we have Umbelliferæ, Araliaceæ, Malvaceæ, Tiliaceæ Sterculiaceæ, and Compositæ; Umbelliferæ and Araliaceæ have a secretory canal behind each peripheric bundle, while the others have their secretory canals arranged irregularly, and the hypodermal collenchyme discontinuous. In division B we have Asclepiadeæ, Apocynaceæ, Convolvulaceæ, Solanaceæ, Myrtaceæ, and Cucurbitaceæ, with bicollateral bundles; and various Rosaceæ, Malvaceæ, Geraniaceæ, Oxalideæ, Cupuliferæ, Amaranthaceæ, Chenopodiaceæ, and Leguminosæ, with no bicollateral bundles. Then in the first five orders mentioned:—in division B the median bundle is much developed; Scrophulariaceæ, Oleaceæ, and Borragineæ have the lower bundle preponderating, and furthermore they have no sclerenchyme. In Oleaceæ the phloem is of more importance than in Scrophulariaceæ, where there are sometimes small prismatic crystals. Papaveraceæ and Compositæ possess secretory tissues; Compositæ have ordinarily thick and sometimes even sclerenchymatous fibres, which are never found in Papaveraceæ. Cruciferæ have thick fibres like Compositæ, but no secretory tissue; many Cruciferæ can be recognized immediately by the structure of their radiating bundles. Ranunculaceæ are distinguished by a transverse section of their fibrovascular bundles, which have the form of an ellipse, in which the phloem is either circular or elliptical.

The author concludes by pointing out the great variation in structure occurring in the petiole, also its importance for taxonomic purposes, and the law which governs the general distribution of fibrovascular bundles in herbaceous and woody plants; isolation of the bundles generally occurring in the former and aggregation in the latter.

Ligneous Tumours in the Vine.*—M. E. Prillieux states that frequently vines may be seen covered with ligneous tumours formed of a number of small nodules aggregated together. These bodies, which have a diameter of 6–8 cm. and a length of 15–20 cm., arise beneath tho fibres of the cortex. The author states that they arise from hypertrophy of the young tissues on certain points in the old wood.

Cuscuta Gronovii.†—Miss H. E. Hooker describes the mode of parasitism of one of the common dodders of the northern United States, *Cuscuta Gronovii.* The seeds are exalbuminous, of comparatively large size, with a conspicuous hilum and hard testa; but the latter yielded readily to soaking in dilute potash, and careful dissection removed the two coats and freed the coiled vermiform embryo. The haustoria are, outwardly, enlarged fleshy discs, and differ from true roots, as does the root-acting end of the stem, in the absence of a root-cap. There is very little differentiation in the tissues of the dodder; the vascular system consists of alternate strips of tracheides and parenchyme, each about two rows of cells wide, and, in the best developed stems, occupies perhaps from one-third to one-half the diameter. Of the adventitious buds the author only studied those producing branches. The regular branching of a stem of *Cuscuta* is abnormal in the centrifugally arranged accessory buds, the last-formed bud being farthest from the parent stem, though sections show it to originate in the axillary bundle. The epiderm of the dodder varies with its position. On the long internodes between adjacent scales stomates are rare, while over haustoria, i. e. on the side of the stem opposite them, very small stomates are quite abundant. Each flower has a short pedicel resembling the main stem in structure, a thickened receptacle, a five-lobed calyx and corolla, and adherent stamens alternating with its lobes; the ovary is bilocular with two ovules in each locule, and there are two knob-like stigmas on short styles.

Vegetative Organs of Bignoniaceæ, Rhinanthaceæ, Orobancheæ, and Utriculariaceæ.‡—M. M. Hovelacque describes in great detail the structures included under these heads. The following are some of the more important generalizations:—

The phloem shows a series of gradually increasing complications in structure from the annual Rhinanthaceæ through the woody Bignoniaceæ to the Orobancheæ. In the xylem there is a corresponding series of stages in complication, the most perfect condition being found in the Bignoniaceæ, the simplest in the Utriculariaceæ.

In the leaves we find the most highly developed internal structure in the woody and climbing Bignoniaceæ, such as *Catalpa* and *Eccremocarpus.* Those of *Utricularia* are very simple, but exhibit a striking dimorphism.

The orders under discussion do not belong to any common type as respects their vegetative organs. A certain resemblance is, however, exhibited in the stem of Bignoniaceæ and Rhinanthaceæ; but the former are of higher organization, and show some affinity to the Scrophulariaceæ. The Lathræeæ resemble the Rhinanthaceæ in all their anatomical peculiarities; the Orobancheæ display but little affinity to the Lathræeæ,

* Bull. Soc. Bot. France, xxxv. (1888) pp. 393–5.
† Bot. Gazette, xiv. (1889) pp. 31–7.
‡ 'Rech. sur l'appareil vég. d. Bignoniacées, Rhinanthacées, Orobanchées et Utriculariées,' 8vo, Paris, 1888, 765 pp. and 651 figs. See Bot. Centralbl., xxxvii. (1889) p. 17.

and resemble much more closely the Gesneriaceæ. The Utriculariaceæ are a well-defined group.

The haustoria of the Orobancheæ and Rhinanthaceæ * are interesting from a morphological point of view. They are usually thallomes which develope above the surface on normal roots; the most simple resemble hairs, the more complicated have a central irregular bundle of xylem and phloem; and they may then assume the function of roots. They may become so closely united with the root of the host, that xylem unites with xylem, phloem with phloem, parenchyme with parenchyme. This is in consequence of the meristem, when it enters the root of the host, developing xylem centripetally from the spot where it comes in contact with the xylem of the host; this again determining the position of the other tissues.

Anatomy of Bromeliaceæ.†—M. A. De Wevre briefly describes the main points in the anatomy of this natural order, derived from the examination of a large number of species.

The most conspicuous character, and a universal one without exception, is the presence of scale-hairs on the leaves. Each hair consists of a plate, a single cell in thickness, borne on a central pluricellular stalk; their form varies greatly; and it is their presence that gives the characteristic silvery appearance to the leaves of bromeliads. In a few species they are found only on the lower part of the leaf. Similar hairs occur nowhere else among Monocotyledons, except in a few palms, where they are deciduous.

There is never in the leaves a well-developed layer of palisade-cells; but in some species the outer cells of the mesophyll are slightly longer than the others. The stomates are arranged in rows, separated by bands of tissue from which they are absent. The guard-cells are always four in number, of which two are parallel to the pore, and two perpendicular to it. All Bromeliaceæ are distinguished by the presence of an aquiferous hypoderm, which occurs also in Palmæ, Pandanaceæ, some Amaryllideæ, &c. In *Ananassa macrodosa* and some other species it constitutes nearly three-fourths of the thickness of the leaf. The cells of which it is composed are sometimes polygonal, sometimes elongated, sometimes of both forms. A tangential section always shows the epidermal cells with undulating walls; these cells have generally thick walls, the thickening being sometimes on the outer, sometimes on the inner wall.

The fibrovascular bundles which run through the whole length of the leaf are usually very numerous, and are collateral in structure, generally surrounded by a very strong sclerotized sheath, especially in the species with long leaves. As in most Monocotyledons, oxalate of lime occurs in the form of raphides, rarely in that of prisms (*Caraguata Zahnii*).

β. Physiology.‡

(1) Reproduction and Germination.

Fertilization of Amorphophallus Rivieri.§—Sig. R. Pirotta has determined that the pollination of this species of Aroideæ is effected by

* Cf. this Journal, 1888, p. 80.

† Bull. Soc. R. Bot. Belg., xxvii. part 2, 1887 (1889) pp. 103–6.

‡ This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

§ Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 156–7.

necrophorous Coleoptera, the species which are by far the most active agents being *Saprinus nitidulus* and *æneus*.

Cleistogamic Flowers.*—Herr A. Schulz confirms Magnus's statement † of the occurrence of cleistogamic flowers in *Spergularia salina*, and has observed the same phenomenon also in *Sagina Linnæi*, *Scleranthus annuus*, and *Stellaria Borreana*. The suppression of the corolla is in these cases also accompanied by a reduction in the number of stamens. The production of these autogamous or self-pollinated flowers appears to be dependent on unfavourable climatal conditions.

Parasitic Castration of Lychnis dioica.‡—M. A. Giard confirms the observations of Magnin § with regard to the effects produced on the floral organs of *Lychnis dioica* by the attacks of *Ustilago antherarum*, and extends them also to *Silene inflata*. He regards it as an example in the vegetable kingdom of a phenomenon which he had previously ‖ described in Crustacea and other animals as parasitic castration, caused by the attacks of parasites, and resulting in partial or complete sterility, from the substitution of one kind of sexual organ for the other. This parasitic castration may be *androgenous* when it produces in the female sex characters which belong ordinarily to the male sex, *thelygenous* when the reverse is the case, or *amphigenous* when it mingles the characters of both sexes by developing in each some of the characters of the other sex.

Fly-catching Habit of Wrightia coccinea.¶—Mr. A. Tomes describes the peculiar structure in this plant by means of which insects (ants and flies), when seeking the honey in the nectaries, are caught in slits between the anthers, and then perish. The contrivance appears to be essentially connected with cross-fertilization; self-fertilization being apparently rendered impossible by the structure and relative position of the anthers and stigmas. There is no evidence of the plant being insectivorous.

(2) Nutrition and Growth (including Movements of Fluids).

Absorption of Light in assimilating leaves.**—Dr. E. Detlefsen has attempted the determination of the question whether the absorption of light in a green leaf which is not assimilating, is the same in amount as that of the same leaf while assimilating. He describes an apparatus in which an object can be exposed alternately to streams of air containing carbon dioxide and free from it, and the experiments from which he concludes that the quantity of light absorbed by an assimilating leaf is always greater than that of the same leaf in sunshine in an atmosphere containing no carbon dioxide; though the discrepancy is not great. About 0·8 per cent. of the kinetic energy of the sunlight which falls on an assimilating leaf is converted into potential energy.

Absorption of Nitrogen by Plants.††—Herr B. Frank has undertaken a series of experiments for the purpose of determining whether the source of nitrogen in the soil for the food of plants is supplemented by

* SB. Ges. Naturf. Freunde, 1888, pp. 51–3.
† Cf. this Journal, 1888, p. 994.
‡ Comptes Rendus, cvii. (1888) pp. 757–9.
§ See *ante*, p. 85.
‖ This Journal, 1888, p. 414.
¶ Scient. Mem. by med. officers of the army of India., part iii. (1888) pp. 41–3.
** Arbeit. Bot. Inst. Würzburg, iii. (1888) pp. 534–52 (3 figs.).
†† Landwirth. Jahrb., 1888, pp. 419–551. See Bot. Centralbl., xxxvii. (1889) p. 248.

nitrogen obtained by the plants directly from the atmosphere. He ascertained in the first place that plants contain nitrates only when they absorb these salts from the soil through the roots. Nitrates were found in all plants growing in the soil, though often only in the roots. When present in the parenchyme he believes it to be stored up there as a food-material. With regard to the total amount of nitrogen in the plant, his conclusion is that the presence of vegetation promotes a process which tends to the increase of the nitrogen contained originally in the soil and in the seeds as sown in the ground. He does not believe that the accumulation of nitrogen in the soil is brought about by the root-tubers of the Leguminosæ, but rather by small Algæ or other chlorophyllous Cryptogams, which are always found in the soil. It depends on the presence of cells containing albuminoids, the development of which must be regarded as an independent process not connected with those which take place in the soil.

(3) Irritability.

Physical Explanation of Irritation-curvatures.*—Dr. F. Noll contests the view of Wortmann † that geotropic and heliotropic curvatures are due to the accumulation of protoplasm on the convex in contrast to the concave side, and supports the theory that they are caused by greater growth of the membrane on the convex side. The observations were made chiefly on the stem of *Hippuris* and on the haulms of grasses.

The author asserts that it can be proved by experiment that there is no difference in turgidity between the two sides of the cell, and that the extensibility of the membrane is greater on the convex than on the concave side; the latter is proved by mechanical bending, the former by the plasmolytic method. Measurements under the Microscope also show, at the commencement of the curvature, a smaller thickness of the membrane on the convex than on the concave side; but this is afterwards neutralized by the apposition of new layers on the thinner wall.

The physical process in irritation-curvatures consists in the membrane (in unicellular organs or non-cellular plants) or membranes (in multicellular plants) of the side which becomes convex becoming more capable of extension, and therefore growing more rapidly in length, than that of the concave side. The greater extensibility, or decrease in elasticity, of the membrane on one side is due to the activity of the parietal layer of protoplasm, in which the movable granular layer takes no part. The parietal layer is excited to this greater activity by external influences such as gravitation and light; and it is this phenomenon which is known as "irritation."

To this Herr J. Wortmann replies,‡ regarding it as very improbable that the difference observed by Noll in the thickness of the membrane on the concave and convex sides of negatively geotropic organs is due entirely to internal causes. External purely mechanical forces must also take part in the phenomenon, and it is doubtful what set of causes has the greatest effect.

* Arbeit. Bot. Inst. Würzburg, iii. (1888) pp. 496–533 (4 figs.).
† Cf. this Journal, 1888, p. 259.
‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 435–8.

(4) Chemical Changes (including Respiration and Fermentation).

Formation of Starch from Organic Solutions.*—M. É. Laurent finds, as the general result of a series of experiments, that, in the potato, the following substances can be transformed into starch, viz.:—glycerin, dextrose, levulose, galactose, saccharose, lactose, and maltose, all of them except the first being sucroses. The following substances appear to have no effect as producers of starch, viz.:—monatomic alcohols, glucol, tetratomic and hexatomic alcohols, ethers, aldehydes, fatty bodies, amines, amides, aromatic compounds, glucosides, and alkaloids.

It must not, however, be assumed that no body which cannot be converted into starch is useful for the nutrition of chlorophyllous plants. Such a substance may serve neither to aid in growth in length, nor in the formation of reserve food-materials, but for use in respiration. A typical instance of this distinction is furnished in *Aspergillus niger*. While saccharose and glucose are sufficient for the full growth of this fungus, alcohol, acetic acid, and even oxalic acid, are burnt by the mature plant. While these substances do not serve directly for nutrition, they yet, by their combustion, develope sufficient energy to assist in the supply of nutriment to organs already formed.

Development of Nitrogen in Putrefaction.†—Herr B. Tacke finds, as the result of a series of experiments, that the ordinary view that free nitrogen can result from the decomposition of vegetable substances only when free oxygen is excluded, is incorrect. Free nitrogen is not formed, whether free oxygen be present or not, if the decaying substances do not contain nitrates. But, if the substance contain a nitrate, then in the presence or absence of free oxygen, the nitric acid is reduced either to the state of free nitrogen or to that of one of the intermediate oxides of nitrogen, N_2O, NO, or N_2O_3. The ordinary gaseous products of the decomposition of vegetable substances are, according to circumstances, carbon dioxide, hydrogen or sulphuretted hydrogen, and marsh gas. The microbes by whose agency the reduction of the nitrates is effected do not bring about any elimination of free hydrogen.

γ. General.

Epiphytic Vegetation of the Tropics.‡—Continuing his investigations on tropical plants, Herr A. F. W. Schimper enumerates the species of epiphytic Phanerogams and Vascular Cryptogams in Tropical and Southern America, 119 belonging to the Orchidaceæ. The mode of adaptation of the seed for the epiphytic habit is threefold: in most cases they have a succulent envelope which is devoured by animals, and the seeds themselves are then voided on to the branches of trees; or they are so small as to be carried readily by the wind to fissures in the bark (Orchidaceæ); or they are provided with a floating apparatus. As respects their nutrition; they either find their nutriment on the moist surface of the host, and are then usually protected against desiccation by the presence of receptacles for holding water; or they

* Bull. Soc. R. Bot. Belg., xxvi., part 1, 1887 (1889) pp. 243–70. Cf. this Journal, 1886, p. 643.

† Landwirth. Jahrb., xvi. pp. 917–39. See Bot. Centralbl., xxxvii. (1889) p. 56.

‡ Bot. Mitth. aus d. Tropen, Heft 2, 162 pp. and 6 pls., Jena, 1888. See Bot. Centralbl., xxxvii. (1889) p. 180. Cf. this Journal, 1888, p. 772.

have aerial roots or roots which reach the soil; or they form themselves a matrix of decaying animal and vegetable matter. Some epiphytes, but exclusively those found on the lower branches of trees, grow also on rocks. The largest number of epiphytic plants are found on the arboreal vegetation of mountain slopes in tropical and subtropical climates.

Influence of Alpine Climate on Vegetation.*—M. G. Bonnier describes certain experiments on the cultivation of plants at various altitudes. His general conclusion is, that, under the same atmospheric conditions, the leaves of plants growing at high altitudes liberate more oxygen than do those growing at lower levels.

Parallel Forms.†—Herr F. Krasan attempts to trace the mode of genesis of one species out of another, and of parallel forms of different species under similar external conditions. He regards variability as not induced by the physical influence of the soil, but as independent of external factors. The environment can only give rise to tendencies which transform the possibilities already in the plant into actual metamorphoses. In order to produce positive results by cultivation, it is necessary to make use of observations and experiments on living plants conducted through a number of years; and only those forms are adapted to this which belong to notoriously variable types.

B. CRYPTOGAMIA.

Bennett and Murray's Cryptogamic Botany.‡—We heartily congratulate the authors on the publication of this book. Following in the wake of Vines's 'Physiology,' Bower's 'Practical Botany,' and the 'Annals of Botany,' it is a healthy sign that the British school has successfully cast off its German moorings. Nothing of the kind "has appeared in the English language since the Rev. M. J. Berkeley's in 1857." "The aim of the authors has been to bring before the reader the main facts of structure, of development, and of life-history, which mark the larger groups," with reference "only to the broader lines of demarcation." By the attention they have paid to the fossil remains, by the numerous illustrations, and precise terminology, they have succeeded in producing a singularly clear and readable handbook.

The plan of dealing with the subject is a descent from the higher to the lower types, arranged in seven subdivisions.

Subdivision I. (Vascular Cryptogams) occupies about one-quarter of the book, and concludes with an admirable account of several fossil forms. Then follow the Muscineæ (Subdivision II.). The Characeæ (Subdivision III.) are considered to be a distinctly higher type than the Thallophytes. The Algæ constitute the fourth subdivision, and occupy another quarter of the book. About 100 pages are devoted to a treatment of the Fungi (Subdivision V.) which forms an excellent introduction to De Bary's 'Comparative Morphology and Biology of the Fungi, Mycetozoa, and Bacteria.' Subdivision VI. deals with the Myxomycetes and Acrasiæ, which are so closely linked with the Amœbæ that they are regarded as

* Bull. Soc. Bot. France, xxxv. (1888) pp. 436–9.

† Oesterr. Bot. Zeitschr., xxxviii. (1888) pp. 192–9, 232–7, 293–5, 337–40.

‡ 'A Handbook of Cryptogamic Botany, by Alfred W. Bennett and George Murray,' 8vo, London, 1889, pp. viii. and 473, 378 figs.

being "outside the limits of the vegetable kingdom." The final subdivision (Protophyta) is remarkable for containing the Diatomaceæ, on the theory that they are not "a family derived from the Desmidiaceæ by retrogression," but "represent a comparatively small ascent from an archaic type." It will be remembered that Goebel also has placed them in the neighbourhood of the Protophyta.

The most novel feature of the book is the terminology, in which there is a revolution of three kinds. In the first place, the authors consider that "the first requisite . . . after accuracy, is simplicity," and "have, wherever possible, used Anglicised instead of Latin and Greek forms." Thus sporangium becomes "sporange," epidermis "epiderm." Secondly, some entirely new have been coined in place of older terms which the system of the book has required to be discarded; these describe the structures to which they are applied with such clearness, and so simplify the comparative life-histories of the different groups, that we think they will be heartily welcomed by teacher and student alike. The result of sexual union is called a "sperm," variously modified as "zygosperm," "oosperm," "carposperm," "hypnosperm" (when it undergoes a period of rest), "parthenosperm." Spermatia has given way to "pollinoids." But we must protest against "zoosphere" (pp. 252, 295).

Thirdly, words the meaning of which has varied with writers who have employed them, have been limited in their meaning and accurately defined. Thus, a "spore" is "any cell produced by ordinary processes of vegetation, and not directly by a union of sexual elements, which becomes detached for the purpose of direct vegetative propagation." "Gonids" (gonidia) has been replaced in the Lichens by "algal cells," but lingers on in the Protophyta; but as it is there made equivalent to "pseudocysts," it might have been omitted entirely.

Macrospore was always liable to be mistaken for microspore, and has given way to the more expressive "megaspore."

There are a few errors which will no doubt be corrected in a future edition. On p. 55, the outer of the two cells produced by the division of the primary cell from which the *antherid* arises in Lycopodium is called a *stigmatic* cell. Writers of text-books are, we know, too prone to copy one another's errors. Fig. 26 was first employed by Sachs, and has been borrowed by Goebel, Van Tieghem, and others. It depicts a fertile branch of *Selaginella* in longitudinal section with the extraordinary arrangement of megasporanges represented on one side of the spike, and microsporanges on the other. At the same time we must confess that the present authors state that the megasporanges are confined to the lower sporophylls. We would like to see the figure modified.

In a handbook where so much trouble has been taken to simplify the terminology, we think it a pity that the word "nucleus" has been retained for the mass of carpospores in the sporocarp of Florideæ (p. 201).

Fig. 132 is *Scapania*, not *Jungermannia* *Ceratium* being the name of an animal on the borders of the animal kingdom, it seems undesirable that the mycetozoid organism figured on p. 404 should bear the same name. But of course a text-book is not the place for establishing new names.

The method of inserting the authority for a name in brackets leads to a remarkable complication on p. 316, where the list of luminous fungi strongly reminds one of an algebraic expression resolved into its factors. On pp. 97–100 *Botrychium Lunaria* Sw. is quoted in five several ways. This, however, is a mere incident of the system of giving the authority for the name of every plant mentioned—an excellent practice which we do not remember to have observed before in any botanical text-book.

Cryptogamia Vascularia.

Azolla filiculoides.*—M. Roze gives details of some observations on *Azolla filiculoides* Lam.

Preliminary to the act of fecundation, the antherozoids emitted by the microspores glide under the upper part of the envelope of the megasporange; they then descend the funnel-shaped body which crowns the prothallium, and easily arrive at the archegones. The result of fecundation is the formation of a cellular embryo which rapidly enlarges. The embryo at an early stage presents the rudiments of the two primordial leaves, and it may be seen to rise to the surface, which it does by the help of a bubble of oxygen which has formed in the upper cavity under the action of solar light. It then emits a lateral root covered with root-hairs which are connected with the two primordial leaves by tracheiform vessels. From experiments which the author has made, although the spores may have been submitted to a temperature of $-7°$ C., they will still retain the power of emitting antherozoids, or producing a prothallium and archegones. The author concludes by calling attention to the curious vital suspension of the embryos of *Azolla* in their pseudo-cotyledonary period, when the temperature of the water is often about $+5°$ C.

Characeæ.

Antherozoids of Characeæ.†—M. L. Guignard has undertaken a series of observations on the antherozoids of *Chara* and *Nitella*, with a view to discover whether they proceed from the nucleus of the mother-cell in which they are formed, or from the cytoplasm, or from both together. By special methods of fixation, hardening, and staining, the details of which are not given, the author finds that the body of the antherozoid is formed from the nucleus itself. A band of nuclear substance appears on the surface of the nucleus, and grows longer and longer by extending between the two extremities which have first appeared, and becomes twisted spirally as it grows longer. As soon as the outline of the anterior extremity of this filament is discernible, the two cilia may be perceived in the thin layer of hyaline protoplasm which is nearest this extremity. Later on, the cilia, which at first lie up against the filament, become separated therefrom and the protoplasm gradually disappears, being absorbed and used up for the nutrition of the antherozoid, so that only a few granulations are left on the posterior extremity of the filament.

The latter proceeds altogether from the nucleus of the mother-cell, and moreover gives all the reactions of nuclein; the vibratile cilia are derived from the cytoplasm, corresponding, in this respect, to the mode

* Bull. Soc. Bot. France, xxxv. (1888) pp. 427–8.
† Comptes Rendus, cviii. (1889) pp. 71–3.

of formation of the antherozoids of Muscineæ and of Vascular Cryptogams, but differing from them in the absence of a vesicle formed from the cytoplasm of the mother-cell.

The details of the technique employed in this investigation are promised later.

Algæ.

Effect of dilute Acids on Algæ.*—Dr. W. Migula states that all acids, and especially mineral acids, have a poisonous effect on Algæ; but some species are much more susceptible to their influence than others. Thus *Volvox globator* is killed in a few hours by a 0·002 per cent. solution of phosphoric acid which *Spirogyra orbicularis* will withstand for many weeks. It is a remarkable fact that growth of the cell will still continue after cell-division has been completely interrupted; but this continued growth takes place in length only, not in diameter, and goes on until the cell has attained three to four times its normal length. Assimilation is arrested by all acids, and the chlorophyll-bodies are gradually bleached.

Structure of the Frond of Champia parvula.†—Mr. R. P. Bigelow publishes a further account of the structure of the frond of this sea-weed. It is hollow and divided into chambers by nearly horizontal diaphragms, and with filaments running longitudinally close to the inner wall and passing through the diaphragms. All the filaments in each chamber have projecting from their inner side one or two small globular or pear-shaped "bulb-cells." The wall or cortex of the frond and the diaphragms are all composed of a single layer of nearly equal cells, and each filament consists of a single row of long cylindrical cells. Mr. Bigelow finds the apex of the frond to be occupied not by a single apical cell, but by a cluster of nearly equal apical cells, each of which is the apex of one of the longitudinal filaments. The diaphragms and the bulb-cells are all formed by outgrowths from the filaments.

The structure of the hollow-chambered frond of *Lomentaria Baileyana* is somewhat similar.

Askenasya polymorpha.‡—Herr M. Möbius corrects, in one respect, his previous description of this new fresh-water Floridea. The cushions found attached to the *Chantransia*-like filaments he now believes to have no connection with them, but to be colonies of an epiphytic Cyanophycea, the rare *Onocobyrsa rivularis*.

Colouring-matter of Bangia.§—Herr F. Noll describes *Bangia fusco-purpurea* of the Gulf of Naples as having the outer cell-layers of its frond of a very gelatinous consistency, which serves as a protection against the great extremes of drought and moisture to which it is subjected. The different cells in the same frond, and even in the same filament, vary greatly in colour between intense red-brown and blue-green, the most common being a dirty brown-red; but the colouring matter resides in the chromatophores alone, the cell-sap being always

* 'Ueb. d. Einfluss stark verdünnter Säurelösungen auf Algenzellen,' Breslau, 1888 (2 pls.). See Biol. Centralbl., viii. (1889) p. 737.

† Proc. Amer. Acad. Boston, xxiii. Part 1 (1888) pp. 111–21 (1 pl. and 1 fig.). Cf. this Journal, 1888, p. 623.

‡ Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 358–60. Cf. this Journal, 1888, p. 93.

§ Arbeit. Bot. Inst. Würzburg, iii. (1888) pp. 489–95 (1 fig.).

colourless. By heating to a temperature between 50° and 70° C., the author determined that two or three pigments are combined in the chromatophores, green with either blue or red or both. The green pigment is identical with chlorophyll; the red pigment appears also to have a nitrogenous composition.

Classification of Confervoideæ.*—Prof. A. Hansgirg suggests the following modifications of his previously published classification of the Confervoideæ.

Under Trentepohliaceæ, the Hansgirgiaceæ are separated as a distinct family, comprising the genus *Phycopeltis*, which includes *Phyllactidium* Moeb., *Chromopeltis* ex p., and *Hansgirgia*; the family Mycoidaceæ now consists of *Mycoidea* alone. Under Confervaceæ is included the family Anadyomenaceæ, consisting of the genera *Anadyomene* and *Microdictyon*. Under Ulothrichaceæ, a new family Entocladiaceæ is proposed, made up of the genera *Entocladia*, *Endoclonium*, *Chætonema*, *Bolbocoleon*, *Epicladia*, and *Pringsheimia* (?). The genus *Acroblaste* is sunk in *Pilinia*; *Polychæte* and *Ochlochæte* in *Aphanochæte* Berth.; *Chroolepus* in *Trentepohlia*; and *Ulothrix* and *Glœotila* ex p. in *Hormiscia*; while *Aphanochæte* A. Br. is referred to *Herposteiron*.

Mycoidea, Hansgirgia, and Phyllactidium.†—Dr. G. B. de Toni identifies Möbius's *Phyllactidium tropicum*,‡ epiphytic on the leaves of Orchideæ, with his own *Hansgirgia flabelligera*,§ found on the leaves of *Anthurium Scherzianum*. The genus *Phyllactidium* Moeb. must be sunk in *Hansgirgia*, which De Toni regards as a connecting link between the Coleochætaceæ, Trentepohliaceæ, and Mycoideaceæ.

M. É. De Wildeman ‖ describes the fructification of both *Mycoidea* and *Hansgirgia*, both genera being, he considers, rather widely distributed in the Tropics. He describes the organs of propagation in both genera, and states that they are readily distinguished by their habit and colour, the disc of *Hansgirgia* being, when fresh, orange, that of *Mycoidea* green. The cells of the upright filaments differ also greatly in size and form.

Prof. A. Hansgirg ¶ points out that two different genera have been confounded under the name *Phyllactidium*. The genus of Kützing is a section of *Coleochæte*, while that of Boreau and Möbius should be included in *Phycopeltis* Mill., which forms the subfamily Hansgirgiaceæ of Trentepohliaceæ.

Tilopterideæ.**—Herr J. Reinke has investigated the structure and development of this very imperfectly known family of brown sea-weeds, in which only three species are at present certainly included, *Haplospora globosa*, *Scaphospora speciosa*, and *Tilopteris Mertensii*, from the northern and western coasts of Europe.

Haplospora globosa grows on stones and the shells of molluscs, rarely on larger sea-weeds, in tufts, resembling in habit a *Sphacelaria* in its lower portion; each filament does not, however, end in a large apical cell, but branches like an *Ectocarpus*, and ends in a hair-like prolonga-

* Hedwigia, xxviii. (1889) pp. 14–7. Cf. this Journal, 1888, p. 776.
† Atti R. Accad. Lincei, 1888 (Rendic.), pp. 221–3.
‡ Cf. *ante*, p. 97. § Cf. this Journal, 1888, p. 1003.
‖ Bull. Soc. R. Bot. Belg., xxvii. (1888) part i., pp. 119–26 (1 pl.), and CR. Soc. R. Bot. Belg., 1889, pp. 34–7. ¶ Hedwigia, xxviii. (1889) pp. 12–4.
** Bot. Ztg., xlvii. (1889) pp. 101–18, 125–39, 155–8 (2 pls.).

tion. It is attached to the substratum by an attachment-organ which varies considerably in its form and degree of development. The only reproductive organ detected was a sporange, which may be stalked, and is less often intercalary. The whole contents of this sporange, which are coloured brown by phycophæin, clothe themselves with a cell-wall within the sporange, and escape as a single large motionless spore, formed non-sexually, the germination of which was followed out. The spore contains four, or sometimes a larger number of nuclei; and the author sees in this a possible rudimentary formation of tetraspores, and alliance with the Dictyotaceæ, although in its mode of growth *Haplospora* comes nearest to the Sphacelariaceæ and Ectocarpaceæ.

In habit and mode of growth *Scaphospora speciosa* closely resembles *Haplospora.* It presents, however, two distinct kinds of reproductive organs. The first, called by the author "oosporanges" and "oogones," are usually intercalary cells, from which the whole contents escape as a single "spore," which differs, however, from that of *Haplospora* in having no cellulose-coat, and only one nucleus. Its germination was not observed. The bodies of the second kind are multilocular sporanges, from which escape a number of spores which are probably zoospores. It is most probable that there is in *Scaphospora* a sexual mode of reproduction. Either the "spores" contained in the organs first described are oospheres, and the others antherozoids, or, as the author thinks more likely, the former are non-sexual spores, the latter zoogametes.

Tilopteris Mertensii resembles the other two genera in its habit and mode of growth, and *Haplospora* in the mode of production of its spores. The author thinks it probable that the three genera may eventually be combined into one.

New Genus of Desmidiaceæ.*—Herr S. Stockmayer proposes a new genus of Desmidiaceæ, *Astrocosmium*, most nearly related to *Cosmarium* and *Cosmaridium*, which it altogether resembles in form, but differing from them in having stellate chromatophores similar to those of *Cylindrocystis*, in contrast to the axile chlorophyll-bands of *Cosmarium*, *Penium*, *Closterium*, and *Mesotænium*, and the parietal chromatophores of *Spirotænia.*

Crenacantha, Periplegmatium, and Hansgirgia.†—From an examination of Kützing's little known *Crenacantha orientalis* from Hebron in Palestine, Prof. A. Hansgirg considers that it must be placed under Chætophoraceæ near to *Draparnaldia.* Reinke's genus *Entocladia* must now be sunk in *Periplegmatium* Ktz., of which there are two sections, *Entocladia* marine, and *Entoderma* fresh-water; the author agrees with Wildeman in placing *Hansgirgia flagelligera* De Toni (= *Phyllactidium tropicum* Moeb.) under the genus *Phycopeltis* Mill.

Trentepohlia.‡—M. É. De Wildeman passes in review the described forms of this genus, and enumerates twenty-eight which he considers to be good species. He finds that *T. aurea* sometimes presents the chaacter of having its gametanges stalked, a character on which Gobi had founded, in *T. uncinata*, a distinct section of the genus; but this species must now be sunk in *T. aurea.* Characters based on the form of the

* SB. K.K. Zool.-Bot. Gesell., xxxviii. (1888) p. 85.
† Flora, lxxii. (1889) pp. 56–9 (1 fig.). Cf. *ante*, p. 259.
‡ Bull. Soc. R. Bot. Belg., xxvii. (1888) part i., pp. 79–83, part ii., pp. 22–4, 136–44, 178–82 (1 pl.). Cf. this Journal, 1888, p. 777.

fructification or on the colour of the cell-contents cannot be used for the delimitation of the species; the only ones which will stand at present are those founded on the external form of the cells and on their arrangement with respect to one another. Several species of *Trentepohlia* enter into the composition of lichens, especially of those belonging to the genus *Cœnogonium*. The following new species are described:—*T. monilia* and *T. torulosa* from Chile, growing on the bark of trees; and *T. diffusa* from Ceylon, on leaves.

Pilinia and Acroblaste.*—Dr. G. B. De Toni assigns reasons for suppressing the new genus of Chroolepideæ *Acroblaste* proposed by Reinsch. The species included under it he regards merely as the fertile condition of Algæ belonging to Kützing's *Pilinia*, also belonging to the Chroolepideæ.

Influence of Position on the Morphological Development of some Siphonocladaceæ.†—Herr F. Noll has endeavoured to determine experimentally whether the great development and branching of the leaf-like portion of the single cell in *Bryopsis muscosa* and *Caulerpa prolifera* is due to heliotropism or to geotropism. By reversing the direction of growth, he found that it was invariably only on the illuminated side of cut leaves that any new development of "leaf" and "stem" took place, whether this illuminated side faced upwards or downwards, while the "roots" were formed only on the dark side, the differentiation being therefore independent of gravity. Herr Noll compares these phenomena to the behaviour of soft iron towards a magnet, regarding it as a kind of polarity. In the Siphonocladaceæ, with their continuous parietal layer of protoplasm, we have plants which, like soft iron, are readily modified by external factors which affect growth, and whose polarity can, therefore, be easily reversed.

Fungi.

Toxic Principles of Fungi.‡—M. G. Dupetit describes the separation and isolation of certain toxic principles from various fungi, and also the effect produced when administered to animals. The author in the first place gives a *resumé* of the toxic principles which are already known to exist in fungi. In *Amanita muscaria* there is a very poisonous alkaloid, muscarine; *A. phalloides* contains a tetanic alkaloid or a glucoside; and ergot of rye contains a very poisonous alkaloid, ergotine. The author then gives the results of an investigation of *Boletus edulis*, which contains a principle capable of causing death by hypodermic injection, but not if taken internally; the juice of the *Boletus*, however, loses its toxic properties under the influence of heat. The development of microbes in the juice of the *Boletus* does not in any way modify its toxic properties; the active principle was also proved to be a soluble poison. Contact with hydrogen or oxygen has no effect upon it, but it is destroyed by ozone. Various solvents were then tried, and the toxic principle was found to be insoluble in chloroform, ether, and alcohol.

The author then gives a method for the extraction of the toxic principle of *Boletus*, which he states possesses the principal characters of a soluble ferment, and for which he proposes the name *mycozymase*.

* Notarisia, iv. (1889) pp. 653–5.
† Arbeit. Bot. Inst. Würzburg, iii. (1888) pp. 466–76 (2 figs.).
‡ Mém. Soc. Sci. Phys. et Nat. Bordeaux, iii. (1887) pp. 185–215.

A search was then made for mycozymases in various edible and poisonous fungi:—*Agaricus campestris*, *A. rubescens*, *A. vaginatus*, *A. phalloides* and *A. cæsarius* contain a mycozymase similar to that of *Boletus;* these fungi (excluding *A. rubescens*), and also *Boletus edulis*, appear to be perfectly innocuous to frogs, while *A. rubescens* contains a substance which is extremely poisonous to these animals. The very poisonous fungi *A. muscarius*, *A. mappa*, and *A. pantherinus* do not appear more poisonous to frogs than do the edible fungi. *A. phalloides* has a marked action. The principle poisonous to frogs contained in *A. rubescens* is distinct from mycozymase; it is soluble in alcohol, and is probably an alkaloid or a glucoside.

New Cases of Mycorhiza.*—Herr A. Schicht finds this phenomenon much more widely distributed than is generally supposed. He has detected it in species belonging to the following natural orders:—Leguminosæ, Rosaceæ, Onagraceæ, Umbelliferæ, Geraniaceæ, Oxalideæ, Hypericaceæ, Violaceæ, Ranunculaceæ, Primulaceæ, Borragineæ, Labiatæ, Plantagineæ, Campanulaceæ, Rubiaceæ, Compositæ, Dipsacaceæ, Valerianaceæ, Smilaceæ, and Gramineæ; while in other species belonging to these or to other orders, the result was negative. He attributes the fact of its being frequently overlooked to the extreme fineness of the hyphæ, the diameter of which often does not exceed 0·04 mm.

Simple Mucedineæ.†—M. J. Costantin distinguishes between the simple and the compound Mucedineæ, including under the former all the Hyphomycetes except the Stilbieæ, Tubercularieæ, and Melanconieæ. The former are divided into fourteen groups, in three of which the spores or chaplets of spores are inserted on a special apparatus, and in nine directly on the filaments; while in one they grow in a chaplet at the extremity and in the interior of a filament which remains an open tube after their escape; in the last group, *Racodium*, *Mycorhiza*, &c., no spores are produced.

One of the fifteen groups is made up of genera usually regarded as nearly allied to the Mucorini, e. g. *Piptocephalis*, being, like them, parasites; they may be classed as a separate family, the Martensselleæ. In another group are placed genera which are parasitic on fungi, such as *Sepedonium*, *Asterophora*, *Mycogone*, *Ramularia*, and *Helminthosporium;* these are related to the Hymenomycetes through *Cephalosporium* and *Zygodesmus;* while *Mycogone* appears to have alliance with *Hypomyces* and *Melanospora;* and the species of *Ramularia* constitute, in their perfect state, Sphæriaceæ, belonging to the genera *Stigmatea* and *Sphærella*.

The general conclusion drawn by M. Costantin from his researches is that the Mucedineæ should not be considered as belonging exclusively to the Ascomycetes, but partly also to the Basidiomycetes; while others should be constituted into the distinct families Martensselleæ and Rhopalomycetes.

Biology of Chytridiaceæ.‡—M. P. A. Dangeard regards the Chytridiaceæ as never true saprophytes. Light appears to favour the

* Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 269–72.

† 'Matériaux pour l'hist. des Champignons,' ii., 8vo, Paris, 1888, 210 pp. See Bull. Soc. Bot. France, xxxvi. (1888), Rev. Bibl., p. 181.

‡ Mém. sur les Chytridinées, 1re sér., fasc. 2 (2 pls.) 1888. See Morot's Journ. de Bot., iii. (1889), Rev. Bibl., p. ii. Cf. this Journal, 1888, p. 783.

emission of the zoospores, which usually takes place at the close of a bright sunny day. It is only in the case of terrestrial species, such as some species of *Synchytrium*, that the emission is favoured by moisture. Temperature appears to have some influence on their development, but its effect is not general.

The author divides the family into two groups, one consisting of the genera destitute of mycele, the other having nutritive filaments, even if rudimentary. The members of the former group are necessarily parasites within the cells of the host; and it is again divided into two sections, according as the sporange is simple or compound. In the second group the position of both mycele and sporange in relation to the host vary; in some the sporange only is exposed; in others it is only the extremities of the mycele which penetrate the cells of the host; other species again are entirely endogenous.

Rosen's section *Dentigera* of *Chytridium* is referred by the author to the genus *Rhizidium*. The following new species are described:—Group I. Section 1, *Olpidium Sphæritæ;* Group I. Section 2, *Micromyces Zygonii;* Group II. *Chytridium Braunii*, *C. zoophthorum*, *C. Brebissonii*, *C. simplex*, *C. Elodeæ*, and *Rhizidium catenatum*.

Rhamphospora, a new genus of Ustilagineæ.*—Dr. D. D. Cunningham describes, under the name *Rhamphospora Nymphææ*, a fungus parasitic on the leaves of several species of *Nymphæa* in India. The spores are produced singly, near the sporiferous branches but not actually at their extremities, and are beaked when mature. The promycele consists of a long germinating tube, with terminal branches which bear the sporids at their apex. The sporids of one branch conjugate with those of another.

Fungi parasitic on the lower Animals and Plants.†—Herr W. Zopf describes in detail a number of fungi parasitic on nematode worms, desmids, diatoms, and other low organisms, animal and vegetable.

Arthrobotrys oligospora is a fungus carrying on at first a saprophytic existence on damp wood or soil, decaying fruit, excrements, &c. Its branches present the peculiarity of bending, so as to form loops in which species of *Anguillula* get captured, and are then rapidly attacked and destroyed by the mycele of the fungus. The author observes that the result of the attacks of the parasite is to set up a fatty degeneration in the organs of the animal attacked. In addition to the ordinary conids, *Arthrobotrys* produces resting-spores.

Another very minute fungus parasitic on species of *Anguillula* is *Harposporium Anguillulæ*, with respect to which Zopf confirms the observations of Lohde, rather than those of Sorokin. It produces crescent- or sickle-shaped conids borne on sterigmata, and resting-cells; but its systematic position cannot as yet be determined.

Chroococcus turgidus is subject to the attacks of a parasitic fungus belonging to the Rhizidiaceæ, to which Zopf gives the name *Rhizophyton agile;* while another species, *R. gibbosum*, attacks Desmidiaceæ (*Cylindrocystis*, *Euastrum*, *Penium*), Diatomaceæ (*Pinnularia*, *Navicula*), as well as the ova of Rotifers. A new genus of Rhizidiaceæ, *Septocarpus*, distinguished by the mode of germination of the zoospores, is formed

* Scient. Mem. by medical officers of the army of India, part iii., 1888, pp. 27–32.
† Nova Acta Acad. K. Leop.-Carol. Akad., lii. (1888) pp. 313–76 (7 pls.).

for another species parasitic on *Navicula*. *Rhizidium Braunii* is also parasitic on diatoms.

The author records the remarkable observation that some Mucorini, especially *Pilobolus crystallinus*, when attacked by *Pleotrachelus* and *Syncephalis*, exhibit a tendency to intermit the ordinary mode of reproduction by spores in favour of the much rarer production of zygosperms.

Observations follow on the decay of the root of *Stiftia chrysantha*, a labiatifloral Composite, caused by *Protomyces radicicolus;* and on a parasitic fungus which attacks decaying *Charas*, nearly allied to *Leptomitus*, which the author places in the genus *Apodachlya*, with the name *A. pyrifera*.

Plowright's British Uredineæ and Ustilagineæ.*—This excellent monograph contains a detailed morphological account of these two classes of Fungi, followed by a systematic description of all the British species, including an enumeration of their host-plants. It is illustrated by eight excellent plates.

Penicilliopsis, a new genus of Ascomycetes.†—Under the name *Penicilliopsis clavariæformis* Graf zu Solms-Laubach describes a fungus found on fallen fruits of *Diospyros macrophylla*, which is interesting as forming a connecting link between *Eurotium* and *Penicillium* on the one hand, and *Onygena* on the other hand, and showing that they all belong to the Tuberaceæ.

The thallus obtains its nutriment from the endosperm of the seed, and projects above the surface of the fruit in the form of club-shaped horns, of a sulphur colour, on which are formed the conids. It also produces small hard reddish-brown tubers which are sporocarps, very similar to those of *Penicillium*, but not going through a period of rest. They consist of a dense mass of interwoven hyphæ, which produce the asci within them only when they have attained nearly their full size; when ripe, the sporocarp consists of several chambers, not of only one, as in *Elaphomyces*. The terminal cells of branches of the ascogenous hyphæ develope directly into asci; the ascospores vary in number; no epiplasm could be detected. When they are mature the outer wall disappears, as in *Penicillium*. The ovate ascospores resemble those of *Eurotium* and *Penicillium*, and are sometimes covered with minute spines, like those of *Tuber ;* they appear, however, to be dimorphic.

The most important difference between *Penicilliopsis* and *Penicillium* lies in the mode of formation of the asci, which, in the latter genus, are connected together in long chains. No trace of sexual organs could be detected. The relation between *Penicilliopsis* and *Onygena* and *Terfezia* is also traced out.

The colouring-matter of *Penicilliopsis clavariæformis* has been examined by Herr J. Reinke,‡ and is found to be a substance allied to chlorophyll and phycoerythrin, crystallizing in red prisms; he proposes to call it *mycoporphyrin*.

Cyttaria.§—Dr. E. Fischer has made a critical examination of this genus of exotic Ascomycetous Fungi, the first species of which,

* 'Monograph of the British Uredineæ and Ustilagineæ, with an account of their Biology,' 8vo, London, 1889, vii. and 348 pp. and 8 pls.

† Ann. Jard. Bot. Buitenzorg, vi. (1887) pp. 53–72 (2 pls.).

‡ T. c., pp. 73–8 (1 pl.). § Bot. Ztg., xlvi. (1888) pp. 813–32, 842–6 (1 pl.).

C. Darwini, was found by Darwin in Terra-del-Fuego, where it grows abundantly on beech-trees, and forms the chief vegetable food of the natives. Other species are distributed through the southern temperate zone, and grow on beeches and other trees, causing extensive deformities.

Dr. Fischer has determined *Cyttaria* to belong to the Discomycetes; but the apotheces remain for a long period, sometimes even till mature, covered by a cortex. They are imbedded in large numbers in a common weft of hyphæ, which may be called a stroma. In the development of the fructification the nearest alliance appears to be with *Cenangium*, although it differs from that genus in the form of the spores. In the discrimination of the species one character relied on is the arrangement of the antherids (spermogones).

Eremothecium, a new genus of Ascomycetes.*—Prof. A. Borzì describes a new species and genus of Fungi, *Eremothecium Cymbalariæ*, found on unripe capsules of *Linaria Cymbalaria*, attacking the interior of the ovary, and forming a dense weft of hyphæ round the seeds. The following is the diagnosis of the genus, which the author regards as most nearly allied to *Gymnoascus* and *Eremascus*:—Mycelio arachnoideo-effuso albicante, hyphis tenerrimis hyalinis, laxe et irregulariter complicato-ramosis, remote septatis, ascis solitariis ad apices hypharum, lageniformibus, sessilibus aut basi breviter attenuatis, membrana lævi, ætate provecta deliquescente, sporis 30 aut plurimis in singulo asco, clavato-acicularibus, rectis vel sæpe curvulis, achrois, simplicibus.

Coniothyrium diplodella.†—In continuation of his researches on the life-history of this parasite, so destructive to the vine-crop in Italy and the south of France, Sig. P. Baccarini states that the fructifications are found, on the approach of winter, still immature on the bunches of grapes, and frequently destroyed by the cold or by the moulds which grow over them; and they can scarcely be efficacious in the propagation of the species. The parasite appears to attack exclusively the bunches of grapes, and not the vegetative organs, commencing with the rachis, and then extending to the berries. The branching of the thallus is in all normal cases monopodial. In the formation of the pycnids no fusion takes place of the contents of the generating hyphæ into a mass of granular hyphæ, nor the formation of a parenchymatous tissue from which are derived the conceptacles and stroma, as has been erroneously stated; the pycnids are, on the contrary, derived from the sporigenous apparatus, which is the result of the segmentation of one or more initial cells; the peridium and superincumbent stroma being formed by the interweaving and segmentation of a large number of finger-like processes proceeding from the neighbouring hyphæ.

Polymorphism of Pleospora herbarum.‡—Dr. O. Mattirolo finds that the ascophorous states of two distinct species of fungus are confused under this name, doubtless due to admixture of the spores in cultures. He identifies the two species as *P. Sarcinulæ* Gib. & Griff. and *P. Alternariæ* Gib. & Griff. The former is synonymous with *Sphæria herbarum*, the latter with *Pleospora infectoria* and *Sphæria infectoria*. The conidial form of the former is known as *Macrosporium Sarcinula*, that of the latter

* Nuov. Giorn. Bot. Ital., xx. (1888) pp. 452–6 (1 fig.).
† Malpighia, ii. (1888) pp. 325–37. ‡ T. c., pp. 357–78.

as *Alternaria tenuis* and *Sporidesmius Alternaria.* Pycnidial forms are known of both species; and of *P. Sarcinulæ* we are also acquainted with microconidial and sclerotoid forms.

Presence of a Sulphurous Oil in Penicillium glaucum.*—Herr B. Jönsson records the occurrence of a fungus-mycele in a bottle of normal 10 per cent. sulphuric acid, which culture proved to be *Penicillium glaucum.* In the cells of the hyphæ were a number of strongly refringent bodies varying greatly in size and form, sometimes completely filling up the cells, and consisting chiefly of sulphur. These bodies show a very strong resemblance to the globules of sulphur found in *Beggiatoa* and other "sulphur-bacteria," † agreeing with them in their general appearance, and in their solubility in carbon bisulphide and in other chemical reactions, but differing from them again in others which show that they do not consist of uncombined sulphur. In some respects they show more similarity to the sulphurous substance contained in the bulbs of *Allium* and the seeds of *Lepidium*, *Sinapis*, &c., and must probably be of the nature of a fatty oil containing sulphur. Substances of an oily or fatty nature are by no means uncommon in Fungi allied to *Penicillium*, especially when in the resting condition or in the sclerotes, and the substance under discussion must certainly be regarded as a reserve food-material.

Dissemination of the Spores in Rhytisma acerinum.‡—Dr. H. Klebahn describes the mode in which the spores of this fungus, parasitic on the maple, are disseminated. The ascospores are about 65 μ long, and only 1·6 μ thick, so that they present a very large surface in proportion to their mass. They are surrounded also by a gelatinous envelope, by means of which they become firmly attached to the leaves on which they fall.

Saccharomyces lactis.§—This new Torula, discovered by Dr. L. Adametz, is stated to be distinguished by the property it possesses of causing the fermentation of milk-sugar. The cells, which are elliptical or somewhat oval, are on the average 7 μ long and 5 μ broad. The buds, which are round, are 3 to 4 μ in diameter. Buds may form at either pole of a cell; sometimes two buds are produced at the same time. No ascospores were produced by cultivating on the gypsum block for twenty days at a temperature of 25° C. Account is given of the cultivation of this torula in pepton-gelatin, in wort-gelatin, in beer wort, and in milk. *S. lactis* causes fermentation of milk sooner or later, according to the temperature. At 40° the appearances of fermentation may be observed within twenty-four hours, at 38° in forty-eight hours, and at 25° C. in four days. No precipitation of paracasein occurs in the process, the milk-sugar only being decomposed.

Phosphorescence of Pleurotus olearius.‖—Prof. G. Arcangeli states that the phosphorescence of the olive-fungus, *Agaricus* (*Pleurotus*) *olearius*, is by no means confined to the hymenium, although this part manifests it most strongly, but is exhibited also by the stipe and the internal tissue, but not by the mature spores. It is displayed by day as

* SB. Bot. Verein Lund, Nov. 18, 1887. See Bot. Centralbl., xxxvii. (1889) pp. 201, 232, and 264.
† See this Journal, 1887, p. 1007. ‡ Hedwigia, xxvii. (1888) pp. 305–6.
§ Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 116–20.
‖ Atti R. Accad. Lincei (Rendic.), iv. (1888) pp. 365–9.

well as by night, but is not the result of previous insolation. The author regards it as due not to any parasite or other extraneous organism, but to a process of oxidation in the tissue itself, dependent either directly on respiration or on a secondary process intimately connected with respiration.

Hymenoconidium.*—Under the name *Hymenoconidium petasatum* Herr H. Zukal describes a remarkable hymenomycetous fungus, found on rotten olive-berries and leaves, in which the formation of the stipe is sometimes entirely suppressed, but the spores are still formed in the normal manner, the hymene being then sessile upon the substratum and remarkably resembling the aggregation of stylospores in the Uredineæ.

M. V. Fayod † believes the fungus thus described to be simply a young state of *Marasmius hygrometricus*.

Mycetozoa.

Tylogonus Agavæ. ‡—Under this name M. S. Miliakaris describes an organism endophytic in the leaves of an *Agave*. It is found in the form of a white plasmode in the palisade-tissue beneath the epiderm, which the author believes to belong to a Myxomycete. The threads of which the plasmode is formed are surrounded by a gelatinous envelope, and the author states that the spores are formed and multiply by division within the cells of the host.

Protophyta.

α. Schizophyceæ.

Scenedesmus.§—M. É. De Wildeman reviews the described species of this genus, which are very difficult to define, from the number of intermediate forms. The presence or absence of horns cannot be regarded as a specific character. One or two forms display a rose-tint in the cell-membrane, similar to that of some species of *Pediastrum*.

Mediterranean Diatoms.‖—M. Peragallo describes in detail the diatoms found by him in the bay of Villafranca on the coast of the Department of Alpes-Maritimes, obtained from the deep-sea, from the bottom by dredging, from algæ to which they adhere, and from the stomachs of fishes and other marine animals. The deep-sea species are characterized by the comparatively small development of the siliceous coat, and consequently by their susceptibility to be destroyed by acids.

In the division of the Diatomaceæ into the larger groups, the author holds it to be a mistake to depend too much on the characters to be drawn from the endochrome, as proposed by Petit. These characters can only be used with great caution in the case of marine diatoms, and not at all in fossil species. If also, as stated by M. Petit, the differences in the arrangement of the endochrome are always correlated with differences in the structure of the valves, this renders the former unnecessary. The author prefers a combination of the systems of classification of Petit and Pfitzer with those of H. L. Smith, Grunow, and Cleve, based

* Bot. Ztg., xlvii. (1889) pp. 61–5 (1 pl.). Cf. this Journal, *ante*, p. 99.
† T. c., pp. 158–9.
‡ 'Tylogonus Agavæ. Ein Beitr. z. Kennt. d. niedern endophytischen Pilze,' 4to, Athens, 1888, 14 pp. and 1 pl. See Bot. Centralbl., xxxvii. (1889) p. 84.
§ Bull. Soc. R. Bot. Belg., xxvii. (1888) part i., pp. 71–9 (1 pl.).
‖ Bull. Soc. Hist. Nat. Toulouse, xxii. (1888) pp. 13–100 (5 pls.)

on external characters. Characters derived from the siliceous valves are in fact the only ones which can be made use of in prepared specimens; those derived from the endochrome, the external sheath, or the stipe, being equally fugacious, while the specific characters run into one another in inextricable confusion. M. Peragallo regards the whole family of diatoms as consisting of five groups, which may be clustered round five types, viz.:—(1) *Navicula;* (2) *Synedra* or *Nitzschia;* (3) *Diatoma* or *Tabellaria;* (4) *Biddulphia;* (5) *Coscinodiscus* or *Melosira.* Of these the two first constitute, in general terms, the Placochromaceæ, the other three the Coccochromaceæ of Petit. Also in a general way the first corresponds to the Raphideæ of Smith, the second and third to the Pseudoraphideæ, the third and fourth to the Cryptoraphideæ.

A very large number of species are described, some of them new, arranged in the following sixty genera and twenty families:—

I. PLACOCHROMACEÆ. Fam. 1, Achnantheæ (*Raphoneis*, *Cocconeis*, *Achnanthes*); Fam. 2, Gomphonemeæ (*Roicosphenia*); Fam. 3, Cymbelleæ (*Amphora*, *Auricula* (?)); Fam. 4, Mastogloiaceæ (*Orthoneis*, *Mastogloia*); Fam. 5, Naviculeæ (*Navicula*, *Schizonema*, *Berkeleya*, *Toxonidea*, *Pleurosigma*, *Donkinia*); Fam. 6, Amphiproreæ (*Amphiprora*, *Plagiotropis*); Fam. 7, Nitzschieæ (*Trybbionella*, *Nitzschia*, *Bacillaria*, *Homœocladia*, *Hantzschia*); Fam. 8, Surirelleæ (*Surirella*, *Campylodiscus*); Fam. 9, Synedreæ (*Synedra*, *Thalassiothrix*).

II. COCCOCHROMACEÆ. Fam. 10, Fragilarieæ (*Cymatosira*, *Dimeregramma*, *Glyphodesmies*, *Plagiogramma*); Fam. 11, Meridieæ (*Asterionella*); Fam. 12, Licmophoreæ (*Podocystis*, *Licmophora*, *Climæosphenia* ; Fam. 13, Tabellarieæ (*Grammatophora*, *Rhabdonema*, *Striatella*, *Terpsinoë*); Fam. 14, Biddulphieæ (*Biddulphia*, *Triceratium*, *Dytilum*, *Lithodesmium*, *Hemiaulus*); Fam. 15, Eupodisceæ (*Cerataulus*, *Auliscus*, *Actinocyclus*, *Euodia*); Fam. 16, Actinoptycheæ (*Actinoptychus*); Fam. 17, Asterolampreæ (*Asterolampra*, *Asteromphalus*); Fam. 18, Coscinodisceæ (*Coscinodiscus*, *Cyclotella*, *Eudictya*, *Stephanopyxis*); Fam. 19, Melosireæ (*Melosira*, *Podosira*, *Hyalodiscus*, *Lauderia*); Fam. 20, Chætocereæ (*Rhizosolenia*, *Chætoceros*, *Bacteriastrum*).

Schmidt's Atlas der Diatomaceenkunde.—The most recently published parts of this magnificent work, Hefte 27–30, with plates 105–120, relate to the genera *Aulacodiscus*, *Auliscus*, *Eupodiscus*, *Glyphodiscus*, *Actinoptychus*, *Trinacria*, *Triceratium*, *Coscinodiscus*, *Cerataulus*, *Kittonia*, and *Biddulphia*. Many new species are described.

Bacillus muralis and Grotto-Schizophyceæ.*—Dr. A. Hansgirg returns to this subject, and confutes the view of Tomaschek that the organism known as *Bacillus muralis* must be a true Schizomycete, because it is altogether destitute of chlorophyll. He reaffirms his statement with regard to its genetic connection with *Aphanothece caldariorum*, and adduces other instances where the presence of a blue-green pigment is not constant in the Cyanophyceæ.

Dr. Hansgirg then enumerates the organisms found by him in dark caves in the limestone mountains of Austria and Bohemia. Among Cyanophyceæ he finds *Glœothece rupestris*, *Aphanothece caldariorum*, and *Lyngbya calcicola*, each presenting a varietal form of Protococcoideæ, *Protococcus glomeratus*, and a *Pleurococcus* nearly allied to *P. miniatus* were found.

* Bot. Centralbl., xxxvii. (1889) pp. 33–9. Cf. this Journal, 1888, p. 786.

β. Schizomycetes.

Nucleus or nucleoid bodies of Schizomycetes.*—Prof. M. Schottelius claims that he is able to show that by suitable illumination and in the stained or unstained condition there exists in bacilli a central nuclear rodlet, and in cocci a central spherical nucleus. Beyond this point he does not go; that is, he does not conclude that these bodies are nuclei in the sense that word is used in when speaking of the animal or vegetable cell, but limits his definition, and merely designs to express by it the central position of this piece of inspissated protoplasm. The bacterium is thus divisible into three zones, an outer homogeneous almost colourless sheath, next a greyish almost homogeneous zone, and finally in the centre a delicate dark streak which somewhat resembles the axis-cylinder in the sheath of a nerve-fibre. These three zones are observable in the living condition, best in gelatin-drop-cultivations, or in clear agar. The differentiation is still clearer in the stained condition; for this purpose aqueous gentian-violet solution is the most suitable, the next most effective stain being fuchsin. With these solutions cover-glass preparations are stained for 1/4–1/2 minute, and the bacillus is shown to be surrounded by an unstained homogeneous sheath. Next comes the stained contour of the protoplasm which is itself uncoloured; next, and lying centrally, is the dark, almost black nucleus-rod, having very often a finely granular appearance as if composed of an aggregation of minute granules. These appearances are, however, only to be obtained from preparations of fresh viable individuals; for when the bacillus dies its nucleus splits up into various pieces.

Micro-organisms of Mytilus edulis.†—Dr. A. Lustig has been attracted by the poisonous effects of eating mussels to an examination of its contained micro-organisms. He finds well-marked differences between specimens living in open sea-water and those found in stagnant canals; the former contain no microbes. The others have at least two, one of which has pathogenetic effects on certain Mammals, in which it appears to cause enteritis. The proof that it is this microbe which causes poisoning in Man can only be decided when the blood and vomit of patients have been examined with the view of seeing whether the microbe in question is there.

Spore-formation in Bacillus Anthracis.‡—Dr. A. M. Lëwin has investigated the question whether anthrax loses its spores after being kept for some time at a high temperature. He comes to the conclusion that anthrax vaccine contains no spores. He proceeded by taking strong cultivations of anthrax obtained from guinea-pigs just dead (36–48 hours after inoculation) and keeping them at 42°–43° C. for 14–20 days. The media were neutral bouillon and agar in test-tubes. Every day four test-tubes were taken out of the thermostat and examined. One bouillon and one agar tube were examined microscopically, and another pair were kept for two hours at a temperature of 62–64° C. in order to kill the bacilli. If spores were really present the cultivations would still be inoculable. Cover-glass preparations were then made and stained by the Ehrlich-Koch method. The supposed spores were red (fuchsin),

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 705-9. Cf. this Journal, 1887, p. 1007.
† Arch. Ital. Biol., x. (1888) pp. 393–400.
‡ Wratsch. 1887, pp. 703 and 739. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 398–9.

the bacilli blue (methylen-blue). It was found that the nitric acid must not be stronger than 1 : 10 or 1 : 15, as the methylen-blue had the power of expelling the fuchsin. All the same, bacilli with true spores were stained. From these two series of experiments it was shown that the hollow spaces were never stained, while the true spores in the central series were stained red on a blue ground. On the other hand the weakened cultures which had been exposed to the temperature of 62°–64° and contained spore-like spaces (microspores) were quite dead, and did not germinate on plates. In order to meet the objection that the bacilli might have accidentally lost their capability of forming spores, the author inoculated from the originals on gelatin and agar. In a few days active spore-formation took place at the temperature of the room.

Bacteria of the Tubercles of Papilionaceæ.*—The tubercles in the root of the Leguminosæ were first noticed two hundred years ago by Malpighi, who described them as galls. In the last twenty years these formations have been much discussed and various explanations offered as to their origin. Quite lately Prof. M. Ward showed that if *Vicia Faba* were grown in sterilized media these tubercles did not appear, and that they were probably caused by a fungus. This fungus was supposed by Prof. Ward to be one of the Ustilagineæ.

Herr M. W. Beyerinck has now gone a step farther and lays it down that a bacterium, *Bacillus radicicola*, is the cause of the tubercles; so that we are still very much where we were two hundred years ago.

Now the contents of the tubercles had from their appearance been described in 1885 as "bacteroids" by Brunchorst,† who conceived that they were autonomous formations of the vegetable protoplasm. The idea of the author (Beyerinck) is that these bacteroids, the existence of which is not disputed, originate from or are produced by immigration of the *B. radicicola* into the roots. To put it into other words, the bacteroids are metamorphosed bacteria which have lost the power of development, and now are virtually albumen corpuscles, though between the two conditions there exist many intermediate stages. Hence the tubercles are caused by the infection of the *B. radicicola*, and this is proved by the fact that they are not produced when the plants are cultivated in sterilized media. The bacillus forms in decoction of bean-stalks and gelatin largish colonies, of irregular size, whitish in colour, and hemispherical in shape. The colonies appear to consist of rods 4 μ long and 1 μ thick, and of small motile elements 0·9 μ long and 0·18 μ thick. These small elements are flagellated, and their motility depends on the presence of oxygen. Smaller colonies also are produced, and in these there seems to be a regular series of transition forms between the typical rodlet and the bacteroids.

B. radicicola failed to produce either diastase or invertin. The author gives numerous varieties of his bacillus, and divides the varieties into two groups with somewhat different characteristics.

Natural mode of infection of Vibrio Metschnikovi.‡—The disease of fowls, gastroenteritis cholerica, discovered by M. N. Gamaleïa to be caused by *Vibrio Metschnikovi*, agrees in many clinical and pathological aspects with the cholera of man—temperature, diarrhœa, cramp, acute

* Bot. Ztg., xlvi. (1888) pp. 725–35, 741–50, 757–71, 781–90, 797–802 (1 pl.). Cf. this Journal, 1887, p. 788.
† Cf. this Journal, 1886, p. 271.
‡ Ann. Instit. Pasteur, 1888, p. 552.

inflammation of the intestine with copious shedding of epithelium, small spleen, &c. Hence the mode of infection by *V. Metschnikovi* becomes interesting, as throwing light on the infection of cholera asiatica. With regard to the latter, one of the chief objections to the cholera-vibrio of Koch is that gastric juice soon and completely destroys it. Hence the ætiology of Asiatic cholera is far from being explained by the discovery of the comma bacillus.

With regard to this new cholera of fowls, it is found that it is not contagious, and that intramuscular and subcutaneous injections are quite useless to infect adult fowls. Hence this cannot be the natural mode of infection, nor was there any marked result from feeding the animals with infected food.

As the mortality from this disease amounts to 10 per cent., a more effective method was evidently required. This was found in lung infection; for when fowls and rabbits were infected by injecting them in the trachea or the lungs, they rapidly succumbed. The author is led to conclude that it is probable that the natural mode of infection is through the air-passages.

MICROSCOPY.

α. Instruments, Accessories, &c.*

(1) Stands.

Dick and Swift's Patent Petrological Microscope.†—Mr. A. Dick describes this Microscope (fig. 57) as follows:—

"Many years ago I requested Mr. Swift to make for me a first-rate Binocular Petrological Microscope. The centering of the stage by screws was, I suppose, as good as it could be made. I found it unsatisfactory when using high powers on small crystals. A centering nose-piece answered no better. Only by the simultaneous rotation of the polarizer and analyser by hand, little by little, could I keep the interference figures of small crystals in the field of view, or feel certain that the figures had not left it during rotation owing to the eccentricity of the centering. By small crystals I mean crystals under 1/1000 in. in diameter, and of such thickness as one finds them at the edges of petrological sections. Results obtained thereby were only slowly got, and always with some uncertainty. I tried the Nachet Microscope, but found it a cumbrous instrument. Latterly, I connected the polarizer and eye-piece analyser by a jointed rod, and got thereby excellent results, whilst I could still retain binocular vision for all but certain observations.

I suggested to Mr. Swift that he should manufacture a more perfect Student's Microscope than any now obtainable; one which would suit alike the mineralogical, petrological, botanical, or medical student. Having agreed upon the design of the instrument, I left to Mr. Swift the carrying out of the details, which he did in an ingenious manner and with excellent workmanship. When the Microscope was finished I went over it carefully, and handed it to several friends interested in such matters for suggestions, all of which have been carried out. You see the result in a small Microscope where there is little lumber and much capability of good work. Its interest to the Mineralogical Society lies in its adaptation to the study of the optical properties of minerals generally, and particularly to that of the thin plates of minerals seen in ordinary sections of rocks prepared for microscopical examination. For this purpose the analyser and polarizer are connected together by toothed wheels. They can thus be turned together in any position relatively to one another—crossed, parallel, or inclined—each nicol being so fitted that it can be set in any position. The wheels can be clamped in any position. The tube of the Microscope is of the ordinary construction. Within the lower part of it is a sliding tube which carries a sliding plate. In the plate are three circular openings, of which the central one is always open. In one of the other openings is fitted a Klein's plate; in the other a lens. The lens can be easily removed and another of different focus put in its place, according to the purpose for which it is to be used.

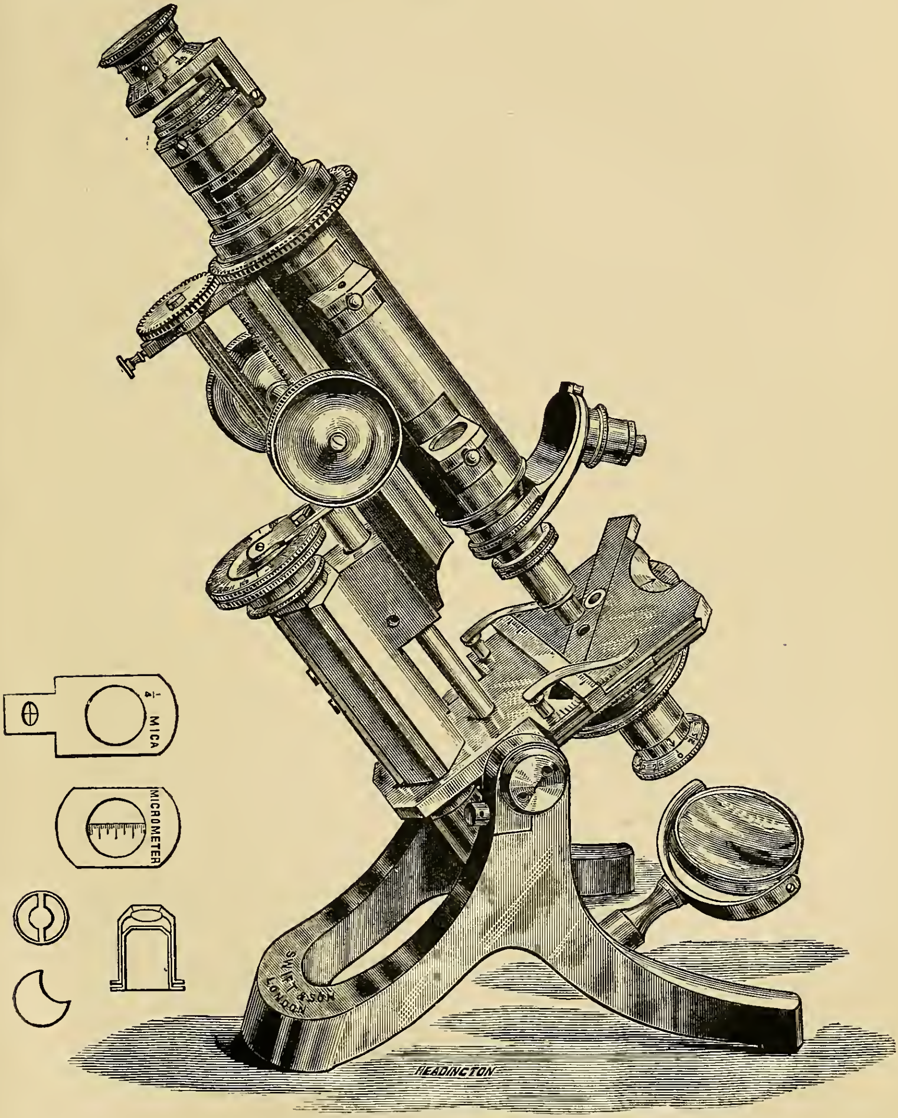
The lens of shorter focus brings interference figures into the eye-piece, where the *dispersion* may be studied, and also where the apparent angle in air of a biaxial crystal may be approximately measured, if the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Mineralogical Magazine, viii. (1889) pp. 160-3.

section is large enough to fill, or nearly fill, the field. For this and other purposes, a micrometer can be pushed into the eye-piece. In the instrument now described, with a B eye-piece, 50° of the scale between

Fig. 57.



the optic axes are equal to an apparent angle in air of $69\frac{1}{2}°$ for muscovite. Exact measurements must, of course, be made by means of a stage goniometer.

The lens of longer focus is intended for use without the eye-piece, to enable the observer to see the interference figures (generally only the axial shadows being visible) by looking down the tube, when a 1/10 or 1/12 in. objective is used on very small crystals, in convergent light, between crossed nicols.

There is a weaker lens for the same purpose fitting into the top of the tube, which can be used with a 1/4 or 1/6 in. objective by those who, like myself, cannot see the figures without some aid.

The eye-piece, when in use, turns with the polarizing apparatus. It contains the usual cross wires, and has an adjustment to enable an observer to focus the wires or the micrometer alluded to above. A quarter-undulation plate of mica or a wedge of mica or quartz can be pushed through the eye-piece at 45° to the direction of the cross wires.

When the eye-piece is not in use its place can be taken by a fitting which carries the analyser and the weakest lens alluded to above. The condenser of the instrument consists of a lens screwed upon the top of the polarizer, which slides up and down. The lens is suitable for all objectives up to the 1/2 in. For higher powers and interference figures a small hemispherical lens is fitted into the stage and can be pushed into the axis of the instrument when required. The upper surface grazes the lower side of the glass slip carrying the object. The focusing is done by raising or lowering the polarizer carrying the aforesaid lens. This arrangement is found to work admirably.

The rotation of the eye-piece and polarizing apparatus is measured on a circle graduated to degrees, but by using a pocket-lens a good reading to half a degree can be obtained, and a fair reading to a quarter of a degree, nearer than which extinctions or angles cannot be measured, even under the most favourable circumstances.

When the indicator is at zero on the graduated circle the cross wires are upright and horizontal as the observer looks into the instrument. If the polarizer is in its catch any suitable crystal with straight extinction will be at the maximum darkness when parallel to either cross wire. If Klein's plate be now pushed into the tube of the Microscope, and the analyser turned in its fitting till the crystal and the field are of one uniform warm blue tint, it will be found that the nicols are accurately parallel. The nicols can then be turned parallel to one another by the toothed wheels. This is almost the only use I have found for the Klein's plate. I wished to put it aside altogether from a student's instrument, but Mr. Swift informed me that a Microscope, to be used even occasionally for petrological investigations, cannot be sold without such a fitting, buyers requiring it though they do not appear to make any use of it. It must be regarded as part of the little lumber which it seems this instrument must possess.

If the mineral with straight extinction is not lying parallel to either cross wire, it will be found that when the wheels are turned the crystal will be extinguished when either of the wires becomes parallel with it. If the mineral has an oblique extinction a reading of the circle must be made when one or other wire is parallel to one of the edges or lines of the crystal, and another reading after continuing the rotation till the maximum extinction is attained. The rotation is then continued through 45°, and a mica- or quartz-wedge pushed through the slot in the eye-piece to ascertain the direction of the major or minor axis of elasticity and its inclination to the edge or line if desired.

It is with the use of convergent light for interference figures that the accuracy and simplicity of this instrument become apparent. No centering being required, it is evident that an interference figure once seen will remain in the centre of the field during the entire rotation. If it passes out of view it is on account of the nature of the figure. Even in the case of the smallest crystals, no doubt is ever left in the mind of the observer whether the figure may not have disappeared owing to imperfect centering.

I have placed on the table two typical sections. The one contains large and well-defined crystals of augite, olivine, and felspar, from the Lion Haunch, near Edinburgh. It will be seen that by pushing any crystal towards the centre of the field till the angle to be measured touches the intersection of the cross wire, a reading of the angle is obtained. Pushing the crystal into the centre of the field, and examining it by convergent light under a high power, it is easy to ascertain the direction of the line joining its optic axes if they can be seen in the section. This is noted, and one of the cross wires brought parallel to it. A reading of the circle is then made, and the rotation continued through 45°. The high power is then replaced by a lower power, and the strongly converging upper lens of the condenser is pushed out so that the mineral may be examined in less strongly convergent light for the purpose of ascertaining in what direction compensation is obtained when the mica or quartz wedge is thrust through the eye-piece parallel or at right angles to the optic axial plane, inclined 45° to the planes of the crossed nicols. By thus studying the emergence of a bisectrix it is seen whether it is positive or negative. The other section consists of a Scotch hornblende-schist. The greater part of the section consists of water-clear granules of quartz and felspar, containing amongst the mosaic a number of well-defined crystals of rutile, and an immense number of less well-defined crystals of some mineral showing very dark borders, due to the fact that its refractive index is much higher or much lower than that of the mosaic. All the grains, except the hornblende and some parts of the mosaic, are under the 1/1000 of an inch, piled upon one another, for the section is a rather thick one except at the edges. In this section are two small grains, one of which shows the emergence of one optic axis of a felspar, whilst the other shows the cross of quartz cut nearly perpendicular to its principal axis. Close to it lies one of the still smaller grains of the more or less highly refractive crystal. It lies flat, gives straight extinction, and shows the nearly perpendicular emergence of an optic axis. I think the mineral is epidote, but draw attention to it merely to show the ease with which interference figures can be studied. To a petrologist accustomed to a rotating stage and fixed cross wires, a familiar section looks strange when first looked at on a fixed stage with movable cross wires, but after a few hours' work with the instrument, the feeling of strangeness passes, and that of the solid advantage of a perfect centering alone remains.

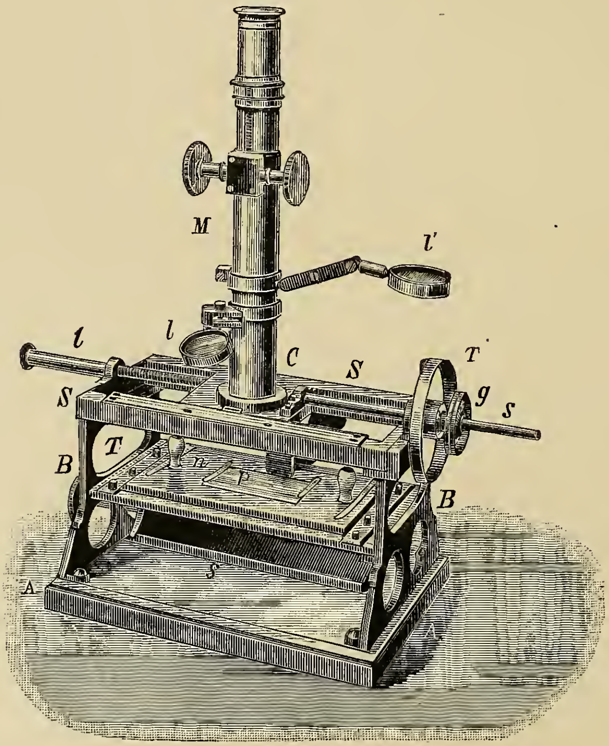
There is one fact which I should allude to in connection with the small interference figures seen on looking down the tube of the Microscope. It is, that the spot of light at the back of the objective in which the figures are seen rotates slightly when the wheels are turned. This is due to its being seen by the extraordinary ray. It may be regarded as a blemish, but is of no practical importance.

Beneath the stage is a universal fitting, whereby any substage arrangement may be applied for special studies. In this paper I have confined my description to those concerned in the application of the Microscope to mineralogy and petrology."

Konkoly's Microscope for observing the Lines in Photographed Spectra.*—Fig. 58 represents the apparatus devised by Dr. N. v. Konkoly on the type of Hilger's instrument for the same purpose.†

A A is a nickeled cast-iron base on which are mounted the two perforated supports B B; these are united by the two frames T and S, of which the former serves as object-stage, while the latter carries the Microscope M. The frame S carries the slide C between swallow-tail

Fig. 58.



guides, and upon C the Microscope is fixed by three tension- and three pressure-screws. *s* is the steel screw which moves the Microscope, and the nut which propels it is the nave of the drum T′, which is turned by the milled head *g*. The screw terminates in a sphere which is inclosed in a socket upon the slide C; the screw is prevented from turning in the socket by a pin, which does not, however, fit into a hole as is usually the case, but into a slightly elongated slit, so that the screw, with a

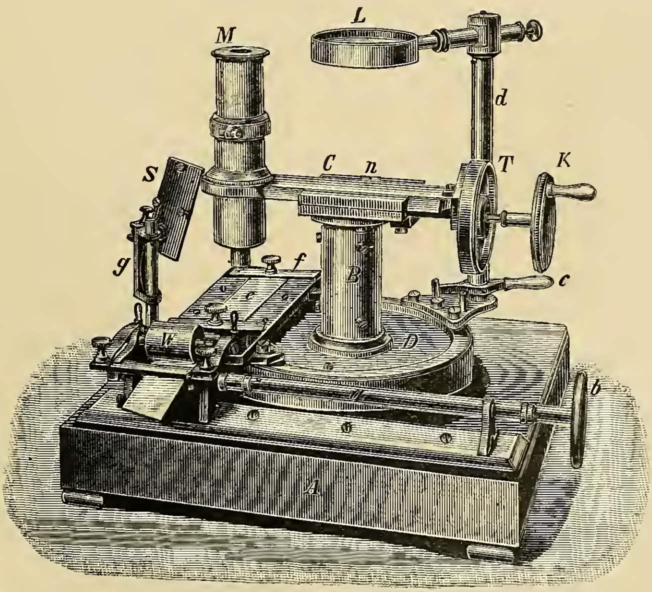
* Central-Ztg. f. Opt. u. Mech., viii. (1887) pp. 241–2 (1 fig.).
† See this Journal, 1887, p. 461.

little play, is able to follow the inequalities of the coarser parts of the apparatus (e. g. the guides S). Backlash is prevented by a spiral spring which is partly inclosed in the box *t*; this spring is made of greater length than usual, so that within the limits of its action there shall be no appreciable variation in the resistance ; the author considers that the large resistance exerted at the beginning of its action by the spring as usually made causes great wear and tear of the micrometer-screw and its bearings, while at the end the resistance is so weak that the drum tends to leave its abutment. In this instrument the drum is a fixture upon the frame S. The drum is divided into 100 parts; the divisions are read by the lens *l'*, and whole turns are registered upon a millimeter scale, which is read by the lens *l*.

The stage T carries a frame which is moved between swallow-tail guides by a fourfold screw of steep pitch (not shown in the figure) in a direction perpendicular to that of the slide C. Upon this frame the negative is placed, and is held by two clips. *p* is a special stage designed to carry the smaller sized negatives of siderospectrographs. By means of the sliding stage different spectra, which have been photographed upon the same plate, can be brought under the Microscope in succession ; the negatives are illuminated from below by an adjustable mirror.

Konkoly's Microscope for Reading the Knorre-Fuess Declinograph.*—Dr. N. v. Konkoly describes this as follows:—Screwed to a

Fig. 59.



mahogany base A is a massive brass disc D, on which is the column B; the latter consists of a tube 3 mm. in thickness, in which a rod is free to

* Central-Ztg. f. Opt. u. Mech., viii. (1887) pp. 217–8 (1 fig.).

turn, and is clamped after adjustment by means of six screws. On this rod is the guide of the sliding piece C, which carries on its left-hand side the Microscope M, having cross-wires in its eye-piece. The slider C and Microscope M are moved by a micrometer screw with drum T, which is divided into 100 parts. The drum is turned by a milled head, into which the ivory handle K is fitted for rapid movement. At *n* is a scale on C, which serves to read the whole turns of the drum. Under the Microscope is the carrier for the strip of paper. With Knorre's system the declination differences are recorded upon a paper ribbon, similar to that of the Morse telegraph, by means of a needle which moves with the micrometer, the zero point being marked by a fixed needle. The carrier consists of a brass plate having a groove which is of exactly the same breadth as the ribbon, and about 1·5 mm. deep, this depth corresponding to the thickness of the glass plate *e* which rests in the groove. This plate carries two brass plates, one of which is visible at *f*, and each of these has at one end a hole which fits over a pin in the carrier. The glass plate presses the ribbon to the bottom of the groove, so that the distance between it and the Microscope is always the same; the brass plates carry two knobs by which the glass plate is lifted. The ribbon passes between two rollers, the upper of which W is pressed by two springs against the lower, which is turned by the spindle *a* and milled head *b*. S is a mirror attached to a universal joint at the head of the column *g*, which serves to illuminate the ribbon. L is the reading lens held by the rod *d*, which can be turned in its socket on D by means of the handle *c*, and provided with two stops which bring it into position either over the scale *n* or the drum T.

Leitz's No. 1 Stand.—This is essentially a reproduction of the Zeiss form. Herr Leitz, however, was one of the first of the Continental makers to supply a rack movement and centering screws to the Abbe condenser.

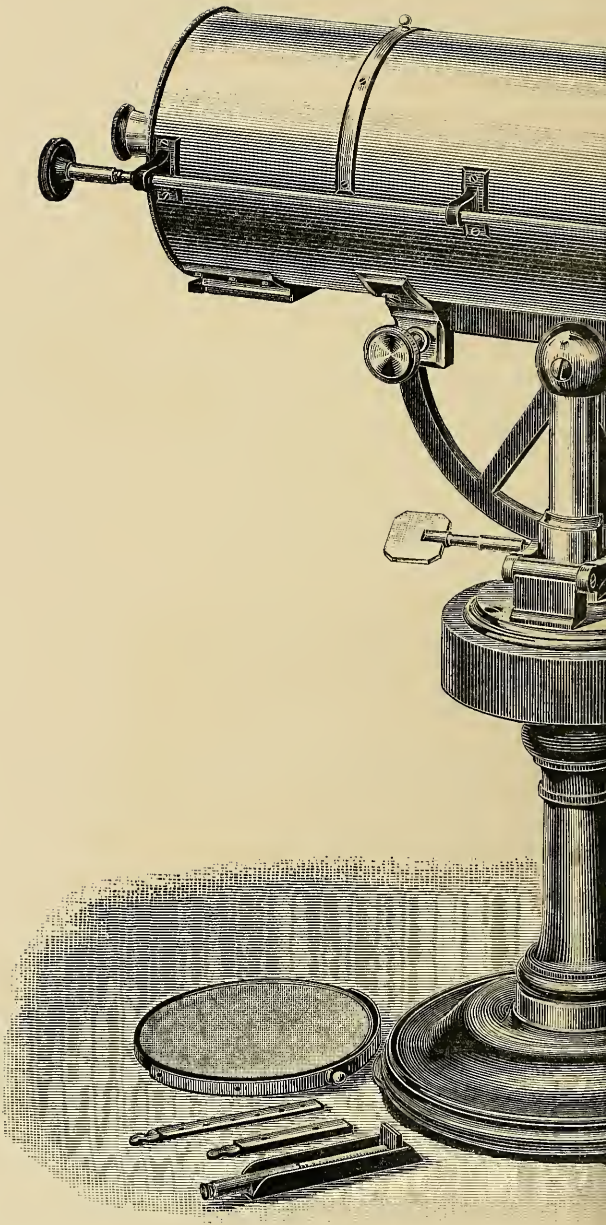
Adams's large Projection and Compound Microscope.—Plate IX. shows a Microscope of unusual design, bearing the inscription "Adams, inventor, London," which appears to have been intended to be used (1) as an ordinary compound Microscope, and (2) as a projection Microscope.

The body-tube is about 7 in. diameter and 24 in. in length, and is supported on an arc-piece toothed on the edge, in which engages an endless-screw for inclining the instrument more or less in the vertical plane. The base and pillar are of wood.

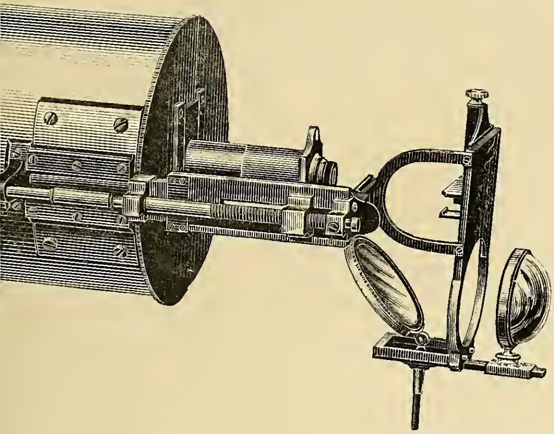
The focal adjustment is effected by an external screw and rod acting on the stage-support, after the manner of the usual focusing movement applied to reflecting telescopes of the Gregorian or Cassegrainian form.

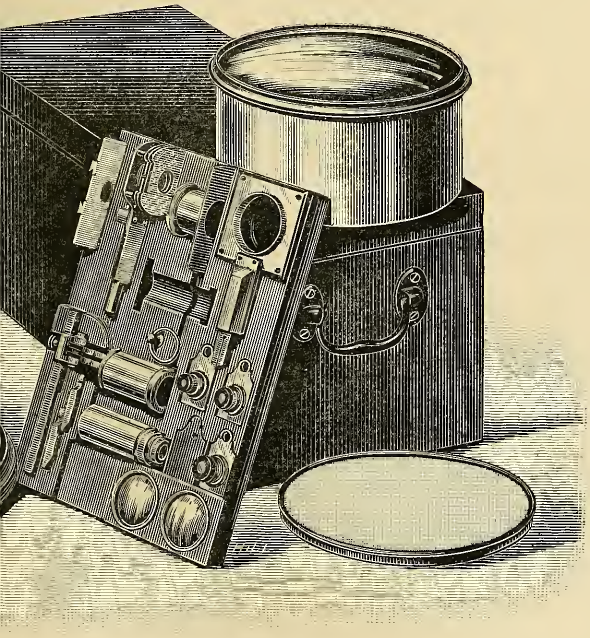
For viewing images on a screen the eye-piece was removed and a disc of ground-glass was inserted in a slot in the body-tube, and when more of the object was required to be seen in one view it is presumed that the ground-glass was removed from the slot and the large double-lens, shown on the box, was applied at the eye-piece end and the image projected through it upon a disc of ground-glass fitting on the end of the cylindrical mount of the double-lens.

The stage figured upon the instrument was for viewing opaque objects; the condenser in front collected the light upon the mirror, which was inclined suitably to reflect the rays upon the object.



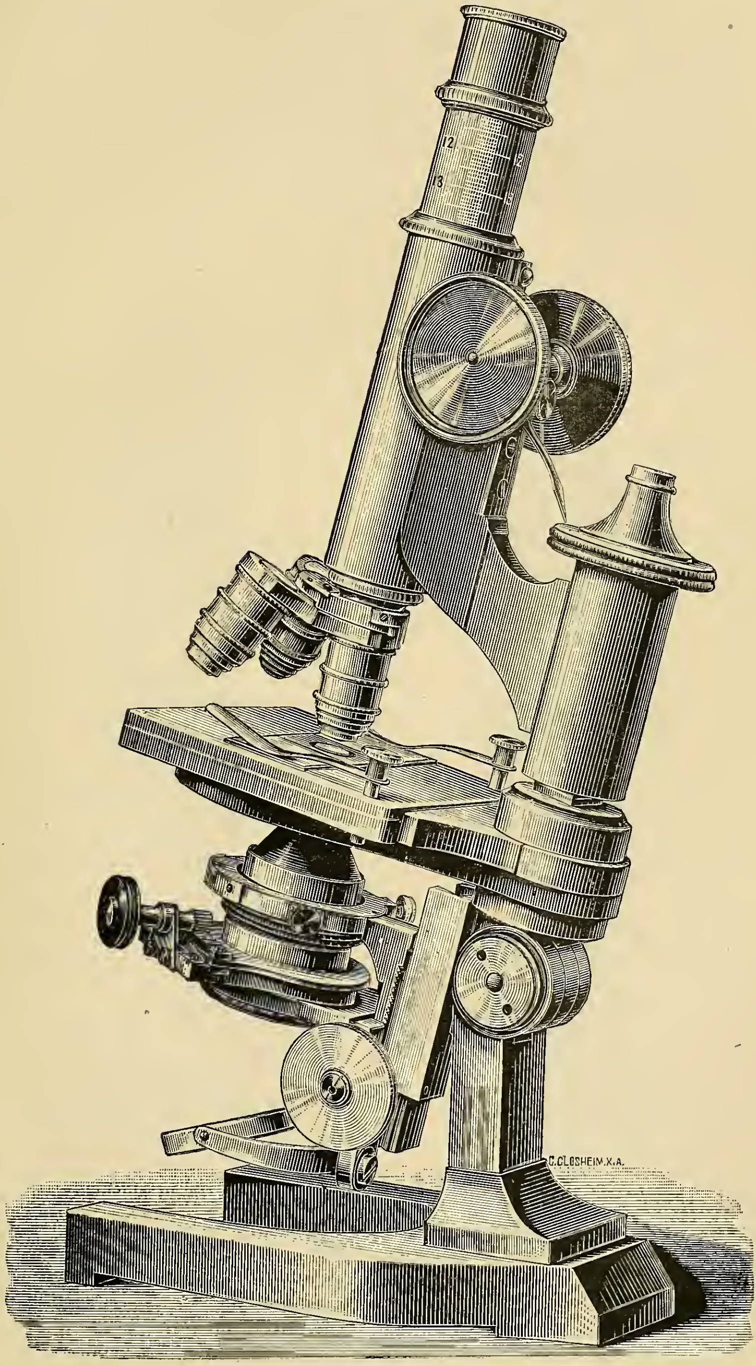
Adams's Large Projec





ompound Microscope.

Fig. 60.



Leitz's No. 1 Stand.

Two additional stages were employed for large or small transparent objects, various condensers being applied beneath. Fifteen simple-lens object-glasses formed the optical battery.

Charles I. Microscope.—At the recent Stuart Exhibition a Microscope exhibited was thus described in the catalogue :—" 389. *Microscope*, covered with gilt leather, which belonged to Charles I. Lent by Hon. A. Holland Hibbert."

By the courtesy of the owner we secured a photograph of the Microscope, whence our fig. 61 is engraved. The owner informs us that the

Fig. 61.

Fig. 62.

instrument descended to him "from an ancestor, Francis Rogers, for some time Keeper of the Wardrobe to Charles I."

As Charles I. died in 1647, the Microscope should represent a type of extremely early construction. In our opinion, however, though we have no difficulty in considering the instrument to date from the latter part of the seventeenth century, the type of construction is too modern for the pedigree assigned to it by the owner.

The construction of the eye-piece is peculiar: the field-lens is fixed on the top of the body-tube, and the eye-lens is in the outer tube sliding over the body-tube, so that the distance between the eye-lens and the field-lens can be varied.

We may remark that the first application of a field-lens to the eye-piece of a Microscope that we have hitherto found recorded is in

Fig. 63.

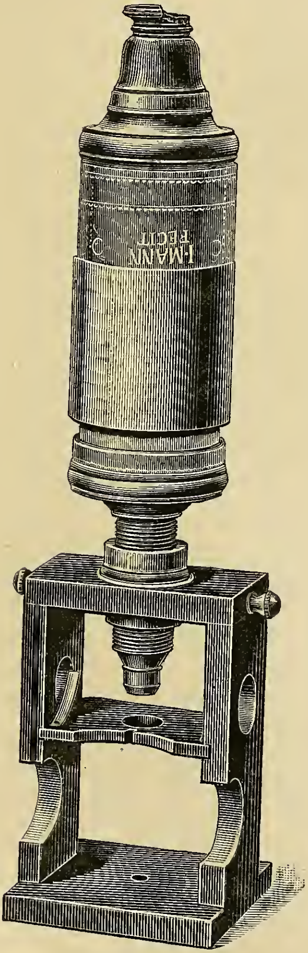


Fig 64.

Monconys' 'Voyages' (Lyon, 1665, 4to), where the editor (M. de Monconys' son) mentions that the first Microscope of this kind was devised by M. de Monconys about ten years previously, and was made at Augsburg.

Hooke appears to have first suggested the use of a very large field-lens, as described in his 'Micrographia' in 1665.

The system of eye-piece shown in the so-called Charles I. Microscope was (we believe) devised by Homberg, the well-known member of the *Académie des Sciences*, and the instrument was first figured in an Italian work (which we have repeatedly cited in this Journal) entitled 'Nvovi inventioni di tvbi ottici,' a communication to the *Accademia Fisico-matematica*, of Rome, in 1686, by Ciampini, the then editor of the *Giornale de' Letterati*. [We note in passing that Ciampini's authorship of the work in question is alluded to by Langenmantel in the *Miscell. curiosa*, 2nd Decade, 7th year, 1689, p. 444, and also in Bonanni's 'Micrographia curiosa' (Rome, 1691, 4to), p. 15.]

From the similarity to the figure of Homberg's Microscope, an instrument in the collection of M. A. Nachet has been identified, in which the peculiar construction of eye-piece above noted obtains. The identification of a number of other Microscopes of similar construction follows as a matter of reasonable probability, and we have thought the present a favourable occasion to notice a few of them (from Mr. Crisp's Collection).

Fig. 62 shows a "Homberg" Microscope acquired in Groningen, Holland, which differs from the "Charles I." instrument (1) in being covered with gilt parchment instead of leather, (2) in having a "set-nut" or clamping screw-ring to correct the tendency of the body-tube to shake in the thin screw-socket in which the focusing screw acts.

Fig. 63 shows a similar Microscope, formerly belonging to George III., but with a (probably) modern base-support, in which a mirror was fixed.

Fig. 64 shows a "Homberg" Microscope, formerly belonging to Pope Benedict XIV., having a small disc object-stage with a slight range of motion in the opening of the base, with a clamp-screw beneath. This instrument shows that the viewing of opaque objects was principally intended.

"Duc de Chaulnes'" Microscope.—We gave on p. 118 a figure of one of these instruments, which we examined in the *Museo di Fisica*, Florence, the specialty of which was evidently the verification of micrometric measurements.

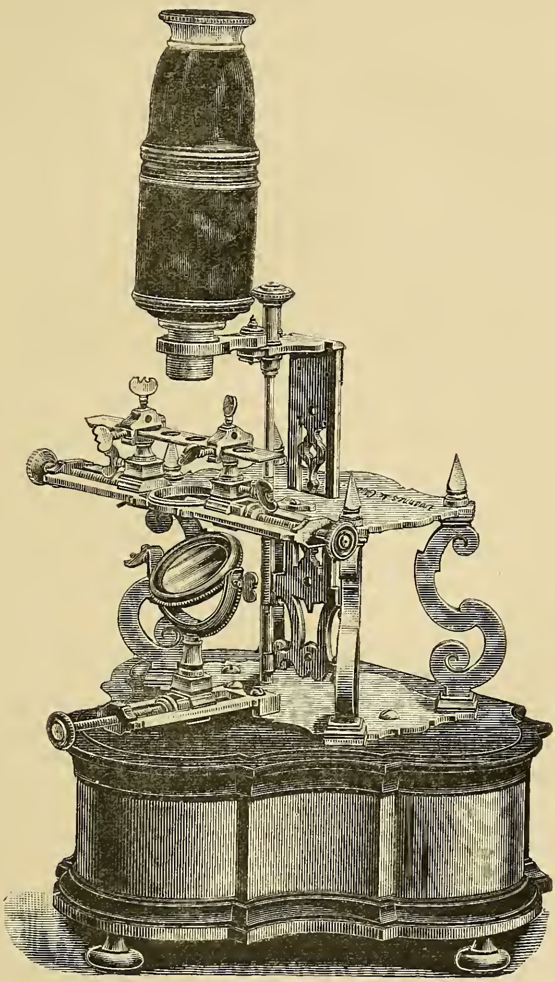
We here give a figure of a Microscope (fig. 65) we obtained in Naples, which is remarkable (1) for its ornate character, and (2) for its general resemblance to the Duc de Chaulnes' Microscope, though the aim of the construction probably differed considerably.

It bears the inscription, "D. Joannes de Guevave F. 1752," at which date even the best Microscopes were seldom provided with any form of mechanical stage. This instrument, however, has object-carriers, consisting of two short pillars travelling laterally, actuated by screws in grooves right and left of the stage; the upper ends of the pillars are pierced to allow the slide to be adjusted and clamped. The body-tube pivots laterally, so that, in combination with the stage movements, every portion of the object can be viewed successively. The mirror is also mounted on a short pillar moving forward or backward in a groove actuated by a screw in front.

In the general construction, stability seems to have been a very secondary consideration, whilst the ornamentation was elaborated with special attention. The body-tube is of tortoise-shell and ivory, and the shaped box base is of inlaid wood.

The peculiarity of the stage having four scroll supports, as in the Duc de Chaulnes' instrument, suggests the influence of one design upon

Fig. 65.



the other, and we have therefore ventured to classify the Microscope under this heading.

Müller, K.—**Die Verwendbarkeit des His'schen Embryographen.** (The utility of the His Embryograph.) *Naturwiss. Wochenschr.*, II. (1888) No. 22.

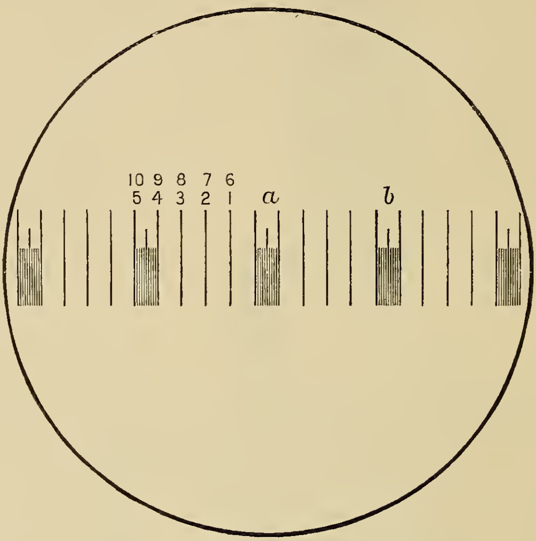
(3) Illuminating and other Apparatus.

Rogers' Eye-piece Micrometer.*—Dr. R. H. Ward describes a form of eye-piece micrometer devised by Prof. W. E. Rogers.

* 'Remarks at the Microscopical Section of the Troy Scientific Association,' 1889, February 4th.

"The whole scale (fig. 66) is divided to 1/100ths in., leaving the field nearly unobstructed and free from the confusion effect of crowded lines; and these wide divisions may be used (taking advantage of the middle lines in the subdivided spaces as a means of reading halves)

Fig. 66.



with low powers where close work is not required. But every fifth space is subdivided into ten, or 1/1000ths in., and by using these divisions for decimals, or these for units and the broad spaces for tens, one may gain the precision of the finer scale with almost the facility of the coarser. With a 1/10 in. objective the coarse spaces may be made, with a moderate use of the draw-tube, to cover 1/10000 in., and to read, with the assistance of one of the fine bands for tenths, 1/100000 in. A slight change of tube-length will give with equal facility a reading by 1/4ths of a micron (μ), or even 1/5 μ for easier relations to decimal notation.

Thus an average human blood-disc may reach from the line marked 2 in the cut to about the 9th line in the fine band *a*, giving two tens and nine units (29) by direct reading in 1/100000 in. Likewise a disc of dog's blood may reach from line 2 to the 7th line of *a*, of beef's blood from 2 to the 3rd line of *a*; or of sheep's blood from 1 to the 9th of *a*; reading respectively 27, 23, and 19 one-hundred-thousandth of an inch. Thus it would be easy to distinguish between all these except the first two, and possible in that case, if we were certain as to the true averages, and sure, which is more than doubtful, that the averages themselves may not vary enough to obliterate the narrow margin between them.

Any one who can subdivide the smallest spaces to tenths, with the eye, can of course read in millionths of an inch, or in fortieths μ; but few persons are likely to go, at any advantage, beyond the record of the finest lines. These appear wide enough apart to estimate in fourths or fifths. But this becomes difficult if not futile on account of diffraction, imperfect definition, inequality in the illumination of the scale and of the object, parallax from tremor in both apparatus and observer, and error in making optical contact between the margin of the object and the line from which measurement is to begin; elements which bring a large personal equation into the case, as they vary greatly according to the capacity of individual workers and the quality of their outfit.

The above is intended to show what can be done by a skilful person with good but commonplace apparatus. The ruling may cost perhaps a couple of dollars, and a high-power ocular to carry it, about twice as much. The objective required for the work is not of unusual power or quality; and any small, plain Microscope of fair quality and good fine-adjustment, can be employed, a lengthening tube being improvised if there be no draw-tube. A screw-movement to adjust the lines in the ocular to the image of the object, or else a mechanical stage for adjusting the object to them, will be of great assistance; but as the latter, of efficient character and applicable to the most unpretending stands, can now be made for 18 dollars, it is not a very unreasonable luxury."

Glass versus Metal Micrometers.*—Prof. M. D. Ewell writes:—"I think most persons who use stage micrometers in the ordinary way, prefer to have them covered, on account of there being less danger of injury and their always being ready for use. When my experience was less than it is now, I remember attempting to clean a really excellent micrometer by Prof. Rogers, 1 cm. long, ruled the whole length to 0·001 mm. I found out that it was uncovered *after* I had scoured the lines vigorously. It was *then clean*, but that was its only remaining recommendation.

Prof. Rogers has experimented much to avoid the sweating that so often obscures the lines when the cover-glass is secured in place by any kind of cement. The most successful method, I think, has been to rule the scale on a cover-glass and mount it with the lines downward, upon a thick ring perforated, so as to allow a free circulation of air. This, again, has its peculiar disadvantages, as I have learned *after* the point of my objective (a 1/25 Spencer) had gone through the cover. The lesson was more impressive after I had paid Mr. Spencer's bill for re-centering the front lens. Micrometers so mounted are very fragile, unless the cover-glass is too thick for ordinary use. In a later communication I shall describe a device of my own to prevent the sweating above alluded to.

Another disadvantage of micrometers ruled on glass is the fact that there is always more or less uncertainty as to their staying qualities for some time after they have been ruled. This, so far as I have observed, is peculiar to all lines ruled on glass; for I have observed them not only in scales ruled by myself, but on those by Prof. Rogers and Mr. Fasoldt. I do not say that this is universal, but it happens often enough to make the possessor sad. The makers are not be blamed for this; for it seems due to an infirmity of the material. The only remedy is to let scales on glass season for an indefinite time, like thermometers, before issuing them.

My own judgment is that the very best scales are ruled upon metal.

* The Microscope, ix. (1889) pp. 43–5.

These can be depended upon. I have never seen one deteriorate by simple lapse of time. But these have their disadvantages. They cannot be used with transmitted light, as can scales ruled on glass. Still this difficulty is not insurmountable. I use up to 400 diameters the opaque illuminating objectives made by Bausch and Lomb, which give excellent results. With higher powers, up to 1/18, I have used with satisfaction Prof. Smith's vertical illuminator, with a bull's-eye condenser to concentrate the light. With a very high power, a 1/18 Zeiss', draw-tube drawn out full length, amplifier and high eye-piecing, I have never yet, on my standard centimeter on speculum metal by Prof. Rogers, been able to see anything but clear sharp edges to the lines, saving now and then a little pit in the metal. Of course, I understand that no *practical* use can be made of so high a power. I refer to its use simply to show the character of the lines. Any one who has used a glass micrometer with *very* high powers will agree with me in saying that in this respect they are vastly inferior to those on speculum metal.

In order not to change the tube-length, when measuring miscellaneous objects, such as blood-corpuscles, &c., I had Mr. Bulloch make for me an adapter or nose-piece of the same length as my Smith's illuminator, also made by him, which I screw on to the front of the tube, in place of the illuminator, when I desire to measure transparent objects. This sort of combination is, in my judgment, the very best that can be used. Metal micrometers have the disadvantage, however, of costing more than scales on glass; for such a scale should be ruled on a carefully prepared surface, which of course adds to the expense.

Now as to covering micrometers, in consideration of the disadvantages incident to covered scales, I would recommend the use of a scale uncovered. If desired for use with a homogeneous-immersion objective, it can be used with a large temporary cover, which can be held down with a mere dot of mucilage or water, not enough to reach the lines. It should not be rubbed, but may be kept sufficiently clean with a camel's hair pencil. I say *sufficiently* clean, of malice prepense; I now think that no one but an amateur with very little experience, will be annoyed by a little dust on a standard when used with a dry objective. If it becomes too thick, it can be removed with a camel's hair pencil. If used with an immersion objective, of course the top of the temporary cover should be clean. I find a little dust a real convenience, as facilitating the finding and focusing of the lines. A really fastidious person should use "Centimeter A" for a time. Its surface, the last time I saw it, was in places seamed and furrowed, like the track of a glacier. But enough of it is perfect for any sort of use, and its lines cannot well be excelled. Its correction for total length is very small, and its second mm. has practically no error.

Of course a micrometer in its ultimate subdivisions, such as are usually used in determining the value to be assigned to one division of the eye-piece micrometer, should have an error so small as to be practically insensible, or its error should be well determined. I have never yet seen, nor do I ever expect to see, a scale in *every* part absolutely free from error. I undertake to say that such a scale cannot be made by any living man, but the absolute and relative errors of a scale can be determined within very narrow limits, and a scale can be made, the errors of whose ultimate subdivisions are practically insensible. Such a micrometer is practically perfect. In a future communication, should the subject be thought of sufficient importance and interest, I will describe the process by which any good observer, who is the owner of a filar micrometer, and who knows the correction for total length of his micrometer, and last but not least, who has sufficient patience, can determine the errors of any subdivisions small enough to be brought within the field of his Microscope."

Micrometer Measurements.*—Dr. M. D. Ewell, referring to his advocacy of the use of metal micrometers *uncovered*, recommends that if such a temporary cover should be used, it should always be used under precisely the same conditions, and the observer should be quite sure that both faces of such cover are parallel, otherwise the influence of refraction, the cover acting as a prism at some part of its surface, might introduce errors of unknown magnitude. For this reason, on further reflection, he thinks it better to have a permanent cover on micrometers intended for use with high power objectives, and to have the corrections of such micrometer determined with such cover *in situ*.

This leads him to notice a table of measurements published by Mr. C. Fasoldt.† intended to invalidate the result of the investigation of Centimetre Scale "A" of the American Society of Microscopists, and its so-called copies, by the different observers who have investigated them. As to this Dr. Ewell says:—"Mr. Fasoldt does not in his published paper give sufficient data to enable one intelligently to criticize or judge of the accuracy of his work; but there is one element of uncertainty about it that seems quite patent, viz. that it does not appear that the glass disc upon which the lines were ruled had either surface plane, or that the two surfaces of the disc were parallel. If nothing else appeared, to my mind the fact that the space was measured with different sorts of illumination, and with the lines first downward and then upward, thus introducing *unknown errors* due to the causes above specified, would deprive the results of any value they might otherwise possess. There is no means of intercomparison and of eliminating these unknown errors.

I cannot ascertain, however, from the paper, with what standard the 4/10 in. was compared, or exactly how it was compared. If, as I suppose, it was compared with the screw of a screw stage-micrometer, which was assumed to be a constant, I must beg to dissent from any conclusion thus obtained. I find it necessary, in ruling standards of any considerable length, to assume a value for the screw, rule a trial scale, and by actual comparison with some *authentic* standard deduce therefrom a series of corrections before ruling the final scale. If great accuracy is desired, it may be necessary to repeat this several times before ruling the final scale; and this is the case notwithstanding the errors of the screw have previously been carefully investigated. I would never trust any screw or train of wheels as a final *standard* of reference for more than about one-half the field of the Microscope, much less for so long a space as 4/10 in."

Klaatsch's Radial Micrometer.‡—The radial micrometer of Dr. H. Klaatsch consists of an eye-piece micrometer-disc, not only subdivided along the usual straight line, but traversed by two diameter lines cutting each other at right angles, and both of which are subdivided. In two

* The Microscope, ix. (1889) pp. 74-6.
† See this Journal, 1888, p. 814.
‡ Anat. Anzeig., ii. (1887) pp. 632-4.

out of the four radii thus produced the divisions are interrupted for a distance of 10 division lines from the centre. The image is thereby rendered clearer in the centre. Besides these divided radii there are four undivided ones, each of which bisects a quadrant. One octant also is subdivided by radii into 10°, 15°, and 20°. To this division of the micrometer-plate corresponds a lithographic chart, which is used in the preparation of the drawing to be made. While the apparatus enables an object to be measured in various directions, by the aid of the paper

Fig. 67.

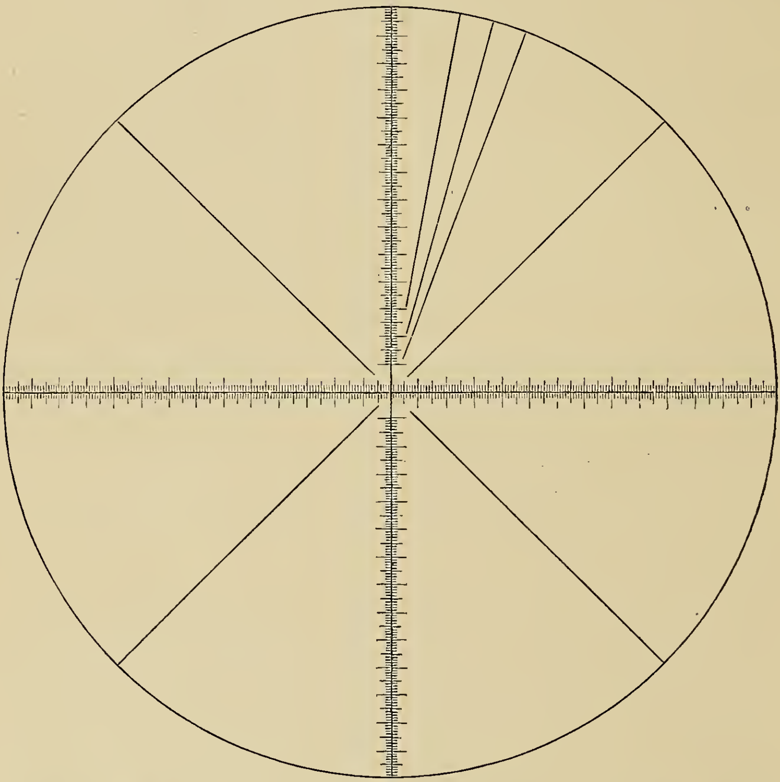


chart it allows the sketch of an accurate drawing to be made. When once from the first position five points (at the centre and on the four radii) are accurately determined, the ocular is turned, so that the undivided radii pass through the points of the preparation through which the divided radii previously passed. Thus four more points are obtained, and if these should not suffice for the sketch the radii of the octant can be made use of to obtain fresh points. In a similar way angles can be measured.

Krysinski's Eye-piece Micrometer and its uses in Microscopical Crystallography.*—The method proposed by Wertheim in 1862 for

* Zeitschr. f. Krystallogr., xiv. (1888) p. 17.

measuring the dihedral angle of microscopical crystals depends on the principle that the angle of inclination of two planes can be easily calculated when the positions have been determined of six points in space, of which three (not collinear) lie in one of these planes. For the measurement of the rectangular co-ordinates of these points, Wertheim used (1) an eye-piece with cross wires; (2) a fine division on the head of the micrometer screw of the Microscope; and (3) an object-stage movable by screws in two directions at right angles.

Dr. S. Krysinski considers that the practical application of this method can lead to no accurate measurements. In the first place the x and y co ordinates cannot be exactly determined, since they are measured by turning the screws on the movable stage, by which no precision can be obtained. The addition of stage micrometer screws would render the instrument too costly and complicated. To avoid this difficulty he proposes to use the screws only for producing the movement, and to effect the measurements by means of the eye-piece. For this purpose the eye-piece micrometer of Hartnack has been modified in the following way.

On the eye-piece fitting, about 12 mm. from the lower end, is a metal drum, 55 mm. in diameter and 10 mm. in height, which consists of two cylinders rotating in one another, of which the under is rigidly connected with the lower end of the eye-piece, while the upper, connected with the upper part of the eye-piece, is movable on the under part. In this under part are fixed the cross wires, and in the upper, just above the cross wires, the micrometer scale. This scale, movable to and fro in a guide by means of a projecting screw, consists of a right-angled triangle, of which one of the sides containing the right angle is exactly ten times as long as the other, and is divided into 100 equal divisions, with each division mark perpendicular to it, and equal in length to the shorter side. It follows from this construction that the segment of the division line cut off between the hypothenuse and the long side is equal to a tenth part of the corresponding segment of the long side. By means of two indices on both parts of the drum and catch-spring, care is taken that the long side of the scale can be brought at once into a position parallel or at right angles to one of the cross wires. Lastly, on the periphery of the drum is a corresponding vernier.

If the size of the microscopical object to be measured does not exceed the value of ten divisions, the measurement is effected by first bringing the long side of the scale into exact coincidence with an edge of the object, and then by means of the screw parallel to the long side pushing the scale along until its hypothenuse cuts the object in the diametrically opposite point. The division mark of the scale passing through this point of contact then gives directly the length of the object. This kind of measurement, which the author distinguishes as "Einkeilung," is executed on any given point of the field of view. When, however, the diameter of the object exceeds the length of ten divisions the long side must be brought into coincidence with it, and the length read off directly. On account of the unreliability of the table supplied by opticians, the author strongly insists that a table of values of the scale divisions should be independently made out for each objective.

The author then describes in what way with this instrument the x and y co-ordinates of a point in space can be easily and simply determined, and then the z co-ordinate by means of the micrometer-screw of the Microscope. The directly found value of the z co-ordinates is the true one, only when object and objective are in the same medium; in any other case the directly found value must be multiplied by the ratio of the refractive indices of the media. The co-ordinates of the six points and the angle required are connected in the most general case by the following equations:—

$$a = y_2 z_3 - y_3 z_2 + y_3 z_1 - y_1 z_3 + y_1 z_2 - y_2 z_1;$$
$$b = x_3 z_2 - x_2 z_3 + x_1 z_3 - x_3 z_1 + x_2 z_1 - x_1 z_2;$$
$$c = x_2 y_3 - x_3 y_2 + x_3 y_1 - x_1 y_3 + x_1 y_2 - x_2 y_1;$$
$$a_1 = y_5 z_6 - y_6 z_5 + y_6 z_4 - y_4 z_6 + y_4 z_5 - y_5 z_4;$$
$$b_1 = x_6 z_5 - x_5 z_6 + x_4 z_6 - x_6 z_4 + x_5 z_4 - x_4 z_5;$$
$$c_1 = x_5 y_6 - x_6 y_5 + x_6 y_4 - x_4 y_6 + x_4 y_5 - x_5 y_4;$$

and

$$\cos \lambda = \frac{a a_1 + b b_1 + c c_1}{\sqrt{a^2+b^2+c^2} \sqrt{a_1^2+b_1^2+c_1^2}}.$$

In conclusion it is pointed out that the instrument described above is very convenient for measuring plane angles. This is simply effected by successively bringing the long side of the scale into coincidence with the two arms of the angle: the difference of the vernier readings in the two cases gives the value of the angle required correct to three minutes.

ENGELMANN, T. W.—**Over electrische verlichting by het Mikroskoop, met demonstraties.** (On electric illumination with the Microscope, with demonstrations.) *Handelingen v. h. I. Nederl. Natuur- en Geneeskund. Congres te Amsterdam.* Op. 30, IX. en 1. X. 1887, p. 129, Haarlem, 1888.

"**Loiterer in a Microscopist's Laboratory.**"—**Notes on the Substage Condenser,** with special reference to that of Prof. Abbe. *Amer. Mon. Micr. Journ.*, X. (1889) pp. 55–60 (1 fig.).

"**Struggling Microscopist.**"—The most useful Condenser for modern objectives. *Engl. Mech.*, XLIX. (1889) p. 196 (1 fig.).

(4) Photomicrography.

Moeller's Photomicrographic Apparatus.* — Dr. H. Moeller's camera (fig. 68) is similar to the one suggested by Harting, without bellows, and with which the eye-piece is used. It differs from it, however, in being fixed directly to the Microscope without any stand of its own. As the stand and fine-adjustment have thus to support the weight of the camera, the latter must be made as light as possible. To this end it consists of a four-sided wooden frame, of the shape shown in the fig., covered with light-proof dark cloth. At the lower end is a socket which slides over the eye-piece, and carries in its upper part a diaphragm disc which rests closely on the upper surface of the eye-piece, forming thus the point of support for the camera and a light-proof connection. For the sake of lightness the plate-holder is made of pasteboard with two easily moving shutters. The height of the camera is 21 cm., and its weight about 445 grm., which is so slight as to have no injurious effect on the micrometer screw.

On the subject of making use of the Microscope stand as a support for the camera, the author mentions that this was the case with the older apparatus of Gerlach, in which the weight was so great that a special

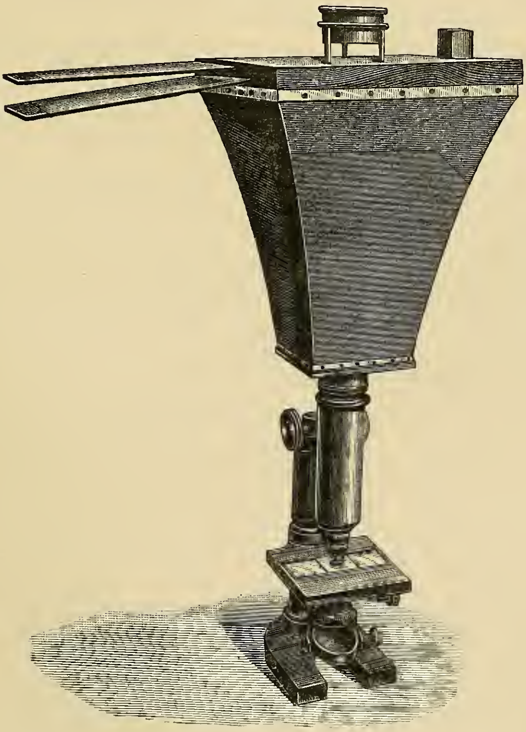
* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 155–65 (1 fig.).

catch had to be added in order to prevent the sinking of the tube. For this reason a separate stand was soon employed, which had, however, the effect of introducing objectionable complications, viz. a difficulty in adjusting the light-proof connection between Microscope and camera, and in avoiding shakings which affected unequally the two parts of the apparatus. The author considers that to the latter cause is to be ascribed a very large proportion of the failures in photomicrography, and from this his apparatus is free.

As the source of illumination, the author employs almost exclusively the Welsbach incandescent gaslight. The lamp is placed as near as possible (20–25 cm. in front of the mirror), and always without the interposition of lenses, so that the object is illuminated by transmitted light. The objection made by Neuhauss to the use of transmitted light, that shadows and coloured margins were produced, was not borne out by the author's observations.

Another source of error, however, viz. the difference between the visual and chemical foci, must in all circumstances be taken into account. This difference varies considerably for lenses of different construction:

Fig 68.



in immersion lenses it is so small as to be negligible, but the lower dry objectives show it without exception and require corresponding correction by the use of monochromatic-blue light.

The focal adjustment of the image in the camera is made on a glass plate placed in the frame of the plate-holder after drawing out the two shutters and putting a 50 grm. weight on the opposite side to prevent the camera from tilting over. The figure represents the apparatus during the adjustment.

A simple method for determining the correct time of exposure was communicated to the author by Dr. Knoevenagel, of Linden, near Hanover; it consists in partially drawing out the under shutter after certain intervals of time, whereby the object to be photographed is brought upon the same plate under three or four different times of exposure. As an explanatory example the author takes the case of a very dark green preparation, using a dry objective which for a clear colourless preparation required an exposure of an hour's duration; the under shutter, before the beginning of the illumination, is drawn out a third, again a third after the expiration of an hour, and quite drawn out after a further half-hour, after which the exposure is continued for another half-hour; thus, on the plate there will be parts of the picture under one, one and a half, and two hours' exposure.

The power of accommodation of the human eye is a trouble to the maker and observer of photomicrographs. The eye sees, in fact, several planes, of which the plate only fixes one; thence arises the practice of the microscopist of rapid up-and-down focusing, by which an impression of relief is given to the object. In the appearance of a photograph there is thus something lacking which gives rise to a feeling of discontent until one has learnt to look at it in the right way. It is a matter of general experience that the drawing of a microscopic object often leads to a correct observation of it; for, whether consciously or unconsciously, it is possible to draw together in one plane images seen in different planes. If it is desired to demonstrate any one detail of a certain small part of a preparation, it is therefore desirable to make a drawing as well as a photograph.

Bézu, Hausser, and Co.'s Photomicrographic Apparatus.*—MM. Bézu, Hausser et Cie. have just brought out a photomicrographic apparatus (fig. 69), of which the following is a description:—

It is constructed on the vertical system, and is composed of three parts. The first is a strong stand, made of oak plank, 55 cm. long and 45 cm. broad, supported on four cast-iron feet about 20 cm. high. In the middle of this oak stage is placed the Microscope upon a copper stand with four legs, and this is moved up and down by means of a screw placed between the legs. The Microscope is firmly fixed to the copper stand by jamming the horse-shoe between grooves and holding it in position by a screw behind.

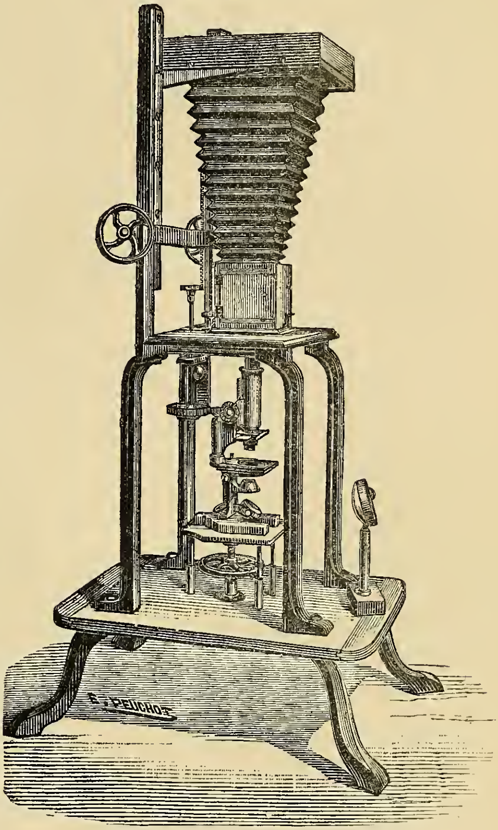
To the oak stand is fixed the table carrying the camera. This table is made of oak planking 35 cm. long and 25 cm. broad, and its legs of cast iron are 45 cm. high. At its centre is a circular aperture for a copper tube lined with black velvet. In the latter the Microscope tube works.

The camera is composed of three parts: a cubical box, the sides of which are 12 cm., a bellows, and a frame for the opaque glass screen. The latter is kept in position by two iron supports, which are really continuations of the hind-legs of the table, and moved up and down by a rackwork arrangement. When the bellows is fully extended the diameter of the image is 18 cm.

* Journ. de Micrographie, xiii. (1889) pp. 189–91 (1 fig.).

In order to examine and focus this image there is at the lower part of the camera a small shutter, behind which is a hole filled in with opaque glass. At the bottom of the camera-box is a mirror, which by means of a lever can be inclined at an angle of 45°, and the image thereby thrown on the small plate of opaque glass. It is then focused in the usual manner.

Fig. 69.



If considerable amplification of the image and high magnification be necessary, the focusing must be done directly on the large opaque screen. For this purpose a special arrangement is necessary, in order to be able to work the fine-adjustment. The milled head of the fine-adjustment is replaced by a toothed one. The stand which supports the camera is perforated by a cleft, into which fits a metal piece capable of vertical and horizontal movement. Connected with this piece is a rod, which, passing through the table, ends in a wheel, the teeth of which gear with those of the head on the fine-adjustment. The upper end of this rod also carries a head, and by turning this fine focusing is effected.

Schmidt and Haensch's Apparatus for Photographing the Tarnish Colours of Iron Surfaces.*—The researches of Martens show that correct pictures of the micro-structure of iron can be obtained by allowing a perfectly level weakly etched iron surface to tarnish at a high temperature, and observing it under the Microscope. Wedding found that the details of the micro-structure are brought out in a much higher degree if the iron surface is inclined obliquely to the axis of the Microscope. The same should apply to the taking of a photomicrograph of the surface. The camera which Schmidt and Haensch employ to this end is a bellows camera, which can be drawn out to a length of 1 m. The Microscope belonging to it has a low magnification, giving a field of view of about 16 sq. mm. The stage can be fixed obliquely to the optic axis of the Microscope by a mechanical contrivance. In this oblique position it is clear that only one line across the field of view will be sharply defined, and in order, then, to keep the stage and object

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 225-6.

at right angles to the axis of the Microscope, and, notwithstanding, to be able to observe and photograph the object in oblique reflected light, Messrs. Schmidt and Haensch insert between the object and the objective a glass plate inclined at an angle of 45° to the axis of the Microscope. A very intense light from the side is then directed to the face of this plate turned towards the object; part of the light passes through the plate, but part is reflected on the object, and by this arrangement of the illumination the iron surface appears in its characteristic tarnish colours, and is observed through the plates.

BASTELBERGER.—**Uses of Photomicrography.**
The Microscope, IX. (1889) pp. 92–3.

MADDOX, R. L.—**Sur l'Application de quelques Méthodes photomicrographiques.** (On the application of some photomicrographic methods.)
Ann. de Micrographie, I. (1889) pp. 145–52.

SHENSTONE, J. C.—**How to take Photomicrographs.**
Pharmaceutical Journ., 1889, April 6 (1 fig.).

(5) Microscopical Optics and Manipulation.

BESSEY, C. E.—**The need of making Measurements in microscopical work.**
["It is greatly to be desired that all workers with the Microscope should make more general use of the micrometer than is now the custom, particularly in botany."]
Amer. Naturl., XXIII. (1889) pp. 52–3.

POLI, A.—**Le Microscope et sa théorie.** (The Microscope and its theory.)
Revue de Botanique, VII. (1888) pp. 20–5.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XLV., XLVI.
[Apochromatic results. Apochromatic focal planes.]
Engl. Mech., XLIX. (1889) pp. 123–4 (6 figs.), 209–10 (4 figs.).

" " " **Microscopical Imagery. Solar Splendours.**
Journ. of Microscopy, II. (1889) pp. 14–5 (1 pl.), 106–10 (1 pl. and 1 fig.).

" " " **A New Apochromatic Test.**
["The new test just discovered is the butterfly *Colias Cæsonia* (foreign). Those scales distinguished by fine ribs widely separated are remarkable for closely-packed molecules, lying in curvilinear rouleaux, generally about 1/120,000 in., and with the best glasses throw up brilliant focal discs."]
Engl. Mech., XLIX. (1889) p. 156.

Aperture Table.—In the table printed at p. 292 two of the figures in the last column (Penetrating Power) have been transposed. 1·35 N.A. = ·741 and 1·34 N.A. = ·746 and not *vice versâ* as printed. 1·37 N.A. = ·729 and not ·739. The water angle corresponding to 0·55 N.A. should be 48° 51′ and not 49° 51′.

(6) Miscellaneous.

Letter of Darwin to Owen.*—Mr. C. F. Cox, President of the New York Microscopical Society, recently laid before the Society the following letter of Charles Darwin to Sir Richard Owen, the date being supplied from the post-mark which it bears:—

"Down, Farnborough, Kent,
Sunday [March 26, 1848].

MY DEAR OWEN,

I do not know whether your MS. instructions are sent in; but even if they are not sent in, I dare say what I am going to write will be absolutely superfluous, but I have derived such infinitely great advantage from my new simple Microscope, in comparison with the one which I

* Journ. New York Micr. Soc., v. (1889) pp. 79–81.

used on board the 'Beagle,' and which was recommended to me by R. Brown, that I cannot forego the mere *chance* of advantage of urging this on you. The leading point of difference consists simply in having the stage for saucers very large and fixed—mine will hold a saucer three inches in inside diameter. I have never seen such a Microscope as mine, though Chevalier's (from whose plan many points of mine are taken), of Paris, approaches it pretty closely. I fully appreciate the utter absurdity of my giving you advice about means of dissecting; but I have appreciated myself the enormous disadvantage of having worked with a bad instrument, though thought a few years since the best. Please to observe that, without you call especial attention to this point, those ignorant of natural history will be sure to get one of the fiddling instruments sold in shops. If you thought fit, I would point out the differences which, from my experience, make a useful Microscope for the kind of dissection, of the invertebrates, which a person would be likely to attempt on board a vessel. But pray again believe that I feel the absurdity of this letter, and I write merely from the chance of yourself possessing great skill and having worked with good instruments, may not possibly be fully aware what an astonishing difference the kind of Microscope makes for those who have not been trained in skill for dissection under water. . . .

Ever, my dear Owen,
Yours sincerely,
C. DARWIN.

P.S.—If I do *not* hear, I shall understand that my letter is superfluous. Smith and Beck were so pleased with the simple Microscope they made for me, that they have made another as a model. If you are consulted by any young naturalists, do recommend them to look at this; I really feel quite a personal gratitude to this form of Microscope and quite a hatred to my old one."

[Addressed] "Professor Owen, Royal College of Surgeons, Lincoln-Inn-Fields, London."

BOSTOCK, E.—**The Presidential Address [to the Postal Microscopical Society].**
Journ. of Microscopy, II. (1889) pp. 1–8.

DETMERS, H. J.—**American and European Microscopes.**
["Referring to the reports of his address which appeared last September, Dr. Detmers says, in contradiction, that he did not take Microscopes, objectives, or accessories to Europe; that he did not make a test of skill with the Germans; that he did not photograph objects in competition with them; and, in short, that no such fighting of objectives as was described occurred."]
Amer. Mon. Micr. Journ., X. (1889) pp. 53–5.

HITCHCOCK, R.—**The making of Apochromatics.**
[Account of a visit to Jena.]
Amer. Mon. Micr. Journ., X. (1889) pp. 49–53 (1 pl. and 3 figs.).

International Competition in Microscopy.
Amer. Mon. Micr. Journ., X. (1889) pp. 70–1.

[MANTON, W. P., and others.]—**Microscopical Outfit for Physicians' use.**
The Microscope, IX. (1889) pp. 83–4.

Zeiss, C. F.—[Obituary Notice and Portrait.]
Central.-Ztg. f. Optik u. Mech., X. (1889) pp. 85–7 (portrait).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Collecting Salt-water Sponges.†—The collector, says Mr. W. B. Hardy, should be on the ground an hour before the tide begins to rise and choose some sheltered nook among the rocks if the coast be a rocky one, or about the piles of a pier if it be an open one. There will be found attached to the under surface of inclined stones, and in the clefts of the rocks, on sea-weed, and in any sheltered spots where there is good surface for attachment, and where the sun does not strike too strongly, tenacious masses of sponge, yellow, green, brown, or orange-colour, and with large orifices on the surface. The most common is of a sponge-yellow colour, shading into green on exposed parts. This is the *Halichondria panicea*, or "bread-crumb" sponge of Ellis. Another common form, of a salmon colour, is *Hymeniacidon sanguinea*. Pieces of the sponge should be removed as carefully as possible and taken home in a considerable quantity of fresh water.

Nutritive Media for the Cultivation of Bacteria.‡—M. L. Benoist gives the following methods for preparing media for the cultivation of micro-organisms:—

(1) Meat broth:—In 4 litres of water are boiled 1 or 2 kg. of lean beef. It is kept boiling 5 hours, and during this time continually skimmed. When cold on the next day the fat is carefully removed and the liquid then filtered. It is then brought up to its original volume and neutralized with a 1 : 10 solution of caustic soda (3 cm. of this solution always suffice to neutralize the acids in 1 kg. of beef). When neutralized the fluid is boiled again for ten minutes and afterwards filtered. To every 1000 cm. of the filtrate 10 g. of sodium chloride are added.

(2) The foregoing may be satisfactorily replaced by the following artificial bouillon:—Water, 1000; pepton Chapoteau, 20; gelatin, 2; wood ashes, 0·15; chloride of sodium, 5. With the exception of the gelatin, the foregoing ingredients are boiled for a few minutes, and when the pepton is dissolved the mixture is filtered, and to it are added 20 cm. of a 10 per cent. gelatin previously clarified. The fluid thus obtained is always perfectly limpid and its composition invariable.

(3) Nutritive gelatin:—Water, 1000; gelatin Coignet No. 1, 100; pepton Chapoteau, 20; chloride of sodium, 5.

The vessels selected for dissolving the gelatin in should be lined with tin or silver, and not with porcelain. The pepton and salt having been dissolved in the boiling water, the vessel is withdrawn from the fire and the gelatin then added in pieces and kept stirred up until it is completely dissolved. The mixture is then neutralized by means of a 1 : 10 solution of caustic soda (1 ccm. of the alkaline solution suffices for 100 g. of gelatin). Two whites of fresh eggs, dissolved separately in 100 ccm. of water, are then added when the temperature of the fluid is about 60° C.; the mixture is then vigorously shaken

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c. (6) Miscellaneous.

† Sci.-Gossip, 1889, p. 11.

‡ Ann. de Micrographie, i. (1888) pp. 75–8.

and replaced on the fire. It is then gradually heated up to boiling, when it is again removed, having been kept the while constantly stirred with a glass rod. The albumen is separated from the gelatin by filtering while warm through fine cotton cloth and plugging the stem of the filter with cotton wool. Filtration is effected in a few minutes, and the liquid thus obtained is perfectly transparent.

(4) Nutritive agar:—The clarification of agar may be effected in the same way, but requires, for its dissolution, to be kept boiling for quite a long time. When quite dissolved it is necessary to add some tartaric acid in solution in order to render it acid. When clarified by means of white of egg, it is neutralized with the soda solution. When coagulated the solution becomes opalescent; but the author states that he hopes shortly to be able to produce agar media as clear as those of gelatin.

Method of Preparing Nutritive Gelatin.*—Mr. N. A. Moore first sterilizes the tubes to be used by heating them for one hour in a hot air sterilizer or oven at 150° C. Then take, say, 250 grams (about half a pound) of beef from which all fat has been removed. Chop or grind this to a fine pulpy mass. Transfer it to a beaker, and add 500 ccm. distilled water, i. e. 2 ccm. to each gram. Thoroughly stir up and place in ice-box till next day. The meat infusion should then be thoroughly stirred, and the liquid portion separated by filtering and squeezing through a linen cloth. The red liquid thus obtained must be brought up to 500 ccm. by adding distilled water. To this is now added 1 per cent. of pepton, 1/2 per cent. sodium chloride, and 10 per cent. of the best gelatin (5 grams pepton, 2·5 salt, and 50 gelatin). The beaker containing the mixture is now placed in a water-bath, and heated to 45° C., and allowed to stand until the gelatin is completely dissolved.

The next step is to add, drop by drop, a nearly saturated solution of sodium carbonate to the beef-infusion-pepton-gelatin mass until the reaction is slightly alkaline. (If it be made too alkaline this condition may be neutralized by acetic acid.) It is next clarified by adding the whites of two eggs, and the mixture is then boiled for half an hour in a water-bath. It is next allowed to cool and set, and then reboiled and filtered in a hot-air filter at 60° C. into the sterilized tubes (7–8 cm. in each). If not perfectly clear it must be refiltered. After they have been filled, the tubes are sterilized in a steamer at 100° C., or three successive days for 10 minutes, or they may be boiled for 5 minutes in a water-bath. If the gelatin is boiled too much it will not set on cooling.

Presence of Nitric Acid in Nutrient Gelatin.†—Dr. R. J. Petri has found that gelatin constantly gives the nitric acid reaction which was first obtained by means of the diphenylamin sulphuric acid reaction, and also by means of the brucin reaction and sulphate of iron with sulphuric acid. As the gelatins used did not give Griess's reaction for nitrous acid, it followed that this compound was a product of bacterial growth.

The next step was to test the various ingredients of the nutrient gelatins. In meat infusion neither nitrates nor nitrites were present. Peptons examined in the same were almost always found to be free, although in a few preparations, traces of nitrate were discovered.

* Amer. Mon. Micr. Journ., x. (1889) pp. 41–2.
† Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 457–60.

The various crude gelatins examined always showed the presence of nitrates.

The method employed was to soak commercial gelatin in distilled water and test the filtrate. This invariably showed the presence of chalk, sulphuric acid, phosphoric acid, and chlorine in addition to the nitric acid.

A second addition of distilled water to the gelatin, showed that the watery extract was now free from nitrates.

Hence it would appear to be advisable to treat gelatin for making nutrient media with distilled water, in order to obtain a pure substance.

Preserving Plate and Tube Cultivations.*—Dr. Schill states that plate and tube cultivations, &c., can be preserved indefinitely by covering them with a mixture of equal parts of alcohol and glycerin, to which one-hundredth to one-thousandth of corrosive sublimate has been added. After 24 hours or so, the fluid is poured off. Considerable care must be exercised in pouring the preservative fluid over the surface. Non-liquefying colonies are not at all damaged by this procedure, but liquefying colonies must be protected by fixing them down by means of a cover-glass, otherwise they run out and leave their excavations only.

Two Modifications of Esmarch's Roll Cultivation.†—(*a*) When test-tubes are used for roll cultivations, the cotton-wood plugs become moistened during sterlization, &c.; this inconvenience is quite avoided, according to Dr. Schill, if the common medicine bottle holding 100, 150, 200 ccm. be used, the narrow neck of which prevents the moisture from running up into the plug.

(*b*) Very often in roll cultivations the gelatin layer is very irregular. A regular and even layer of gelatin may be obtained by simply doing away with the rolling altogether, and adopting the following device. After the gelatin has been poured in, and the germs diseminated by shaking, a smaller (sterilized) tube is jammed inside it. This causes the gelatin to form a perfectly even layer, and when cool the inner tube is easily withdrawn by just pouring a little hot water in to loosen it. Of course, for non-aerobic organisms, there is no necessity to withdraw it at all. In the latter case, if it be desired to get at a colony, a piece of the outer tube must be removed with a diamond.

Flask Cultivations.‡—Instead of plate cultivations, Dr. Schill has used for several years small cast pocket-flasks (canteens) of colourless glass, which are about 6 cm. broad, 10 cm. high, and the sides about $1\frac{1}{2}$ cm. apart. The neck, which has a lumen of 7–9 mm., is about 3 cm. long, and is situate about the middle of one of the small sides. One third full of gelatin, and laid on a broad side, these bottles afford a gelatin plate 50–60 cm. square.

Wafers for Cultivation Purposes.§—Wafers (Oblaten) are especially recommended by Dr. Schill as solid media for cultivating chromogenous Bacteria. The wafers are moistened with a nutrient solution, and sterilized in a Petri's capsule.

Development of Pathogenic Microbes on Media previously exhausted by other micro-organisms.‖—Dr. Soyka and Dr. Bandler have

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) p. 337.
† T. c., pp. 337–9 (1 fig.). ‡ T. c., p. 339. § T. c., p. 340.
‖ Fortschritte d. Med., 1888, pp. 769–73.

made experiments with the object of ascertaining if in nutrient gelatin which has been exhausted by the growth of some other Schizomycete, other kinds of fission fungi, afterwards introduced, would develope. Their results are as follows:—

(1) *Sp. choleræ asiaticæ* developed after *M. tetragonus Pneumoniæ*, swine erysipelas, pigeon diphtheria.

(2) *Sp. Finkleri* after Emmerich's short rods, erysipelas, rabbit septicæmia, *M. tetragonus pneumoniæ*, swine erysipelas, pigeon diphtheria, typhus abd.

(3) *Bacillus anthracis* after erysipelas, rabbit septicæmia, *M. tetragonus pneumoniæ*, swine erysipelas, pigeon diphtheria, and typhus abd.

(4) *Staphylococcus pyogenes citreus* after Emmerich's short rods, erysipelas, rabbit septicæmia, *M. tetragonus pneumoniæ*, pigeon diphtheria, and typhus abd.

(5) *Bacillus pyocyaneus* after Emmerich's short rods, erysipelas, rabbit septicæmia. *M. tetragonus pneumoniæ*, pigeon diphtheria, and typhus abd.

(6) *Bacillus prodigiosus* after Emmerich's short rods, rabbit septicæmia, *M. tetragonus*, *Staphylococcus flavus*, *B. cyanogenes*.

(7) *B. cyanogenes* after *B. typhi abd.*

Prevention of Cultivations from Drying.*—Dr. H. Plaut has found that sterilized oil preserves cultivations from drying excellently well. A flask of olive oil well plugged with cotton-wool is boiled, and when cold, is poured over the cultivation so that it forms thereon a layer about a finger's breadth deep. This procedure may also be adopted for cultivations which liquefy the medium, and does not prevent them from being inoculated on others.

(2) Preparing Objects.

Investigation of Cell structure.†—Herr G. P. Platner in his investigations on cell-division found that the best method of preserving the subsidiary nuclei and their products is the use of osmic acid. The degree of concentration of Flemming's acid mixture is quite sufficient if allowed to act long enough. But as half an hour is not sufficient, and as a longer period essentially affects the power of making sections, some new method had to be adopted. Pieces of hermaphrodite glands cut up as small as possible must be put fresh into the stronger of Flemming's mixtures, and remain in it for an hour; the solution must then be diluted with three or four times its volume of water, and left to stand for twenty-four hours. After careful washing, alcohol of increasing degrees of strength may be added. The best staining material is hæmatoxylin prepared by Apathy's method. The hæmatoxylin solution consists of 1 part of crystals of hæmatoxylin, 70 parts of absolute alcohol and 30 of distilled water; the solution must be kept in dark vessels. The objects are stained *in toto* for twenty-four hours. Then they are removed to 1 per cent. alcoholic solution of bichromate of potash for a day; if lighter staining be required, the objects must remain longer. The objects were then placed in 70 per cent. alcohol, and kept in it, in dark vessels, for several days. Dehydration by absolute alcohol and use of cedar-wood-oil are all that are now necessary.

The specimens should next be imbedded in overheated paraffin for

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) p. 324.
† Arch. f. Mikr. Anat., xxxiii. (1889) pp. 126–7.

about twenty minutes, when bands of section 0·005 mm. thick can be easily cut. The advantages of this method are a good hardening and coloration first, and a consequent preservation of all parts of the series of sections.

Examining the Central Termination of Optic Nerve in Vertebrata.*—For tracing the course of nerve-fibres the following has been employed with great success by Prof. J. Bellonci:—

(1) The brain or a part containing the nervus opticus is placed in osmic acid (1/2 to 1 per cent.) for fourteen to twenty hours.

(2) Freehand sections are then made in 70 per cent. spirit. The sections are washed in distilled water for a few minutes, and then placed in 80 per cent. spirit for three or four hours.

(3) The sections are again placed in distilled water, and then transferred to the slide and the cover-glass put on.

(4) A few drops of ammonia are then allowed to mix with the water under the cover-glass. This reagent makes the brain as transparent as glass, except the nerve-fibres, which remain black, and which are brought out with such distinctness that their course is easily followed.

The sections are of course thick, but this is an advantage in tracing the winding course of the nerve-fibres. Sections cut in celloidin with the microtome can be treated in the same manner, but the action of the ammonia is then much slower, requiring several days.

Preserving Nervous Systems.†—Mr. A. Sanders has been examining the nervous system of *Ceratodus Forsteri* in the wild parts of Queensland. He adopted a method of treatment to which the nervous system was subjected before molecular death could take place. The head, immediately after it was cut off, was placed in Müller's solution to which alcohol in the proportion of one-third had been added; the solution was changed next day, and two or three times in the course of the succeeding three weeks. The skull containing the brain was then placed in a 2 per cent. solution of potassium bichromate, which was changed once a fortnight, until the brain was sufficiently hard to be cut into sections. This occurs at various periods, taking a shorter time in the higher Vertebrates than in the lower; in the case of *Ceratodus* the period was longer than a year. Mr. Sanders has always found this method to succeed well, and thinks it is of great advantage when there is no opportunity of cutting sections till some time after the capture of the animals, and he "can recommend it as an all-round method for travellers."

Investigation of Ova of Sepia.‡—M. L. Vialleton fixed the ova of *Sepia* with osmic acid and Kleinenberg's picrosulphuric mixture. After two days they were placed in 70 per cent. alcohol, which was renewed till all colour was removed, and they were then stained with carmine, and cut into sections, To isolate the protoplasmic layer the ova were placed in a mixture of equal parts of Kleinenberg's fluid and a 2·5 per cent. solution of bichromate of potash. This immediately hardens the chorion and allows of its being easily separated from the yolk; the eggs should not remain in for more than one or two minutes. They are then placed in a watch-glass containing Kleinenberg's fluid in such a way that the protoplasmic layer looks upwards. At the end of an hour and

* Zeitschr. f. Wiss. Zool., xlvii. (1888) p. 4.
† Ann. and Mag. Nat. Hist., iii. (1889) p. 158.
‡ Ann. Sci. Nat., vi. (1888) pp. 168–71.

a half this layer may be removed with a spatula from the subjacent yolk, and should then be spread out in a flat glass containing a very small quantity of picrosulphuric acid. This last should next be replaced by alcohol of from 70° to 90°. Boracic carmine and alcohol are good for staining advanced embryos; Kleinenberg's hæmatoxylin gives excellent results in the study of karyokinesis. Saffranin was used also as a control staining fluid.

Examining Ants for Intestinal Parasitic Infusoria.*—Mr. J. W. Simmons cuts off the abdomen of the insect, places it in a drop of distilled water, and teases. Cochran's crimson ink is recommended for staining the organisms, but any carmine ink would probably answer the purpose. Rosein is also useful. Osmic acid is employed for killing and fixing the Infusoria.

Mounting Fungi.†—The Rev. J. E. Vize writes that as to the medium in which the microscopic forms are to be mounted, he had worked at the Microscope for thirty-five years, and cannot tell yet, nor does he think the man is born who can tell, which is the best mounting medium. What suits one fungus does not necessarily suit another. Canada balsam contracts the spores and is apt to contort them. Glycerin pure and simple simply refuses in course of time to remain in the cell of the slide, and works its way out. Glycerin jelly is nearly as bad, and, in common with gelatin medium, contracts and expands with the temperature of the weather, and therefore is unreliable. Thwaite's fluid, like water, may be very successful for a time, but will be sure to change the colour of the tissue eventually. Camphor water and the other media which have been used in the vain attempt of beautifully balancing themselves, so as to check either the growth or decay of the plant, all fail. If any one asks him what media he should now use, and recommend others to use, his answer would be—for any fungi that would bear them (and they are not numerous), employ Canada balsam. First take the greatest possible care to keep the spores in their natural place by giving them as small a quantity, not of pure spirits of wine, which scatters them, but benzol, which has a different effect. Let the benzol evaporate, then mount. When Canada balsam will not suit, as is generally the case, he uses gelatin, warming all the materials used. Water is, to the best of his knowledge, indispensable when you want to see such portions of a fungus as the zoospores. Much advantage may be gained by putting on the label of the slide not only the name of the object, but the medium in which the same is mounted. He has slides in his cabinet of great scarcity, which it would be next to impossible to replace. Some of them have lost the whole of the medium in which they are placed through evaporation, and are almost valueless. Others have not gone so badly, but there are large bubbles of air in them, which are the forerunners of total evaporation. Had the original mounter of the same named the fluid in which they are placed on the slide, there would have been little difficulty in bringing them back to their primitive condition.

Fixing of the Spores of Hymenomycetes.‡—Dr. C. O. Harz finds that coloured spores of Hymenomycetous Fungi can be very well fixed

* The Microscope, ix. (1889) p. 88.

† Provincial Med. Journ., 1888, November. Cf. The Microscope, ix. (1889) pp. 91–2.

‡ SB. Bot. Ver. München, December 10, 1888. See Bot. Centralbl., xxxvii. (1889) p. 77.

on white paper by moistening the reverse side of the paper by a solution of Canada balsam in absolute alcohol. In the cases of colourless spores the difficulty is to find a coloured paper the pigment of which is not soluble in alcohol; and Dr. Harz used instead a slightly warmed solution of 1 vol. Canada balsam in 4 vols. turpentine oil, placed with a fine camel's hair brush on the reverse side of the paper. In the course of from two to four days the preparation can then be laid aside between paper, but is not completely dry for several weeks.

CARTER, F. B.—**Desmids: their Life-history and their Classification. II.**
[Contains directions for "Collecting" and "Preserving and Mounting."]
Amer. Mon. Micr. Journ., X. (1889) pp. 73–9.

JAMES, F. L.—**The Philosophy of Mounting Objects.**
Amer. Mon. Micr. Journ., X. (1889) pp. 61–3.
from 'Elementary Microscopical Technology.'

WALLER, T. H.—**Micro-chemical Methods for the Examination of Minerals.**
Midl. Naturalist., XII. (1889) pp. 59–65.

(3) Cutting, including Imbedding and Microtomes.

Imbedding in Paraffin.*—Dr. G. A. Piersol says that although the turpentine-paraffin so commonly employed in histological work yields excellent results, the advantages of chloroform-paraffin have led to its exclusive adoption in the laboratory of the University of Pennsylvania. It is very desirable to secure homogeneity of the paraffin after imbedding, and for this purpose the method of Kölliker is employed. In this the cell containing the object and melted paraffin is surrounded with cold water, the upper surface, which is alone left exposed, being cooled by blowing until a film is formed, when the whole is submerged.

The best paraffin is that commercially known as winter worked gum stock, and comes in cakes about 4 cm. thick; that having a bluish tint and emitting a metallic ring when struck is the best.

Substitute for Corks in Imbedding.†—Dr. G. C. Freeborn recommends "deck-plugs," which are cylinders of white pine, to be obtained of manufacturers of barrel bungs, and vary in diameter from 1/2 in. to 1½ in. Not only are they not made soft and yielding by soaking in dilute alcohol, but they may be written upon with lead pencil, thus enabling the microscopist to keep several specimens in the same bottle of alcohol.

JAMES, F. L.—**Sharpening the Section Knife.**
St. Louis Med. and Surg. Journ., LVI. (1889) pp. 156–7 (2 figs.).

(4) Staining and Injecting.

Logwood Staining Solution.‡—Prof. H. Gibbes recommends a logwood stain which is made as follows:—Take of logwood chips, 1 lb.; distilled water, 50 oz. Heat slowly to boiling in a porcelain-lined saucepan. Boil for 10 minutes, stirring the while with a glass rod, and add very slowly 1/2 to 1 oz. of potash alum. Only sufficient alum is to be added to turn the colour almost black. Set aside for 24 hours, then filter and add 4 oz. of rectified spirit. This solution is ready for use at once.

* University Medical Magazine, December 1888. The Microscope, ix. (1889) p. 89.

† The Microscope, ix. (1889) p. 93, from 'Pharmaceutical Era.'

‡ The Microscope, ix. (1889) p. 109.

Soluble Prussian Blue.*—M. C. E. Guignet gives the two following methods for making soluble prussian blue for injection purposes.

(1) Ordinary soluble prussian blue. To a boiling solution of 110 grams of ferridcyanide of potash, are gradually added 70 grams of crystallized iron sulphate. After boiling two hours it is filtered, and the filtrate washed with fresh water until the washings are strongly blue. The blue is then dried at 100° C.

Thus made the blue is of an extremely rich colour, and will take up a large quantity of gelatin without precipitating it.

(2) Pure prussian blue soluble in water. A saturated solution of oxalic acid is mixed to a pasty consistence with an excess of pure prussian blue. The liquid is filtered and allowed to stand for two months until all the blue is precipitated. It is then filtered and washed with weak spirit in order to remove any oxalic acid. When dried the blue dissolves easily in water.

A similar result may be at once obtained by precipitating the oxalic solution with 95 per cent. alcohol, or with a concentrated solution of sodium sulphate, and then washing the precipitate with weak spirit.

The author adds that molybdic acid will dissolve ordinary prussian blue in large quantities. A mixture of the blue and the acid are heated together, and after filtering, a deep blue liquid is obtained, which does not alter in boiling, or precipitate on the addition of gelatin, and when cold sets to a transparent mass of a dark blue colour. The molybdic solution is precipitated by sulphuric, nitric acids, &c. The molybdate and tungstate of ammonia also dissolve prussian blue.

Vital Reaction of Methyl-blue.†—Dr. Max Joseph has tested Ehrlich's method on Heteropods, and found that the clear intra vitam stain could not be satisfactorily fixed. He remarks that the commercial methyl-blue is unfit for use, and that only the chemically pure article will give the results obtained by Ehrlich. Instead of a saturated solution, the author recommends the strength originally employed by Ehrlich, 1/4 gram dye in 100 grams of physiological salt solution.

The best stain was reached about six hours after injection in the body-cavity.

Process of Staining Sections simplified by mixing the staining fluids with turpentine.‡—According to Dr. Kükenthal's experiments, a large number of colouring substances admit of being mixed with turpentine, and serial sections may be stained in a short time by such a combination. Methyl-green, methyl-blue, gentian-violet, safranin, Bismarck-brown, eosin, fuchsin, tropæolin, and malachite-green may be used in this way.

The dry colouring substance is dissolved in *absolute* alcohol, and the solution dropped into turpentine until the mixture has any intensity of colour desired.

Meyer's§ carmine solution.—Absolute alcohol, 100 ccm.; pulverized carmine, 3 gr.; hydrochloric acid (neutralized with ammonia), 25 drops.

* Journ. de Micrographie, xiii. (1889) pp. 94–5.

† Anat. Anzeig., 1888, p. 420. ‡ Amer. Naturalist, 1888, p. 1140.

§ The carmine is boiled in the alcohol and then the acid added. The solution is then filtered, hot, and enough ammonia added to neutralize. After filtering again the solution is mixed with turpentine and absolute alcohol.

Can be united with a mixture of turpentine and absolute alcohol (in equal parts ?), and in this form used for staining sections.

The method of using these stains is very simple. The sections are fastened to the slide by Schällibaum's collodion, then left in the oven of the water-bath until the clove oil has been completely driven off. The paraffin is next removed by washing in turpentine, and then the slide is immersed in the staining mixture. As soon as the desired depth of stain has been received, the sections may be washed in pure turpentine and mounted in balsam.

If the stain is too deep, or a sharp nuclear stain is desired, it is only necessary to leave the slide a short time in a mixture of turpentine and pure (free from any trace of acid) absolute alcohol, and the colour will be reduced.

The colouring mixture may become cloudy, as the result of the evaporation of the alcohol; in such an event, the addition of a drop or two of alcohol generally suffices to clear the mixture.

This method enables one to use easily several stains in succession. Objects may also be coloured, *in toto*, with the advantage that the process of staining can be followed and easily controlled.

Double, Triple, and Quadruple Staining.*—Dr. H. Griesbach demonstrated at the meeting of the Anatomical Society held at Würzburg the following methods of staining. The dyes used were anilins in concentrated aqueous solutions either in combination, or as single successive stains. The stained specimens were cleared in anise oil, and mounted in balsam.

Double Stains.—Metanil yellow [phenylamidobenzolmetasulphonate of soda], and azo blue [tetraazoditolylbetanaphtholdisulphonate of soda]. Preparation: ala nasi of a child, alcohol hardening.

The sections are stained in a mixture of equal parts of the two staining fluids for 10 minutes, or for 10 minutes in the yellow fluid, and then for four minutes in the blue.

The epidermis, hair-shaft, inner root-sheath, striated and smooth muscle stain yellow; the rete Malpighii, the outer root-sheath, sebaceous and sweat glands stain brownish-yellow; connective tissue, elastic fibres, and membrane of fat-cell stain violet-blue; hyaline cartilage and nuclei do not stain.

Metanil-yellow and methyl-green.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained in a mixture of 5 ccm. of the yellow staining fluid, and 3 ccm. of the green. A crystalline precipitate forms which does not interfere with the staining. The sections are allowed to remain in this fluid for eight minutes or longer [1/4 of an hour], or they are stained for eight minutes in the yellow fluid, and then for one minute in the green.

Epidermis, hair-shaft, inner root-sheath, striated and smooth muscle stain yellow; the rete Malpighii, outer root-sheath, hair follicle, sweat and sebaceous glands, and nuclei stain green; hyaline cartilage and cells stain green.

Metanil-yellow and crystal violet [Hydrochloride of hexamethylpararosaniline].—Preparation: ala nasi of child, alcohol hardening.

Mix 7 ccm. of the yellow fluid with 2 ccm. of the violet. An amorphous

* Amer. Mon. Micr. Journ., x. (1889) pp. 30–3.

precipitate results which does not interfere with the staining. The sections are stained in this mixture for 6 minutes, or they are stained for 10 minutes in the yellow fluid, and then for 30 seconds in the violet.

Epidermis, hair-shaft, inner root-sheath, connective tissue, and elastic fibres, the membrane of fat-cells, and striated muscle stain yellow; the rete Malpighii, the outer root-sheath, all glands, smooth muscle, and cartilage with its cell-nuclei stain violet.

Metanil-yellow and safranin.—Preparation: human lip, alcohol hardening.

Mix 6 ccm. of the yellow fluid with 1 ccm. of safranin. An amorphous precipitate forms. This mixture gives either with a long or short stain more sharp pictures than the successive single staining.

Connective tissue stains yellow; epidermis, the rete Malpighii and the analogous layer in the mucous tissue, muscle, and labial glands stain light red, the nuclei standing out sharply.

Metanil-yellow and crystal Ponceau [alphaazonaphthallindisulfo-betanaphthol of soda].—Preparation: spinal cord of calf, alcohol hardening.

For the single as well as the combined stain, 24 hours are required.

The grey matter stains yellow, the white reddish. Under strong magnification, the neuroglia and connective tissue are found to be stained yellow; the axis cylinders dark bluish-red; the myelin light yellowish-red; one sort of ganglion-cells dark purple, another bluish-red; nuclei do not stand out sharp.

Metanil-yellow and Congo-red [tetraazodiphenyldinaphthylamindi-sulphonate of soda].—Preparation: spinal cord of calf, alcohol hardening.

The sections are stained in a mixture of the staining fluids for eight minutes, or they are stained for ten minutes in the yellow stain and then for five minutes in the red.

Ganglion-cells [without clear nuclei staining] and axis-cylinders stain dark violet-red; the medullary sheath light citron-yellow; neuroglia and all connective tissue light violet-red; epithelium of the central canal brownish-red.

Carminate of soda and metanil-yellow.—The central nervous system is hardened in Müller's fluid, then stained *in toto* with the carmine fluid. Sections are then stained for ten minutes in the yellow stain.

All nervous elements are stained red; all connective tissue elements yellow.

Crystal Ponceau and crystal violet.—Preparation: transverse section of the carotid of the calf, alcohol hardening.

The sections are stained for five minutes in the red Ponceau fluid, and then for one minute in the violet.

Nuclei of the endothelium and smooth muscle stain violet; all the other tissues red.

Congo-red and anisol-red [bisulfoxylnatronbetaoxynaphthalinazo-orthometoxylbenzol].—Preparation: spinal cord of the calf, alcohol hardening.

The sections are stained for five minutes in the combined stains, or for five minutes in the Congo-red solution and then for five minutes in the anisol-red.

Axis-cylinders and cell-bodies stain purple; all other tissues stain light red. Nuclei do not stain.

Metanil-yellow and ethylin-blue.—Preparation: ala nasi of a child, alcohol hardening.

When the two staining solutions are combined a black precipitate is formed, which redissolves in an excess of the metanil-yellow solution. This solution stains yellowish-green, the cartilage only being stained blue. If the sections are first stained for five minutes in a mixture of 5 ccm. of the yellow and 4 ccm. of the blue stain, or if the sections are stained for ten minutes in the yellow and then for two minutes in the blue, the pictures will be sharp.

The epidermis, hair-shaft, outer root-sheath, connective tissue, elastic fibres, smooth and striated muscle stain yellow; all glands, membrane of fat-cells, cartilage, and nuclei stain blue.

Triple stains.—Metanil-yellow, methyl-green, and safranin.—Preparation: ali nasi of a child, alcohol hardening.

The sections are stained for eight minutes in the yellow solution, then for thirty seconds in the safranin solution, then for twenty seconds in the methyl-green solution, and finally passed through the metanil-yellow solution.

The different elements are differentiated as in the double stain with metanil-yellow and methyl-green, except the colour is of a darker shade, and all muscular elements are stained red.

Metanil-yellow, crystal Ponceau, and crystal violet.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained for 2–16 minutes in a mixture of 5 ccm. of the yellow solution, 5 ccm. of the Ponceau solution, and 3 ccm. of the violet solution, or they are stained for eight minutes in the yellow solution, then for six minutes in the Ponceau solution, and finally for fifteen seconds in the violet solution.

Cartilage and nuclei of cartilage-cells, the superficial layer of the epidermis stain bluish-violet; connective tissue, elastic fibres, and glands stain light red; the deep layer of the epidermis, the rete Malpighii, hair-shaft, the root-sheaths, membrane of fat-cells and muscle stain yellow.

Metanil-yellow, azo-blue, and methyl-green.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained for ten minutes in the yellow solution, then for six minutes in the blue solution, and then for two minutes in the green solution, finally, the sections are passed through the yellow solution.

The epidermis, hair-shaft, inner root-sheath, smooth and striated muscle stain yellow; membrane of cells, the rete Malpighii, membrana propria of glands, elastic fibres, and connective tissue stain violet; nuclei of gland cells and nuclei of the cells of the Malpighian layer, outer root-sheath, smooth muscle, and connective tissue stain green.

Crystal Ponceau, methyl-green, and crystal violet.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained for eight minutes in a mixture of 10 ccm. of the Ponceau solution, 4 ccm. of the green, and 2 ccm. of the violet, or they are stained for eight minutes in Ponceau solution, then for three minutes in the methyl-green solution, and then for five seconds in the violet solution.

The epidermis, hair-shaft, and outer root-sheath stain violet; smooth and striated muscle, elastic fibres, and connective tissue stain rose-red;

the stratum mucosum stain green; the inner root-sheath, all glands and membrane of fat-cells, cartilage, and nuclei of its cells stain green.

Quadruple stains. — Metanil-yellow, safranin, methyl-green, and crystal violet.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained for twenty minutes in the yellow solution, then for one minute in the safranin solution, then again for five seconds in the yellow solution, then for two minutes in the methyl-green solution, then again for five seconds in the safranin, then again for five seconds in the yellow solution, and finally for ten seconds in the violet solution.

The epidermis, hair-shaft, inner root-sheath, and all nuclei stain yellow; the rete Malpighii, outer root-sheath, sweat glands, sebaceous glands, the nuclei of cells, and smooth muscle stain green; nuclei of connective tissue, elastic fibres, lobes of the sebaceous glands, with the nuclei of their cells, membrane of fat-cells stain red; cartilage and the nuclei of its cells stain violet.

Staining Muscle with Saffron.*—In his researches on the regeneration of striated muscle, Leven first injected Flemming's solution into the muscle, and then having cut out a piece, this was, after further subdivision, placed for some days in the Flemming's solution, and finally hardened in absolute alcohol. Sections were stained in 4–8 hours with a solution of saffron made as follows: saffron, 1 part; absolute alcohol, 100 parts; distilled water, 200 parts. The sections were then washed in distilled water and left in acidulated alcohol (0·5 per cent. HCl) until they recovered their former yellow colour. They were then treated with absolute alcohol, oil of cloves, and finally mounted in dammar. If successfully done, the karyokinetic figures appear dark red, while the muscle nuclei are pale with dark-red nucleoli. Leucocytes take on the colouring matter more easily and keep it longer than the rest of the tissues, with the exception of the mitotic figures.

Iodine Reactions of Cellulose.†—M. L. Mangin describes a number of reagents into whose composition iodine enters which give staining reactions with cellulose.

The two well-known reactions, the one with iodine and sulphuric acid, and the other with iodine and chloride of zinc, are to a certain extent inconvenient of application. If iodized sulphuric acid be employed in too concentrated a state, the tissues are altered; while if it be employed too weak there will be no action. With solution of chloride of zinc the concentration is variable, so that it is difficult to obtain identical results; and, furthermore, this reagent produces a coloration only after a certain period of time, and several hours are sometimes necessary for the staining to show itself.

The author then gives a list of salts and acids which, together with iodine, produce a staining reaction with cellulose, viz.:—Chloride of aluminium, chloride of calcium, chloride of manganese, chloride of magnesium, hydrated bichloride of tin, nitrate of zinc, nitrate of lime, phosphoric acid. These different reagents have not the same sensitiveness. In the case, for instance, of iodized chloride of aluminium, the staining appears more rapidly than is the case with chloride of zinc, and is preserved for several days. The chlorides of manganese and magnesium, and the nitrates of lime and zinc, only produce a feeble colora-

* Medical Chronicle, November, 1888. The Microscope, ix. (1889) p. 88.
† Bull. Soc. Bot. France, xxxv. (1888) pp. 421–6.

tion, but the author specially recommends phosphoric acid and chloride of calcium as being likely to replace advantageously iodized chloride of zinc and iodized sulphuric acid.

The author then describes the preparation of several of these new reagents. In order to make iodized phosphoric acid, the pure crystallized phosphoric acid must be taken, and to this must be added, in order to effect solution, a fourth or a third of its bulk of water, and then some crystals of iodide of potassium or iodine must be added until the liquid acquires the tint of rum or curaçoa. It is advisable to prepare this reagent in different states of concentration. It will be found to colour cellulose in a few minutes a deep blue colour. Occasionally, when the cellulose coloration is found to be partly masked by other matters present, it may be advisable to warm the sections to be studied with a weak solution of hydrochloric acid (1 per cent.) or potash (4 per cent.). After this the staining will be found to appear instantly.

Staining the Bacillus of Glanders.*—Dr. H. Kühne, who considers the staining of *B. mallei* to be especially difficult, advises the following procedure. Before immersing in the stain the sections are to be thoroughly freed from spirit. This done, they are placed for 3–4 minutes in carbol-methylen-blue (water, 100; carbolic acid, 5; alcohol, 10; methylen-blue, 1·5 gr.) and then decolorized in water acidulated with hydrochloric acid, after which the acid is extracted with distilled water. After a transitory immersion in alcohol they are transferred to anilin oil to which 6–8 drops of oil of turpentine have been added. Then to pure turpentine, xylol, and lastly balsam.

New Rapid Process for Staining Bacillus Tuberculi.—MM. Pittion and Roux have presented to the Société de Médecine de Lyon † a process for differential staining of bacillus tuberculi, in which the easily decomposable anilin water, or its substitute, carbolized water, is supplanted by aqua ammoniæ. There are in the process three fluids, viz.:—

Solution A. Ten parts of fuchsin dissolved in 100 parts of absolute alcohol.

Solution B. Three parts of liquid ammonia dissolved in 100 parts of distilled water.

Solution C. Alcohol, 50 parts; water, 30 parts; nitric acid, 20 parts; anilin-green, to saturation. In preparing this solution dissolve the green in the alcohol, add the water, and lastly the acid.

To use. To 10 parts of solution B add 1 part of solution A, and heat until vapour begins to show itself, then immerse the cover-glass, prepared as in the ordinary method of staining. One minute suffices to thoroughly stain the bacilli. Wash with plenty of water, and after rinsing with distilled water let fall on the film side of the cover-glass 2 or 3 drops of the green solution (C), and let it remain not longer than 40 seconds. Wash off with abundant water, dry, and mount in xylol balsam. The bacilli will, on examination, be found to be stained a fine rose red upon a pale or delicate green ground.

Most excellent preparations may be obtained by replacing the fuchsin with gentian-violet and the anilin-green with a weak solution of chrysoidin.

An experiment made with the above stain by Dr. F. L. James ‡ seems

* Fortschritte der Med., 1888, p. 860.

† St. Louis Med. and Surg. Journ., lvi. (1889) p. 155.

‡ T. c., p. 156.

to prove its claims to superiority over all other stains yet tried. Not only is the process more rapid than any hitherto used (except that of Glorieux, and it equals even this remarkably rapid method), but a greater number of bacilli are developed. Further than this, the bacilli appear to be swollen by the process, and show up larger and more clearly.

(5) Mounting, including Slides, Preservative Fluids, &c.

Preparing and Mounting Diatoms.*—In his account of the diatoms of the Bay of Villafranca, M. Peragallo recommends the following plan for separating and preparing them for examination, in the case of those species which are dredged up from the bottom mixed with sand and mud.

The material is first passed through a coarse sieve with meshes about 1 mm. in diameter, the residue (which has passed through the sieve) placed in a dish, and hydrochloric acid added drop by drop to dissolve the calcareous matter; when effervescence has ceased, the deposit is placed in a large vessel and allowed to settle repeatedly after washing with water until every trace of acid has disappeared. It is then boiled in water alkalized by potassium or sodium carbonate, and shaken; the diatoms fall to the bottom, while the mud remains in suspension, and by repeated decanting the diatoms are obtained with but small admixture of any foreign matter except sand, especially if finally treated with sulphuric acid. The diatoms are lastly separated from the sand by a tedious process of moistening with alcohol and passing down an inclined glass tube, when the diatoms pass down and the sand remains behind. The whole process occupies more than a month, but is stated to produce very good results.

For mounting, the diatoms are always placed on the cover-glass. The fixing material recommended is gum adraganth, as prepared by M. Brun of Geneva, the refractive index of which is very near to that of glass, and as a saturating fluid a solution of styrax or liquidambar in benzin or in a mixture of benzin and absolute alcohol. The diatoms are placed in the position they are intended to occupy on the cover-glass by means of a mounted hair or small pincers with a wooden handle. The pincers are then lightly dipped into the solution of gum adraganth, and, after moistening the cover by the breath, the diatoms are lightly touched with the pincers. When the moisture has entirely evaporated, a drop of the saturating fluid is placed on the cover-glass, and when the air-bubbles have entirely disappeared, and before the fluid has completely evaporated, a drop of styrax is added. The preparation is then warmed, and placed by pincers on the slide, and the excess of styrax removed by linen soaked in alcohol.

Mounting Diatoms.†—M. Bialle de Langibaudière mounts diatoms in the following manner. Upon a clean cover-glass, previously placed upon a bronze or iron table, are dropped from a pipette several drops of distilled water. Then from the bottle in which the diatoms are preserved in spirit, is removed a small quantity of the fluid, with the same pipette. Of this fluid one drop is let fall into the distilled water on the cover-glass. Owing to the alcoholic fluid falling into water, the diatoms are scattered all over the cover-glass. The metal table is then gently heated, so that the water evaporates very slowly and without ebullition. The rest of the manipulation is performed in the usual manner.

* Bull. Soc. Hist. Nat. Toulouse, xxii. (1888) pp. 16–35. Cf. *ante*, p. 427.
† Journ. de Micrographie, xiii. (1889) p. 59.

Cement Varnishes and Cells.*—Mr. S. G. Shank finds that every medium of an aqueous or glycerin nature sooner or later softens all ordinary cell cements. Mounts of Algæ, &c., in copper solution, glycerin, in solution of chloral hydrate, in cells of solution of sealing wax and such similar cements, when about three years old, all show the cement creeping in towards the centre of the mount. All cells to be used for fluid (other than alcoholic) and glycerin solutions should be carefully covered with shellac. This may whiten where the fluid touches it, but it resists well. Cement down the cover with shellac also, and back it with a more tenacious varnish.

Lovett's cement, which is white lead 2, red lead 2, litharge 3, ground together with thin gold size to a working consistence, hardens more quickly than gold size, and seems to be entirely permanent. Mounts four years old prepared with this cement are still perfect, resisting glycerin and weak alcoholic solutions. This cement is troublesome to prepare and cannot be well kept, like shellac varnish.

Cells are, as a rule, made too deep or too wide. The expansion and contraction of considerable bodies of fluid soon loosen any but very carefully made cells. Fluid mounts which show signs of failure should, as a rule, be immediately remounted. The presence of air seems to facilitate decomposition. Frequently the bubble is a gaseous result of internal decomposition, which progresses in spite of liberal coats of varnish subsequently applied.

Glass slips, with concave centre, should be prepared for many objects. They cost about the same as loose glass cells, and are deep enough for a head of Tænia Solium, &c., and the addition of a ring of thick shellac, well dried, forms a cell deep enough for a wide range of objects. All fluid mounts ought to be revarnished every year whether they show signs of failure or not.

King's amber or Brown's rubber are transparent varnishes, and neither will impair the beauty of any fancy finish. White and black finishing varnishes may be made by adding to shellac varnish, tube oil-colour, ivory black, or zinc white. The resulting finish does not crack, but is not as brilliant as zinc cement or asphaltum.

The surface of a slide to which a cell is to be cemented, should be well cleaned with a mixture of equal parts of alcohol and chloroform. The best cement fails to adhere on a dirty glass surface.

Copal Cement.†—Mr. W. Z. Davies makes a transparent and colourless cement, which is useful as a finishing varnish and for cell-building, in the following manner:—

Take best clear copal gum, coarsely pulverized, mix with a sufficient quantity of benzol to cover it, and let stand for 24 hours. Take of chloroform twice as much as of the benzol, and in it as much gum camphor to saturate the chloroform, and then add a small quantity of pale linseed, nut, or poppy oil. The quantity of oil will vary according as a quick or slow drying cement is desired. If no oil, or a very small quantity is added, the cement will dry very quickly. Next add the mixture to the copal and benzol, shaking at intervals for several days, until as large a quantity as possible of the gum has been dissolved. Pour off, filter, and evaporate to any desired consistency.

This cement adheres well to glass, especially if the glass is warm

* The Microscope, ix. (1889) pp. 126–7. † T. c., pp. 78–9.

when the first coat is applied. Cells built up entirely of it are as colourless as the glass itself.

Finishing Slides.*—The only factors, says Miss M. A. Booth, to be taken into account for filling up the distance from slide to cover-glass without spreading, are a proper cement and the proper consistency of that cement. Let us assume that the cell is of block tin, and firmly attached to the slide by shellac cement or by gold size or marine glue, and so thoroughly dried that the cell cannot be moved on the glass by the vigorous use of a file. Where strength is not required, no cement is so convenient as asphalte or Brunswick black for rounding out the wall, and if applied at one operation there is nothing treacherous about it. But never put a fresh coat over a partially dried one.

Where it is desired to reinforce the cement which attaches the cell to the slip, the cement should be used pretty thick, and it is well to keep two bottles of each kind of cement, one a fresh and therefore thin one, and another from which the solvent has partially evaporated. With most cements it is best that they should be applied in successive coats, allowing time for each to dry before the next is applied. With cement of a proper thickness and a penknife to turn up the cement towards the cell, while the turntable is revolving, filling up the distance from slide to cover-glass is quite easy.

Lyon, H. N.—**Cements, Varnishes, and Cells.**
The Microscope, IX. (1889) pp. 69–74.
Zabriskie, J. L.—**A Nest of Watch-glass Covers.**
Journ. New York Micr. Soc., V. (1889) pp. 76–8 (3 figs.).

(6) Miscellaneous.

Counting the Colonies in an Esmarch Plate.†—Where it is desirable to make an accurate enumeration of the number of colonies developed on an Esmarch plate, and where these are not very numerous, Dr. Tavel adopts the following method. The tube to be counted is pushed slowly and with a screw-like motion into an Esmarch enumerator, and at the same time a glass rod is fixed to its clamp, so that a spiral line is traced upon the glass, the turns of which are about 1 cm. distant from one another. The counting is done by following with a lens the course of the spiral from its beginning to its end. In this way the risk of counting a colony twice over is prevented.

Benecke, F.—**Die Bedeutung der mikroskopischen Untersuchung von Kraftfuttermitteln für die landwirthschaftliche Praxis.** (The importance of the microscopical investigation of strengthening-fodder for practical agriculture.)
15 pp., 8vo, Dresden, 1888.
Bidwell, W. D.—**A Land Title settled by the Microscope.**
[Examination of some lead-pencil memoranda alleged to be of different dates.]
Amer. Mon. Micr. Journ., X. (1889) p. 60.
Brown, F. W.—**A Course in Animal Histology.** IX.
[Muscle.] *The Microscope*, IX. (1889) pp. 81–2.
Freeborn, G. C.—**Notices of New Methods.** VIII., IX.
Amer. Mon. Micr. Journ., X. (1889) pp. 66, 79–80.
Tate, A. N.—**The Application of the Microscope to Technological Purposes.**
20th Ann. Rep. Liverpool Micr. Soc., 1889, pp. 6–9.
Whelpley, H. M.—**Microscopical Laboratory Notes.**
Amer. Mon. Micr. Journ., X. (1889) pp. 65–6.

* Micr. Bulletin, vi. (1889) p. 8.
† Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) p. 552.

PROCEEDINGS OF THE SOCIETY.

Meeting of 10th April, 1889, at King's College, Strand, W.C., Prof. Charles Stewart, F.L.S., Vice-President, in the Chair.

The Minutes of the meeting of 13th March last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Didelot, L., Du Pouvoir Amplifiant du Microscope. 2nd edition. 86 pp., and 1 plate. (8vo., Paris, 1887)	*Mr. Crisp.*

Messrs. Dick & Swift's new form of Petrological Microscope was exhibited by Mr. Crisp, and the detailed description read to the meeting (*supra*, p. 432).

The Chairman thought that the instrument was very ingeniously contrived, and very well adapted to the particular purpose for which it was designed.

Dr. Van Heurck's communication was read giving the preliminary particulars of a Botanical and Microscopical Exhibition which it was proposed to hold at Antwerp in 1890 in celebration of the 300th anniversary of the invention of the Microscope. Further and more detailed information was promised hereafter.

Mr. G. Massee's paper on "A Revision of the Trichiaceæ" was taken as read, the Secretary explaining that its length and extremely technical character rendered it impossible for any one but the author to give a *résumé* of it. It would be published *in extenso* in the Journal, and would be a valuable addition to their proceedings (*supra*, p. 325).

Mr. E. M. Nelson's paper on "The Action of the Wide-angled Illuminating Axial Cone and its relation to the Diffraction Theory," was, in the absence of the author, read by Mr. Crisp, many of the illustrations being enlarged upon the board by Prof. Stewart.

The paper was discussed by the Chairman, Mr. Crisp, Mr. Ingpen, Prof. Lowne, and Mr. T. F. Smith, and will be printed in the next number of the Journal. The discussion occupied the rest of the evening.

The Chairman announced that the next Conversazione would take place on May 1st.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. William Gadd, C. W. Hoagland, M.D., and George H. F. Nuttall, M.D.

Meeting of 8th May, 1889, at King's College, Strand, W.C., the President (Dr. C. T. Hudson, M.A., LL.D.) in the Chair.

The Minutes of the meeting of 10th April last were read and confirmed, and were signed by the President.

The President said that some new species of *Asplanchna* had recently been described by M. de Guerne, but upon examining the figures which were given in illustration he had come to the conclusion that this observer had studied the teeth by the examination of specimens which had either been crushed or treated with caustic potash. The teeth of these rotifera were extremely brittle, and if any pressure was applied to them, as was most frequently done, they were very liable to be fractured, and the pieces would then get scattered about in various directions. There were cases in which new species had actually been made out of them in accordance with the positions in which they happened to fall. By means of a drawing upon the black-board, the President showed the effects of such crushing in producing a variety of alterations in the apparent structure of the trophi of *Asplanchna*. The solid triangular base of the ramus, which was described as one of the new characters, was nothing more than a muscular portion at its lower end, namely, the half of a stout muscle which embraced the free end of the fulcrum and sloped upwards to a projection on either ramus. To make it quite clear how a difference in the aspect or position would produce some of the alterations described, he had made a large model in wax composition of the trophi of *Asplanchna*, by means of which he pointed out how some of the so-called new forms could readily be seen by viewing the model from different points.

The President also said that amongst the nominations read that evening was the name of Mr. Thomas Whitelegge, a gentleman living in Australia, who had sent him a great many beautiful things at different times. Amongst these was a specimen of *Lacinularia*, which was very curious, consisting of a number of separate individuals associated together in a cluster, but all united at their lower ends to a common stem of remarkable length, the lower end of which was spread out as a kind of solid foot. A representation of the form having been drawn on the board and further described, the President said it was possible to suggest a way of accounting for this curious growth by supposing that these rotifers, being capable of secreting a viscid material, had done this somewhat abundantly, and being drawn upwards by the action of the trochal discs, an elongation of that viscid material would take place, and then, by the motions given to them by the ciliary action, these stems would first be plaited together, and ultimately become fused.

In modelling the trophi of *Asplanchna*, he had trusted to a formula he had met with for making the material; this was equal parts of bees'-wax, olive oil, flake white, and lead-plaster. The result was as they saw before them; something which it was very easy to mould in any required form, but which remained so soft that it could not be touched without spoiling. If any of the Fellows present could tell him how to make something of the kind which would harden he should be very much obliged.

Mr. J. D. Hardy asked the President whether, in the case of the

Lacinularia to which he had drawn attention, there was any gelatinous surrounding to the stem.

The President said that the spherical portion at the top of the stem was gelatinous, but the stem itself was not so; at the upper end it was white and clear, then lower down it got more horny, and became more and more yellow as it continued towards the base.

Mr. Hardy thought that the idea of making a model such as the President exhibited that evening was an extremely good one, and that if that plan was more adopted they would be able to get a better idea of the facts of the case than any drawing could give them. He suggested that if a photograph of that model was taken under a good oblique light, it would give any one a far better notion of the structure than any other mode of representation.

Mr. T. F. Smith said he had brought for exhibition the Abbe diffraction-plate, shown by means of stops of various apertures, to clear up a point of difference between Mr. Nelson and Prof. Lowne during the discussion which took place at the previous meeting. Having drawn a series of diagrams upon the board to represent the bands of lines on the plate, parallel and crossed at right angles and obliquely, he proceeded to point out that the effect of reducing the size of the aperture in the stop was simply to alter the resolving power; that where the lines were resolved they were shown correctly, and where not resolved they were blotted out altogether. In further illustration of his meaning, Mr. Smith exhibited a number of photomicrographs of the various bands taken under the conditions to which he had alluded.

Mr. Crisp said that Mr. Smith had not explained the point he desired to make as the result of his observations.

Mr. Smith said his conclusion was that it was not possible to falsify the appearance of the structure of an object with central light, and that if it was resolved at all it was under those conditions resolved correctly.

Mr. Crisp inquired if Mr. Smith remembered where the contrary had been stated?

Mr. Smith could not give the reference asked for, but thought something to that effect had been stated at the Quekett Club.

Mr. Crisp was glad to hear that it did not originate with this Society; he had feared it was some heresy emanating from them which Mr. Smith was endeavouring to combat.

Messrs. C. D. Sherborn and F. Chapman's "Additional note on the Foraminifera of the London Clay" was read, describing thirty-four varieties of Foraminifera from the London Clay exposed in the drainage works some time since carried out in Piccadilly.

Dr. A. C. Stokes' paper on "New Peritrichous Infusoria from the Fresh Waters of the United States" was read.

The President said they had heard with great regret of the death of Dr. Warren de la Rue, one who was so well known to all as a scientist that it was needless for him to say more than to express their deep sense of the loss sustained by the removal of so eminent a man, who had formerly held the office of Vice-President of their Society.

Mr. J. Mayall, jun., thought it was a point of special interest to be mentioned in connection with Dr. de la Rue that in quite the early days, when the Microscope was not so perfect as at present, he acquired for himself considerable skill in its application, and was the first to make a systematic study of Nobert's lines, some account of which was published in the third edition of 'Quekett on the Microscope.' He corresponded with Nobert at the time upon the subject, and was one of the first to produce photomicrographs.

The President said he might mention that a new species of *Brachionus* had been found by Mr. Rousselet which presented some very interesting features. He would not anticipate Mr. Rousselet by then describing them, but would draw upon the board the sideways appearance of the lorica of another curious species from Australia which had been sent to him by Surgeon Vidal Gunson Thorpe, R.N. He felt sure that most of the mistakes made in the descriptions of these creatures arose from attempts to kill them first and examine them afterwards; to get correct results from this was hopeless, because when killed they became opaque, and began to disintegrate almost at once. Another instance he might mention was that of Dr. E. von Daday's elaborate memoir on *Pedalion*, in which there were drawings untrue to nature, owing to their having been made from creatures brought home in spirit, and consequently distorted in many ways. All the speaker's own drawings had been made from life, after two months' constant observation, in consequence of the extreme difficulty of getting the creature into the proper position for seeing the particular portion wanted; and he must certainly say that of all rotifera *Pedalion* was the most aggravating one he knew of in this respect. For the correct observation of Rotifera there were only two directions to be given: first, see them alive; second, for reagents use patience.

Mr. J. D. Hardy said it might be worth mentioning that the best way he knew of to keep these rotifera quiet for a sufficiently long time to be able to draw them, especially when they were such active creatures as the one last mentioned, was to make a strong solution of common loaf sugar, and add it drop by drop to the water until the rapid motion of the rotifer was stopped. This did not prevent them from keeping up their ciliary action, and the liquid remained sufficiently transparent to make observation quite easy.

The President said this idea was quite new to him, and inquired how much syrup it was proper to add to the water.

Mr. Hardy said the quantity would depend upon the size of the cell. The plan was merely to mix loaf sugar and water until a syrup was produced about as thick as treacle, and then to add this drop by drop to the water in the cell until the rotifer was fairly fixed.

The President inquired if Mr. Hardy had ever tried this plan with *Asplanchna*, because whenever he had tried mixing anything with the water he found that they either blew themselves out quite tight, or else shrivelled up altogether.

Mr. Hardy said that the syrup being added very gradually, diffused itself through the water, so that the density of the liquid very soon got to be the same within the creature as outside, which he thought would prevent the distortion mentioned. He did not remember to have tried the plan with *Asplanchna*, but he had done so with *Bursaria*, which was a very active animal.

The President said he should certainly try the method. There was another substance sometimes used for the purpose, and that was a very weak solution of salicylic acid. The rotifers would swim about in this for hours, and then slowly die. This was the only way in which he had found it possible to see *Synchæta*. Another thing sometimes used was a very weak solution of chromic acid. A weak mixture of the two acids was also a good preservative.

Mr. Hardy asked whether the acid did not kill the rotifers.

The President said that the solution used did so after six hours or so, but it also preserved them.

Mr. Hardy said that the syrup had the great advantage of simply quieting without killing them, and their freedom of action could be afterwards restored by the addition of more water.

The following Instruments, Objects, &c., were exhibited:—

Dr. Hudson :—Wax model of the trophi of *Asplanchna*.

Mr. T. F. Smith :—Abbe Diffraction-plate and Photomicrographs.

New Fellows :—The following were elected *Ordinary* Fellows :— Messrs. Joseph R. Ratcliffe, M.B.; Thomas W. Shore, M.D., B.Sc.; Clarence M. Weed, M.Sc.; and Rev. B. Jones Bateman.