TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

VOL. V.

TRANSACTIONS

OF THE

HERTFORDSHIRE

NATURAL HISTORY SOCIETY

AND

FIELD CLUB.

EDITED BY JOHN HOPKINSON, F.L.S., F.G.S.

VOLUME V.

November, 1887, to October, 1889.

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WOODCUTS.

Dates of publication of the several parts contained in this volume:

Part 1.	Pages 1–32	August, 1888.
,, 2.	,, 33–64	October, 1888.
,, 3.	,, 65–96	December, 1888.
,, 4.	,, 97–128	April, 1889.
,, 5.	,, 129–160	June, 1889.
,, 6.	,, 161–192	October, 1889.
,, 7.	,, 193–216	December, 1889.
,, 8.	,, ix–xlviii	April, 1890.
,, 9.	,, i–viii, and 217–224.....	May, 1890.

Dates of completion of previous volumes:

Transactions of the Watford Natural History Society.

Vol. I. (pp. lxiv and 248)	August, 1878.
,, II. (pp. lx and 260)	June, 1880.

Transactions of the Hertfordshire Natural History Society.

Vol. I. (pp. lxviii and 272)	May, 1882.
,, II. (pp. lxviii and 286)	May, 1884.
,, III. (pp. lxxii and 274)	March, 1886.
,, IV. (pp. lii and 232)	June, 1888.

PROCEEDINGS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

Ordinary Meeting, 3rd November, 1887, at Hoddesdon.

F. M. Campbell, Esq., F.L.S., F.Z.S., etc., President, in the Chair.

Mr. Ernest Beck, Hoddesdon; Mr. Howard L. Cooper, Broxbourne; Mr. J. A. Tregellis, Hoddesdon; and Mr. J. Reynolds Vaizey, B.A., St. Peter's College, Cambridge, were proposed as Members of the Society.

The following papers were read:—

1. "Meteorological Observations taken at Watford during the year 1877."* By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. IV, p. 205.)

2. "Meteorological Observations taken at Throcking during the year 1886." By the Rev. C. W. Harvey, M.A., F.R.Met.Soc. (*Transactions*, Vol. IV, p. 209.)

3. "Report on the Rainfall in Hertfordshire in 1886." By the Rev. C. W. Harvey. (*Transactions*, Vol. IV, p. 214.)

4. "On *Walckenaëra interjecta*, a new Spider from Hoddesdon." By the Rev. O. P. Cambridge, M.A., F.R.S. Communicated by the President. (*Transactions*, Vol. V, p. 18.)

Microscopic and other Natural-History objects were exhibited.

Ordinary Meeting, 15th November, 1887, at Watford.

F. M. Campbell, Esq., F.L.S., F.Z.S., etc., President, in the Chair.

Mr. Ernest Beck, Mr. and Mrs. Howard Braden, Mr. H. L. Cooper, Mr. J. A. Tregellis, Mr. J. R. Vaizey, B.A., and Mr. H. A. Vincent, were elected Members of the Society.

Mr. Robert Henty and Miss M. A. Henty, Langley House, Abbot's Langley; Mr. J. A. Hunt, Hoddesdon; and Mr. James Thornhill, F.L.S., Oxford House, St. Albans, were proposed as Members.

* An Appendix to previous Reports.

The following lecture was delivered :—

"The Anthropoid Apes, in relation to the Doctrine of Evolution." By Arthur Nicols, F.G.S., F.R.G.S.

Ordinary Meeting, 13th December, 1887, at Hertford.

F. M. Campbell, Esq., F.L.S., F.Z.S., etc., President, in the Chair.

The following paper was read :—

"Wild Plants: their Attributes and Names." By F. G. Lloyd, Hon. Sec.

Ordinary Meeting, 31st January, 1888, at Watford.

Professor Attfield, Ph.D., F.R.S., F.C.S., etc., Vice-President, in the Chair.

Mr. R. Henty, Miss M. A. Henty, Mr. J. A. Hunt, and Mr. J. Thornhill, F.L.S., were elected Members of the Society.

Mr. Ernest Harby, Street Lodge, Watford, and Mr. W. P. Young, Hertford House, Albert Road, Battersea Park, London, S.W., were proposed as Members.

The following papers were read :—

1. "Gold-mining in Britain, with special reference to Recent Discoveries of Gold in Wales." By John Hopkinson, F.L.S., F.G.S., etc.

2. "A Record of Water-level in a deep Chalk Well at Barley, Herts, 1864–86." By H. George Fordham, F.G.S. (*Transactions*, Vol. V, p. 20.)

Mr. Littleboy stated that the water in the River Gade was lower now than he ever remembered it to have been, and he enquired whether the wells in the Chalk were affected in the same way.

Prof. Attfield replied that such was the case, the water in his own well at Watford being lower than it had been for several years.

Dr. Brett mentioned that Mr. Wailes kept a record of the height of the water in the well at the London Orphan Asylum, Watford.

Mr. Verini said that the Society should have the results of his observations on the height of the water in the Colne Valley Water Company's well.

Mr. Hopkinson said that a Committee of the British Association was investigating the circulation of underground waters, and he hoped would receive valuable assistance from members of the Society.

3. "Contributions to the Knowledge of the Entomological Fauna of Hertfordshire. No. 1.—Lepidoptera." By J. Hartley Durrant, F.E.S. (*Transactions*, Vol. V, p. 63.)

Mr. T. A. Dennison* and Mr. John Weall were nominated auditors of the accounts for 1887.

* Mr. Dennison being unable to serve, Mr. H. Cayley consented to act as auditor in his place.

Anniversary Meeting, 21st February, 1888.
(At Watford.)

F. M. Campbell, Esq., F.L.S., F.Z.S., etc., President, in the Chair.

The Report of the Council for 1887, and the Treasurer's Account of Income and Expenditure, were read and adopted.

The President delivered an Address on "The Means of Protection possessed by Plants." (*Transactions*, Vol. V, p. 1.)

The following gentlemen were duly elected as the Officers and Council for the ensuing year :—

President.—F. M. Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S.

Vice-Presidents.—Prof. Attfield, M.A., Ph.D., F.R.S., F.I.C., F.C.S.; Perceval Bosanquet; Alfred Fowell Buxton; Augustus Hawks; John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc.; Arthur Stradling, C.M.Z.S.

Treasurer.—John Weall.

Hon. Secretaries.—Frederick G. Lloyd, and Charles Edward Shelly, B.A., M.B.

Librarian.—F. Haycraft Berry, M.D.

Curator.—William Verini.

Other Members.—Allan Barraud; Arthur P. Blathwayt; Alfred T. Brett, M.D.; Richard B. Croft, R.N., F.L.S., F.R.M.S.; John Evans, D.C.L., LL.D., Treas.R.S., Pres.S.A., F.L.S., F.G.S.; Upfield Green; Daniel Hill; John E. Littleboy; John Morison, M.D., F.G.S.; Isaac Robinson; George Rooper, F.Z.S.; the Rev. E. T. Vaughan, M.A.

The thanks of the Society were accorded to Mr. R. B. Croft, F.L.S., and Dr. John Evans, F.R.S., retiring from the office of Vice-President; to Mr. C. R. Humbert retiring from the office of Treasurer; and to Mr. A. E. Gibbs, F.L.S., and Dr. Mark Hovell retiring from the Council.

Report of the Council for 1887.

The Council of the Hertfordshire Natural History Society and Field Club has the pleasure of reporting that there is no falling off in the amount of work done, in the number of meetings held, or in the number of members.

During the year twenty ordinary members have been elected, fourteen have resigned, and the Council regrets to have record the loss of six members by death, thus making the numbers of members exactly the same as last year.

	1886.	1887.
Honorary Members	20	20
Life Members	42	42
Annual Subscribers	197	197
	259	259

The following papers and lectures have been read or delivered during the year :—

Jan. 18, at Watford.—On Fish and Fish-culture ; by W. Oldham Chambers, F.L.S.

Feb. 15, at Watford.—Anniversary Address; by the President, Professor Attfield, Ph.D., F.R.S., F.I.C., F.C.S.

—— 24, at Hertford.—Observations on Diatomaceæ from the neighbourhood of Hertford ; by Isaac Robinson.

March 22, at Watford.—Notes on Birds observed in Hertfordshire during the year 1886 ; by J. E. Littleboy.

—— 31, at Hertford.—On some Points in the Anatomy of the Honey-bee; by R. T. Andrews.

April 19, at Watford.—Meteorological Observations taken at Wansford House, Watford, during the year 1886 ; by John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

—— Report on Phenological Phenomena observed in Hertfordshire during the year 1886 ; by John Hopkinson.

—— A Naturalist's Calendar for the Northern Border of Hertfordshire ; by H. George Fordham, F.G.S.

—— List of Flowering Plants observed in Hertfordshire during the year 1886 ; by Ada Selby.

—— Report on Insects observed in Hertfordshire during the year 1886 ; by F. W. Silvester, F.R.Met.Soc.

May 9, at St. Albans.—Earthquakes and their Relation to Volcanic Phenomena ; by F. W. Rudler, F.G.S., M.A.I.

—— 10, at Hertford.—The Hessian Fly ; by the President, F. M. Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S.

Nov. 3, at Hoddesdon.—Meteorological Observations taken at Watford during the year 1887 (an appendix to previous reports) ; by John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

—— Meteorological Observations taken at Throcking, Herts, during the year 1886 ; by the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

—— Report on the Rainfall in Hertfordshire in 1886 ; by the Rev. C. W. Harvey.

—— On *Walckenaëra interjecta*, a new Spider from Hoddesdon ; by the Rev. O. P. Cambridge, M.A., F.R.S.

—— 15, at Watford.—The Anthropoid Apes, in Relation to the Doctrine of Evolution ; by Arthur Nicols, F.G.S., F.R.G.S.

Dec. 13, at Hertford.—Wild Plants, their Attributes and Names ; by F. G. Lloyd, Hon. Sec.

The following Field Meetings were held during the year :—

April 16.—Springfield, St. Albans.
May 14.—Watford and Bushey.
June 4.—Rickmansworth.
—— 11.—Berkhamsted, Ashridge, and Aldbury.
—— 18.—St. Albans.
Oct. 13.—Broxbourne.

The Society visited the Zoological Gardens on May 28th, and is indebted to Mr. F. E. Beddard and Mr. Arthur Stradling, C.M.Z.S., for demonstrations. The meeting at Rickmansworth was held in conjunction with the Geologists' Association ; that at Broxbourne was the annual Fungus Foray and Cryptogamic Meeting.

The Society is indebted, for hospitality kindly accorded at the Field Meetings, to Mr. S. Monckton White, at Springfield, St. Albans ; to Mr. R. Attenborough, at Bushey ; to Dr. Brett, at the

Rickmansworth meeting; to Mr. Hopkinson, at St. Albans; and to Mr. H. J. Busby, at Wormleybury, Broxbourne.

The Library is in a satisfactory condition, and numerous works have been received during the year by donation and in exchange.

The 'Flora of Hertfordshire,' which has been in the press for the last two years, was published and issued to subscribers in December. The completion of this most valuable contribution to the Natural History of Hertfordshire, a work of 650 pages, is an era in the history of the Society which calls for more than a passing notice. The name of the author, Alfred Reginald Pryor, whom we have hitherto known as R. A. Pryor (reversed initials being adopted by him to avoid confusion with his father), has frequently appeared in our annual reports, in the very first (that for 1875) as the contributor of botanical papers, and in that for 1881 in the record of his death in that year and his bequest to the Society. Since then, in every report, some steps taken with regard to the publication of the work of his life have been chronicled, and although its preparation for the press was from various causes delayed for some years, the time that has elapsed since the editorship was entrusted to Mr. Daydon Jackson cannot be considered of undue length when the difficulties attending it are taken into consideration,—difficulties which only those who have undertaken similar work can fully appreciate. Mr. Jackson has been assisted by Mr. A. E. Gibbs, who transcribed the original MS., and by Mr. John Hopkinson, who revised the proofs and contributed the map of the botanical districts and the greater portion of the Introduction. The thanks of the Society are also due to Mr. J. Vincent Elsden for the use of the blocks of the two maps introduced to illustrate the superficial geology of the county.

The work has necessarily entailed a great expense upon the Society. The large-paper edition of 50 copies having been fully subscribed for, except one copy sent to the British Museum Library in accordance with the Copyright Act, and two copies reserved for the Society's library, has realised the cost of its production; but of the small-paper edition only about 100 of the 500 copies printed have so far been disposed of, leaving a considerable deficit, which can only be covered by the sale in course of years of the greater part of the stock remaining on hand.

Owing to the expense of the production of the 'Flora,' it has been necessary to curtail to some extent the Society's 'Transactions,' each quarterly part of which, for the last two years, has consisted of 32 instead of the usual 48 pages. Four parts of Vol. IV, containing 128 pages and one plate, were issued during the year, and the volume will be completed in two more parts, one containing the proceedings of the last two sessions, and the other the title-page, contents, index, etc.

In conclusion the Council has to express the thanks of the Society to the Committee of the Watford Public Library for the accommodation afforded.

INCOME AND EXPENDITURE FOR THE YEAR ENDING 31*st* *DECEMBER*, 1887.

Dr.	£	s.	d.
To Balance from 1886	40	16	8
,, Entrance Fees	9	10	0
,, Subscriptions for 1885	4	0	6
,, ,, ,, 1886	17	10	6
,, ,, ,, 1887	67	12	0
,, ,, ,, 1888	11	10	0
,, Dividends on £203 4*s.* 6*d.* Consols (less Income Tax)	5	18	4
,, Subscriptions for 'Flora of Hertfordshire'	69	0	6
,, Sale of 'Transactions'	2	3	2
	£228	1	8

Cr.	£	s.	d.
By Printing 'Flora of Hertfordshire'	88	1	9
,, ,, 'Transactions'*	5	2	6
,, Miscellaneous Printing	8	17	6
,, Expenses of Meetings	11	17	0
,, Library	4	5	0
,, Salary of Assistant	6	0	0
,, Postages	15	1	10
,, Various small expenses.	0	16	6
,, Balance at Bank	87	19	7
	£228	1	8

Amount invested in the purchase of £203 4*s.* 6*d.* Consols . . . . £198 15*s.*

Audited and found correct this 20th day of February, 1888, { HENRY CAYLEY, JOHN WEALL.

* Due for printing 'Transactions' in 1887: £46 13*s.* 9*d.*

Additions to the Library in 1887.

Presented.

Title.	Donor.
British Association for the Advancement of Science. Report, 1886. 8vo. London, 1887	*The Association.*
Cooke, M. C. (Ed.) Grevillea. Vol. xvi, Nos. 75–78. 8vo. London, 1887	*The Editor.*
Henslow, Rev. G. First Report on the Effects of the Severe Frosts on Vegetation during the Winters of 1879-80 and 1880-81. 8vo. London, 1887 . .	*The Author.*
Hughes, Prof. T. McK. Notes on the Geology of the Vale of Clwyd. (*Proc. Chester Soc. Nat. Sci.* 1884.) . .	”
——. On some Perched Blocks and Associated Phenomena. (*Quart. Journ. Geol. Soc.* 1886.)	”
——. On the Geology of Anglesey.—No. 2. (*Ib.* 1882.) .	”
——. International Geological Congress. Report of Sub-committee, 1885. 8vo.	”
Linnean Society. Transactions. Botany. Second Series. Vol. ii, parts 2–8. Zoology. Second Series. Vol. ii, parts 5-11 and 13, 14. Vol. iii, parts 1-3. 4to. London, 1882-85.	*Mr. R. B. Croft.*
——. Journal. Botany. Vol. xxi, Nos. 138-140; Vol. xxii, Nos. 141-147; Vol. xxiii, No. 151. Zoology. Vol. xix, Nos. 109-115; Vol. xx, No. 116; Vol. xxi, No. 126. 8vo. London, 1885-86.	”
——. Proceedings. 1883-86. *Ib.* 1886	”
Marr, J. E. The Earth History of the Remote Past compared with that of Recent Times. 8vo. Cambridge, 1886	*The Author.*
National Fish-Culture Association. Vol. i, No. 4. 8vo. London, 1887	*The Association.*
Ormerod, Miss E. A. Report of Observations of Injurious Insects for 1886. 8vo. London, 1887 . . .	*The Authoress.*
——. The Hessian Fly in Great Britain in 1887. 8vo. London, 1887	”
Owen, Sir R. Description of Fossil Remains of two Species of a Megalian Genus (*Meiolania*). (*Phil. Trans. Roy. Soc.* 1886.).	*The Author.*
——. Additional Evidences of the Affinities of the Extinct Marsupial Quadruped, *Thylacolea carnifex* (Owen). (*Ib.* 1887.)	”
——. On the Skull and Dentition of a Triassic Saurian (*Galesaurus planiceps*, Owen). (*Quart. Journ. Geol. Soc.* 1887.)	”
Price, F. G. H. A Monograph of the Gault. 8vo. London, 1879	”
Strahan, A. Note on the Relations of the Lincolnshire Carstone. (*Quart. Journ. Geol. Soc.* 1886.) . .	*Mr. W. Whitaker.*
Symons, G. J. (Ed.) Monthly Meteorological Magazine. Vol. xxii. 8vo. London, 1887	*The Editor.*
Whitaker, W. On the Lincolnshire Carstone. (*Quart. Journ. Geol. Soc.* 1886.)	*The Author.*
——. Further Notes on the Results of some Deep Borings in Kent. (*Ib.* 1887.)	”
——. Sanitary Institute of Great Britain. Address to Section III. York, 1886. 8vo.	”
Whitehead, C. Hints on Vegetables and Fruit-farming. (*Journ. Royal Agric. Soc.* 1882.)	
Wood, S. V. On the Pebble Beds of Middlesex, Essex, and Herts. (*Quart. Journ. Geol. Soc.* 1868.) . . .	*Mr. W. Whitaker.*

Title.	Donor.
Zoological Society. Transactions. Vol. xii, parts 4-6. 4to. London	*Mr. A. Stradling.*
——. Proceedings, 1885, part 4, 1886, parts 1-4, 1887, part 1. 8vo. London, 1885-87.	,,

Received in Exchange.

American Museum of Natural History. Annual Report for 1886–87. 8vo. New York, 1887.

———. Bulletin. Vol. i, Nos. 7–8. Vol. ii, No. 1. *Ib.* 1886–87.

Bath Natural History and Antiquarian Field Club. Proceedings. Vol. vi, No. 2. 8vo. Bath, 1887.

Belfast Natural History and Philosophical Society. Annual Report and Proceedings. Vol. ii, part 6. 8vo. Belfast, 1887.

Birmingham Philosophical Society. Proceedings. Vol. v, part 2. 8vo. Birmingham, 1887.

Boston Society of Natural History. Proceedings. Vol. xxiii, part 2. 8vo. Boston (U.S.A.), 1886.

Brighton and Sussex Natural History Society. Annual Reports for 1885–86, and 1886–87. 8vo. Brighton [1886–87].

Bristol Naturalists' Society. Proceedings. Vol. v, part 2. 8vo. Bristol, 1887.

Cardiff Naturalists' Society. Report and Transactions. Vols. xviii, xix, part 1. 8vo. Cardiff, 1887.

———. The Flora of Cardiff. 8vo. [Cardiff,] 1886.

Chester Society of Natural Science. Annual Report for 1886–87. 8vo. Chester, 1887.

Conchology, Journal of. Vol. v, Nos. 5–8. 8vo. Leeds, 1887.

Eastbourne Natural History Society. Transactions. Vol. i, part 11, Vol. ii, part 1. 8vo. Eastbourne, [1887].

Cumberland and Westmoreland Association. Transactions. No. 12. 8vo. Carlisle, 1887.

East Kent Natural History Society. 19th, 25th, and 26th Annual Reports. 8vo. Caterham, 1883–84.

Edinburgh. Botanical Society. Transactions and Proceedings. Vol. xvi, part 3. 8vo. Edinburgh, 1887.

——— Geological Society. Transactions. Vol. v, parts 2, 3. 8vo. Edinburgh, 1886-87.

——— ———. Catalogue of the Library. *Ib.* 1887.

———. Royal Physical Society. Proceedings, 1886-87. 8vo. Edinburgh, 1887.

Glasgow, Geological Society of. Transactions. Vol. viii, part 1. 8vo. Glasgow, 1887.

——— Natural History Society. Proceedings and Transactions. N.S. vol. i, part 3. 8vo. Glasgow, 1887.

———, Philosophical Society of. Proceedings. Vol. xviii. 8vo. Glasgow, 1887.

Liverpool Geological Society. Proceedings. Vol. v, part 3. 8vo. Liverpool, 1887.

——— Literary and Philosophical Society. Proceedings. Vol. xl. 8vo. Liverpool, 1886.

——— Naturalists' Field Club. Proceedings for 1886-87. 8vo. Liverpool, 1887.

——— Scientific Students' Association. Annual Report and Proceedings, 1886-87. 8vo. Liverpool, 1887.

London. Entomological Society. Proceedings for 1886. 8vo. London, [1887].

———, Geological Society of. Abstracts of the Proceedings. Session 1886-87. 8vo. London, 1887.

LONDON. GEOLOGISTS' ASSOCIATION. Proceedings. Vol. ix, Nos. 5-8, Vol. x, Nos. 1, 2. 8vo. London, 1886-87.
———. QUEKETT MICROSCOPICAL CLUB. Journal. Ser. II, Vol. iii, Nos. 17-20. 8vo. London, 1887.
———. ———. Annual Reports for 1872 and 1874. 8vo. London, 1873-75.
———. ROYAL METEOROLOGICAL SOCIETY. Quarterly Journal. Vol. xiii, Nos. 61-64. 8vo. London, 1887.
———. ———. The Meteorological Record. Vol. vi, Nos. 23-26. *Ib.*
———. ROYAL MICROSCOPICAL SOCIETY. Journal. Ser. 2, vol. vii. 8vo. London, 1887.
MANCHESTER GEOLOGICAL SOCIETY. Transactions. Vol. xix, parts 2–12. 8vo. Manchester, 1887.
——— SCIENTIFIC STUDENTS' ASSOCIATION. Reports and Proceedings for 1886. 8vo. [Manchester,] 1887.
MARLBOROUGH COLLEGE NATURAL HISTORY SOCIETY. Report for 1886 (No. 35). 8vo. Marlborough, 1887.
MIDLAND NATURALIST. Vol. x. 8vo. Birmingham, 1857.
NATURALIST. New Series. Vol. xii. 8vo. Leeds, 1887.
NEW YORK ACADEMY OF SCIENCES. Annals. Vol. iii, Nos. 11, 12. Transactions. Vol. v, parts 7, 8. 8vo. New York, 1887.
——— MICROSCOPICAL SOCIETY. Journal. Vol. i, No. 3. 8vo. New York, 1886.
——— STATE MUSEUM OF NATURAL HISTORY. 38th and 39th Annual Reports. 8vo. Albany, 1885–86.
——— STATE LIBRARY. Annual Reports of the Trustees for the years 1884–86. 8vo. Albany, 1885–87.
NORTHAMPTONSHIRE NATURAL HISTORY SOCIETY. Journal. Vol. vi. 8vo. Northampton, 1887.
NOTTINGHAM NATURALISTS' SOCIETY. Transactions and Annual Report for 1886. 4to. Nottingham, [1887].
RUGBY SCHOOL NATURAL HISTORY SOCIETY. Report for 1886. 8vo. Rugby, 1887.
SCIENCE GOSSIP. Vol. xxiii. 8vo. London, 1887.
SMITHSONIAN INSTITUTION. Annual Report for 1884, part 2; 1885, part 1. 8vo. Washington, 1885–86.
UNITED STATES GEOLOGICAL SURVEY. Sixth Annual Report, 1884–85. 4to. Washington, 1885.
———. Bulletin, Nos. 27–33. 8vo. Washington, 1886.
———. Monographs. Vol. x. Extinct Order of Gigantic Mammals (Dinocerata). 4to. Washington, 1886.
———. ———. Vol. xi. Geological History of Lake Lahontan. By Israel Cork Russell. 4to. Washington, 1885.
———. Mineral Resources of the United States . . . . 1885. By David T. Day. 8vo. Washington, 1886.
WILTSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY. Magazine. Vol. xxiii. 8vo. Devizes, [1887].
YORKSHIRE NATURALISTS' UNION. Transactions. Part 9. 8vo. Leeds, 1886.

PURCHASED.

BOTANY, Journal of. New Series, vol. xvi. 8vo. London, 1887.
BUCKLER, W. The Larvæ of the British Butterflies and Moths. Vol. ii. (*Ray Society.*) 8vo. London, 1887.
ENTOMOLOGIST. Vol. xx. 8vo. London, 1887.
GEOLOGICAL RECORD for 1879. 8vo. London, 1887.
YEAR-BOOK of the Scientific and Learned Societies of Great Britain and Ireland. Fourth Annual Issue. 8vo. London, 1887.
ZOOLOGIST. 3rd Series, Vol. xi. 8vo. London, 1887.

Ordinary Meeting, 28th February, 1888, at Hertford.

F. M. Campbell, Esq., F.L.S., F.Z.S., etc., President, in the Chair.

Mr. C. Giles-Puller, Youngsbury, Ware, and the Honourable Walter Rothschild, Tring Park, were proposed as Members of the Society.

The following paper was read :—

" Some Methods of Moth-collecting." By R. W. Bowyer, M.A. (*Transactions*, Vol. V, p. 23.)

Ordinary Meeting, 20th March, 1888, at Watford.

John Hopkinson, Esq., F.L.S., F.G.S., etc., Vice-President, in the Chair.

Mr. E. Harby, Mr. C. Giles-Puller, the Honourable Walter Rothschild, and Mr. W. P. Young, were elected Members of the Society.

The Rev. J. Harvey Bloom, B.A., St. Andrew's Street, Hertford, and Mr. Allan Maclean, L.R.C.S., The Hall, Harpenden, were proposed as Members.

The following paper was read :—

" Notes on Birds observed in Hertfordshire during the year 1887, and on the Birds frequenting the Tring Reservoirs." By John E. Littleboy. (*Transactions*, Vol. V, p. 76.)

Ordinary Meeting, 27th March, 1888, at Hertford.

Augustus Hawks, Esq., Vice-President, in the Chair.

The following paper was read :—

" Some Reminiscences of Hertford in the 17th and 18th Centuries." By R. T. Andrews.

Ordinary Meeting, 16th April, 1888, at St. Albans.

F. M. Campbell, Esq., F.L.S., F.Z.S., etc., President, in the Chair.

The following paper was read :—

" The Meteorite of the 20th of November, 1887." By H. George Fordham, F.G.S. (*Transactions*, Vol. V, p. 33.)

Field Meeting, 28th April, 1888.

PRÉ WOOD, ST. ALBANS.

The first field meeting of the season was arranged with the special object of collecting mosses, but it was not successful in this respect; a continuance of dry weather had much interfered with their growth, and very few species were found, none being rare.

A party of about thirty assembled at the London and North Western Station and crossed the fields to the raised path on the site of the ancient causeway, thence proceeding by the footpath through the wood into Watling Street. On one side of this path are the ruins of a Roman wall, built of flints with courses of Roman tiles, and on the other is a deep fosse, the wall and fosse together apparently having formed an important section of the defensive works of Verulam. This spot is now locally known as the "Verulam Hills," and the section of Watling Street which was then entered, as King Harry Lane. From the footpath near the lower end of the wood a block of the old wall of Verulam was seen, and in a field just beyond the point where Watling Street is crossed by the Hempstead Road there is another block of this wall, on which was found in fruit the curious extinguisher moss, *Encalyptus vulgaris*.

Pré Wood was entered near the farm just across this field and was strolled through into Gorhambury Park. In the wood the wood-anemone (*Anemone nemorosa*), wood-sorrel (*Adoxa moschatelina*), blue-bell (*Endymion nutans*), and daffodil (*Narcissus Pseudo-narcissus*), were found in flower, and a few mosses were collected.

The return walk was by Gorham Block and through the Hollows, along King Harry Lane for a short distance, and then across the fields to Woad Mead, where the members and their friends were very kindly entertained at tea by Mr. and Mrs. Phillips.

The meeting was under the direction of Mr. Hopkinson, with Dr. Braithwaite and Mr. A. E. Gibbs as bryologists.

Ordinary Meeting, 8th May, 1888, at Watford.

Professor Attfield, Ph.D., F.R.S., etc., Vice-President, in the Chair.

The Rev. J. Harvey Bloom, B.A., and Mr. Allan Maclean, L.R.C.S., were elected Members of the Society.

A letter was read from the Secretaries of the International Geological Congress stating that the fourth triennial meeting of the Congress would be held in London (in Burlington House) from the 17th to the 22nd of September, and inviting members of the Society to become members of the Congress.

The following papers were read :—

1. "The International Geological Congress, with special reference to the London Meeting in 1888." By John Hopkinson, F.L.S., F.G.S., etc.*

2. "Report on Flowering Plants observed in Hertfordshire during the year 1887." By Ada Selby.

3. "Report on Insects observed in Hertfordshire in 1887." By F. W. Silvester, F.R.Met.Soc. (*Transactions*, Vol. V, p. 89.)

4. "Fish-fatality in the River Colne at Watford." By Alfred T. Brett, M.D. (*Transactions*, Vol. V, p. 93.)

* A copy of this paper was inserted in part 1 of the present volume.

Field Meeting, 12th May, 1888.

CHANDLER'S CROSS, WATFORD.

From Watford Station, the party, about forty in number, under the direction of Mr. Upfield Green, walked through Cassiobury Park and Whippendale Woods to Chandler's Cross. Then taking the private road leading to Micklefield, in a wood by the roadside half a mile beyond Chandler's Cross, was seen the swallow-hole and chalk-pit which it was the chief object of this meeting to examine.

The depth of the subsidence or erosion of the chalk in this dell was found to be from ten to fifteen feet, and the flints, occurring abundantly both in the superincumbent soil and in the chalk itself, were observed to present, without exception, evidence of erosive infiltration, resulting in geodes, some of which presented a banded structure, consisting of flint, chalcedony, and quartz crystals.

Referring to these flints, the Director stated that they illustrated one of Nature's battle-fields in which the two "great powers," silica or silicic acid and carbonic acid, had contended for mastery. The object of their ceaseless and never-ending strife was the possession of the various bases, such as lime, potash, soda, and magnesia; and the possessions of each appeared to be constantly exposed to attack by its opponent. In the depths of the earth-crust silica appeared to reign supreme, while at or near the surface carbonic acid successfully disputed its sway. The only base which silica succeeded under all circumstances in retaining was alumina, the silicate of which appeared to be as unaffected by carbonic acid as silica itself. This was well observed in the decomposition of felspars. Exhibiting various flints taken from the Chalk, Mr. Green showed how in some cases they were concretionary, and in others pseudo-morphic after organic remains, but that in all cases a subsequent alteration had taken place. In some cases this was probably owing to the decomposition of the silicate of lime by the constant percolation of water charged with carbonic acid dissolving out the lime, freeing the associated silica, and leaving it in the form of a siliceous meal, while in others the colloid silica had been dissolved out, allowing a re-arrangement of the crystalline particles in the form of chalcedony and quartz crystals. In some specimens the intermediate stages could be well observed. The late Dr. Mohr, of Bonn, had admirably compared the relationship of colloid to crystalline silica with that of barley-sugar to sugar-candy, the former in each case being readily soluble, the latter with greater difficulty, while the intermediate micro-crystalline forms of silica presented by flint, chalcedony, etc., would find their analogues in the more or less easily-soluble forms of so-called moist sugar.

This Chalk dell, and the small wood or spinney in which it is situated, were then searched by the botanists of the party, and the columbine (*Aquilegia vulgaris*), coralwort (*Dentaria bulbifera*), and spurge-laurel (*Daphne Laureola*) were found. The following mosses, also, were collected and identified by Mr. A. E. Gibbs:—

Acrocarpi.	Pleurocarpi.
Dicranella heteromalla, Hedw.	*Thuidium tamariscinum*, Hedw.
Dicranum scoparium, L.	*Brachythecium rutabulum*, *L.*
Barbula fallax, Hedw.	*Eurhynchium piliferum*, Schreb.
Mnium hornum, L.	*Amblystegium serpens*, Schpr.
Polytrichum commune, L.	*Hypnum cupressiforme*, L.

After partaking of tea, kindly provided by the Director and Mrs. Green, the return walk was commenced. The fine avenue of oaks and beeches at Red Heath ("Finch's Avenue") was first passed through, and here the lesser periwinkle (*Vinca minor*) was seen, and the coralwort again. From Red Hall the fields were crossed to Cassiobury Park, and Watford was reached by a rather different route through the Park from that taken on the outward walk.

The following birds are reported by Mr. Henry Lewis as seen or heard during the walk :—song-thrush, redbreast, nightingale, greater whitethroat, chiff-chaff, willow-warbler, hedge-sparrow, coal tit, blue tit, nuthatch, tree-pipit, spotted flycatcher, swallow, martin, greenfinch, house-sparrow, chaffinch, yellow bunting, jay, starling, jackdaw, rook, skylark, cuckoo, turtle-dove, pheasant, common partridge, and lapwing.

Field Meeting, 26th May, 1888.
ST. PETER'S, ST. ALBANS.

From St. Peter's Church, the place of meeting, the members, about twenty-five in number, under the guidance of Mr. A. E. Gibbs, crossed St. Peter's Park into Sandpit Lane. On arriving at Hall Heath the Avenue was entered, and then Beaumont's Farm was visited, and the traces of the moat which surrounded the mansion formerly occupying this site were viewed. The old house, Mr. Gibbs stated, was destroyed by fire about a century ago, and the three cottages at the entrance to the avenue, and also the Half-way House on the Harpenden Road, were built with bricks from its ruins. Near its site an oak supposed to have been planted by Oliver Cromwell was growing until a few years ago, when it was destroyed by fire. In crossing the orchard the silver-moss (*Bryum argenteum*) was seen growing in profusion on the walls.

The road to Marshall's Wick was then taken for a short distance, and a circuit was made along the green lanes on the east into the same road a little further on. In a small pond that was passed, the Canadian pond-weed (*Anacharis Alsinastrum*) was seen growing, and it seemed difficult to account for its presence so far from any large body of water or running stream. Introduced into England about forty years ago, this plant has spread so rapidly that it now chokes up rivers and ponds all over the country.

On the return walk by Sandpit Lane the subterranean trefoil (*Trifolium subterraneum*) was seen, and the curious habit it has of burying its seed-pods in the earth by the motion of its flower-stalk was remarked upon.

On reaching St. Albans tea was kindly provided by Mr. Gibbs at his residence, The Hollies.

In the course of the walk, nests of the whitethroat, willow-warbler, and chaffinch were seen, and eggs of the blackbird were picked up. The following is a list of the plants observed, the flowering plants recorded being either in bud, flower, or seed.

PHANEROGAMIA.

Dicotyledonæ.

Ficaria verna, Huds.
Ranunculus repens, L.
,, *acris*, L.
,, *auricomus*, L.
,, *bulbosus*, L.
Raphanistrum innocuum, Med.
Barbarea vulgaris, R. Br.
Cardamine pratensis, L.
Alliaria officinalis, Andrz.
Capsella Bursa-pastoris, Moench.
Viola Riviniana, Reichb.
,, *canina*, L.
,, *tricolor*, L.
Cerastium viscosum, L.
,, *semidecandrum*, L.
Stellaria media, Cyr.
,, *Holostea*, L.
,, *uliginosa*, Murr.
Geranium Robertianum, L.
Acer pseudoplatanus, L.
,, *campestre*, L.
Ilex Aquifolium, L.
Ulex europæus, L.
Trifolium medium, L.
,, *subterraneum*, L.
Lotus corniculatus, L.
Vicia sativa, L.
Prunus avium, L.
,, *spinosa*, L.
Fragaria vesca, L.
Potentilla Fragariastrum, Ehrh.
Pyrus Malus, L.
Cratægus oxyacantha, L.
Anthriscus silvestris, Hoffm.
Conopodium denudatum, Koch.
Sanicula europæa, L.
Galium Aparine, L.
Asperula odorata, L.
Senecio vulgaris, L.
Bellis perennis, L.
Taraxacum officinale, Weber.
Fraxinus excelsior, L.
Myosotis cæspitosa, K. F. Schultz.
,, *versicolor*, Sm.
Scrophularia nodosa, L.
Veronica Chamædrys, L.
,, *serpyllifolia*, L.
Ajuga reptans, L.
Lamium album, L.
,, *purpureum*, L.
Galeobdolon luteum, Huds.
Glechoma hederacea, L.
Primula officinalis, Jacq.
Plantago lanceolata, L.
Rumex Acetosa, L.
,, *Acetosella*, L.
Mercurialis perennis, L.
Quercus pedunculata, Ehrh.
Salix Caprea, L.

Monocotyledonæ.

Orchis maculata, L.
Scilla nutans, Sm.
Arum maculatum, L.
Luzula maxima, DC.
,, *campestris*, DC.
Carex silvatica, Huds.
Anthoxanthum odoratum, L.
Alopecuris myosuroides, Huds.
Melica uniflora, Retz.

CRYPTOGAMIA.

Musci.

Acrocarpi.

Barbula ruralis, L.
Bryum argenteum, L.

Pleurocarpi.

Thuidium tamariscinum, Hedw.
Homalothecium sericeum, L.
Eurhynchium striatum, Schreb.
,, *prælongum*, Dill.
Amblystegium serpens, L.
Hypnum cupressiforme, L.
,, *cuspidatum*, L.
Hylocomium squarrosum, L.

Hepaticæ.

Frullania dilatata, Dum.

Lichenes.

Lichenacei.

Ramelina fraxinea, L.
Parmelia caperata, L.
,, *olivacea*, L.
Physcia parietina, L.
Lecanora atra, Huds.
Pertusaria communis, DC.
,, *fallax*, Pers.

Field Meeting, 2nd June, 1888.

ALDBURY AND ASHRIDGE PARK.

A numerous party assembled at Tring Station under the direction of Mr. J. E. Littleboy. Some rode direct from the station to Aldbury, and others walked across Aldbury Meads and through Owers Wood. All leaving Aldbury together, ascended the hill on which the Bridgewater Monument stands, and then dispersed in small parties to investigate the natural history of the neighbourhood, meeting again at the foot of the monument, where tea was kindly provided by Mr. Littleboy.

After tea had been partaken of, the party assembled on the edge of the Chalk ridge, where an extensive view was obtained over the Chalk hills and dales and the Gault plain beyond; and here Dr. John Evans, F.R.S., gave a short address on the geology and archæology of the neighbourhood. They were, he said, assembled on an escarpment of the Chalk. At the foot of the hills was a plain, which consisted of Gault Clay, and towards Leighton of the Lower Greensand. Although named Greensand, it need not be sand generally speaking, and it was red, and not green. In cutting the canal through Tring Summit, the Upper Greensand was found. Before them they had as it were a double escarpment, the Chalk escarpment and the Totternhoe escarpment, the latter being due to the existence of a hard bed at the bottom of the Chalk. The question occurred, to what was the deep valley in front of them due? He thought, though he could not speak with certainty, that it was due to subaërial action. At one time this country was covered with ice, and in many parts they found stones with glacial markings upon them. The valleys were partly excavated at the time of the last submergence, and glaciers had travelled over them. There were in these valleys at certain levels gravels which consisted of sandstone pebbles, which could have been brought from no nearer spot than Warwickshire. If they examined the escarpment between Aldbury and Dunstable, they would find running into it at certain places deep valleys as regular as railway-cuttings. In many of these coombes they still found running water, which contained much chalk in solution, and by this means these deep coombes were excavated. He could not help thinking that the valley immediately at their feet was really one of these coombes one side of which was at a different angle from the other. He thought they might consider that a great deal of that valley had been excavated by the agency of spring water cutting a channel. Dr. Evans then proceeded to speak of the archæological features of the district. The Chalk escarpment appeared, he said, to have been inhabited by early tribes, for a number of camps and burial mounds were found, and also worked flint implements of the neolithic period. These might be found anywhere at the foot of the downs. It was claimed that the village of Kimble was the burial-place of Cunobeline, better known to readers of Shakespeare as Cymbeline. There was a curious old charter in the British Museum, which mentioned a tribe called "Cunobelingas" as dwelling in this neighbourhood, and coins of Cunobeline had been found in the vicinity. In Roman times the place was inhabited, for at Moneybury Hill, which received its name from the coins found there, Roman remains had been discovered. In making a road many coins had been found ranging from A.D. 62 to A.D. 250, all of a large size, and also certain other smaller coins bringing the date down to 270. A great part of these were really forgeries. Moulds had been made from the Roman coins in which the spurious ones had been cast. There were evidently people in Hertfordshire in those days who were willing to turn an honest penny.

The return walk was then taken down the hill by way of Aldbury and direct to Tring Station.

Field Meeting, 9th June, 1888.

HARPENDEN.

This meeting was held in conjunction with the Bedfordshire Natural History Society, and under the direction of Dr. Morison, F.G.S. Its object was the study of the geological features of the neighbourhood of Harpenden. Owing to wet weather it was not numerously attended.

Assembling at the Midland Station, Harpenden, a section of the Upper Chalk by the roadside near the station was first examined, and the party then proceeded to the Cold Harbour cutting on the Luton branch of the Great Northern Railway, where the Chalk Rock, which forms the top bed of the Middle Chalk, is well exposed. There is also evidence of its presence close to the surface a little lower down the valley of the Lea, its most eastern point in Hertfordshire.

After crossing the fields for a short distance the Midland line was again reached, and at the new junction (just about to be opened) of the Hemel Hempstead branch, connecting it with the down main line, a good section of the Upper Chalk showed the extreme irregularity of its upper surface, due doubtless to its varying solubility. The depressions or "pipes" in the chalk thus produced by solution were seen to be filled up by clay-with-flints, believed to be the insoluble residue of the chalk, and by brick-earth, sand, and gravel, presumably of glacial age.

Walking along the line, by permission of the Manager of the Midland Railway, the cutting was soon left for an embankment crossing the Harpenden valley, and it was noticed how the bottom of the valley is covered with river-gravel, showing that a stream of water must at one time have flowed along it, doubtless to join the River Lea. The Chalk, which comes to the surface on the slopes of the hills, was seen to be capped on their summits by clay-with-flints and glacial deposits.

In a shallow cutting mottled clay and red and white sands showed the presence of the Woolwich and Reading Beds. They also appear in a disused brickfield a short distance to the south of the line, but there was not time to visit it.

Along the embankment and in this cutting several interesting plants were collected, amongst which may be mentioned the field cerast (*Cerastium arvense*) not before recorded from here, and the Nottingham catchfly (*Silene nutans*), for which the only station in the county hitherto on record is an old wall in Dagnall Street, St. Albans, where it was growing in 1820, but from which it has long since disappeared.

On leaving the line a green lane was taken for a short distance, and then the fields were crossed to Harpenden, and at Harpenden Hall the members of the two Societies were hospitably entertained at tea by Dr. and Mrs. Maclean, to whom thanks were accorded on the proposition of Mr. Hopkinson on behalf of the Herts Society, seconded by Mr. Cameron on behalf of the Bedfordshire Society.

Field Meeting, 16th June, 1888.
BROXBOURNE and HODDESDON.

From Broxbourne Station the party, under the direction of Mr. H. Warner, proceeded by way of the beech avenue to Baas Hill, passing the quaint old Manor House of Baas, which has been converted into a cottage; thence by Carnel's Green (formerly Cardinal's Green) to St. John's Well, across the fields to the Berkhampstead Road, and by a cross-road into the Brickendon Road. These roads run through double avenues of fine beech trees.

On Broxbourne Common a pond furnished a number of plants of the bladderwort (*Utricularia vulgaris*) of interest for its carnivorous propensities. The Common was left by the Roman Road, now called Elbow Lane, and, passing through Hoddesdon Great Wood, the party arrived at Rose Hill, Hoddesdon, the residence of the President, Mr. F. M. Campbell, F.L.S., who very kindly provided refreshments. After a ramble through the picturesque grounds of Rose Hill, the party dispersed.

The specimens collected were named by Mr. A. E. Gibbs, F.L.S., Mr. T. B. Lowne, F.L.S., and Mr. J. R. Vaizey, F.L.S.

The following is a list of the mosses, furnished by Mr. Gibbs.

Acrocarpi.

Weissia cirrhata, Hedw.
Dicranella heteromalla, Hedw.
Dicranum scoparium, L.
Ceratodon purpureum, L.
Webera nutans, Schreb.
Mnium undulatum, Hedw.
,, *hornum*, L.
Aulacomnium palustre, L.
Atrichum undulatum, L.

Cladocarpi.

Fontinalis antipyretica, L.

Pleurocarpi.

Neckera complanata, L.
Thuidium tamariscinum, Hedw.
Homolothecium sericeum, L.
Brachythecium albicans, Neck.
,, *rutabulum*, L.
Eurhynthecium striatum, Schreb.
,, *prælongum*, Dill.
Rhynchostegium confertum, Dick.
Amblystegium serpens, L.
Hypnum cupressiforme, L.
,, *cuspidatum*, L.
,, *purum*, L.
Hylocomium squarrosum, L.

Mr. Gibbs also records the finding of the scale-mosses *Ricciella fluitans*, L., and *Cephalozia bicuspidata*, L., and the lichen *Parmelia parietina*, L.

Field Meeting, 30th June, 1888.

RICKMANSWORTH AND CHORLEY WOOD.

The last field meeting of the season was held in the neighbourhood of Rickmansworth, in conjunction with the Geologists' Association of London, and under the direction of Mr. Hopkinson. Its chief object was to examine sections of the Upper Chalk exposed in cuttings of the extension of the Metropolitan Railway beyond Rickmansworth now in progress, sections of the London Clay and Woolwich and Reading Beds along the same line of railway between Pinner and Rickmansworth having been examined on a former occasion.*

The route taken was through Rickmansworth and Loudwater Parks in the valley of the Chess, over the hill on the south-west into the dry valley which extends from Loudhams, about midway between Chenies and Amersham, to the valley of the Chess at Rickmansworth, and then up the next hill to Chorley Wood Kiln.

This is not now a brickfield, but part of the garden of a private house, the occupier of which allowed the members to inspect the section exposed. It is nearly on the edge of an outlier of the Reading Beds of about a square mile in extent, conspicuous from the valley below by forming a well-wooded eminence, and its chief interest is in showing an unusual development of the bottom-bed of flint-pebbles. This bed is 12 feet in thickness, and the pebbles, some of which are very large and might almost be called boulders, are closely packed together, only the interstices left by their spherical shape being filled up with sand. It is this bed which, somewhat similarly developed, forms, in the neighbourhood of Radlett, the well-known Hertfordshire conglomerate.

The following is Mr. Whitaker's description of the Reading Beds seen in this section: †—

Plastic clay (*paving clay*).
Clayey sand, brown and light-coloured, 1½ feet.
Red-mottled plastic clay (*tile-clay*).
Bluish-grey sandy clay (*devil*).
Green sandy clay (*fire-earth*), with an irregular line of ironstone nodules (*red-knob*); below which it is more sandy, and passes into
Green sand.
Bottom-bed.—Flint-pebbles, some very large, in sand, greenish towards the top, brown and light-coloured lower down; about 12 feet.

The junction with the Chalk was seen in a pit close by; and at a little distance to the west there is a swallow-hole formed by water falling as rain on the Reading Beds and flowing over or percolating through them to the edge of the Chalk, on meeting which it sinks through and dissolves it. This swallow-hole, it was found, now holds water, having evidently been artificially plugged by puddling in order to form a pond.

A footpath was then taken down to Chorley Wood Bottom, by which the Common was reached, and the return walk to Rick-

* See 'Transactions,' Vol. IV, p. xlvii.
† 'Geology of London,' p. 193.

mansworth was commenced where a cutting is being made through the south-western corner of the Common.

The route was now entirely along the new railway-line. An immense "pipe" in the Chalk first attracted attention, and the Director showed the identity of such pipes with swallow-holes, the chalk originally in them having been gradually dissolved and carried away by water holding carbonic acid in solution, and its place having been taken by the insoluble portions of the superincumbent strata, in this case chiefly sand and flint-pebbles. The probable origin of the dry valley before mentioned, part of which was now to be traversed, was then touched upon, and it was shown that the valley could be accounted for if the water-level in the Chalk had been in former times a little higher than it is now, when water would have flowed on the surface of the ground, instead of, as at present, only through the pervious chalk underground. This dry valley has been taken advantage of in the construction of the new line, which would without it have been a continuous cutting from Rickmansworth to Chorley Wood Common.

In the course of the return walk two deep cuttings were passed through, showing sections, about 90 feet in height, of the Upper Chalk entirely free from "pipes," owing to clay being on the surface and forming an impermeable capping, instead of gravel or sand which allow water to percolate through them.

On arrival at Rickmansworth the members of the two Societies had tea and then dispersed to their several destinations. The party numbered forty.

Ordinary Meeting, 27th November, 1888, at Watford.

Professor Attfield, Ph.D., F.R.S., etc., Vice-President, in the Chair.

The Chairman spoke of the great loss the Society had sustained by the recent death of Mr. John E. Littleboy, and of the valuable services he had rendered to the Society.

Mr. J. E. Daw, Elmhurst, Watford; Mr. T. Farries, 30, Clarendon Road, Watford; Mr. Sydney T. Klein, F.L.S., F.R.A.S., F.E.S., The Red House, Stanmore; and Mr. J. M. McLarty, Market Place, St. Albans, were proposed as Members of the Society.

The following lecture was delivered :—

"Rattlesnakes." By Arthur Stradling, C.M.Z.S.

The lecture was illustrated by living specimens.

Ordinary Meeting, 27th November, 1888, at Hertford.

F. M. Campbell, Esq., F.L.S., F.Z.S., President, in the Chair.

The President exhibited a moth, captured at Bull's Cross, near Waltham, which had been identified as the Alpine moth (*Setina aurita*, Linn.), but which he suggested might be merely a variety of the common dew moth (*S. irronella*, Aspa).

The following lecture was delivered :—

"Three Weeks in Newfoundland." By F. W. Headley, M.A.

Specimens and diagrams were exhibited in illustration of the lecture.

ORDINARY MEETING, 11TH DECEMBER, 1888, AT HERTFORD.

F. M. CAMPBELL, ESQ., F.L.S., F.Z.S., President, in the Chair.

Mr. Edward E. Berry, F.E.S., Much Hadham; Dr. A. Eteson, M.R.C.S., Clarendon Road, Watford; and Mr. A. S. Walker, Bonningtons, Watford, were proposed as Members of the Society.

The attendance of members being very small, the paper announced for reading was deferred, and the meeting was adjourned.*

ORDINARY MEETING, 18TH DECEMBER, 1888, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., etc., Vice-President, in the Chair.

Mr. E. E. Berry, F.E.S., Mr. J. E. Daw, Dr. A. Eteson, M.R.C.S., Mr. T. Farries, Mr. Sydney T. Klein, F.L.S., F.R.A.S., F.E.S., Mr. J. M. McLarty, and Mr. A. S. Walker, were elected Members of the Society.

Mr. F. J. Butcher, Tring, and Mr. J. Panton, Manor House, Watford, were proposed as Members.

The following lecture was delivered :—

"The Geological Work of Water." By John Morison, M.D., F.G.S.

ORDINARY MEETING, 22ND JANUARY, 1889, AT WATFORD.

F. M. CAMPBELL, ESQ., F.L.S., F.Z.S., President, in the Chair.

Mr. F. J. Butcher and Mr. J. Panton were elected Members of the Society.

The Rev. Arthur Johnson, M.A., The Rectory, Berkhamsted, and Mr. E. H. Loyd, Langleybury, Watford, were proposed as Members.

The following paper was read :—

"Birds: their Nests and Habits." By George Rooper, F.Z.S. (*Transactions*, Vol. V, p. 97.)

Mr. T. J. Broad and Mr. H. Cayley were nominated Auditors of the Accounts for 1888.

ANNIVERSARY MEETING, 22ND FEBRUARY, 1889.

(AT WATFORD.)

F. M. CAMPBELL, ESQ., F.L.S., F.Z.S., President, in the Chair.

The Report of the Council for 1888, and the Treasurer's Account of Income and Expenditure, were read and adopted.

The President delivered an Address on "Structural Variations in the Eyes of Animals in reference to their Function." (*Transactions*, Vol. V, p. 107.)

* The adjourned meeting was held on the 29th March, 1889 (see p. xxxv).

The following gentlemen were duly elected as the Officers and Council for the ensuing year :—

President.—The Right Honourable the Earl of Clarendon.

Vice-Presidents.—Prof. Attfield, M.A., Ph.D., F.R.S., F.I.C., F.C.S. ; Percival Bosanquet; F. M. Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S. ; Augustus Hawks; George Rooper, F.Z.S. ; Arthur Stradling, C.M.Z.S.

Treasurer.—John Weall.

Hon. Secretaries.—John Morison, M.D., F.G.S., and Charles Edward Shelly, B.A., M.B.

Librarian.—Upfield Green, F.G.S.

Curator.—A. E. Gibbs, F.L.S.

Other Members.—Allan Barraud; F. Haycraft Berry, M.D. ; A. P. Blathwayt ; Alfred T. Brett, M.D. ; Henry Cayley, F.R.C.S. ; R. B. Croft, R.N., F.L.S., F.R.M.S. ; John Evans, D.C.L., LL.D., Treas.R.S., Pres.S.A., F.L.S., F.G.S. ; Daniel Hill ; John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc. ; F. G. Lloyd ; Isaac Robinson ; Rev. E. T. Vaughan, M.A.

The thanks of the Society were accorded to Mr. A. Fowell Buxton and Mr. John Hopkinson retiring from the office of Vice-President ; to Dr. F. H. Berry retiring from the office of Librarian ; and to Mr. W. Verini retiring from the office of Curator.

Report of the Council for 1888.

The Council of the Hertfordshire Natural History Society and Field Club has again the pleasure of reporting the number of members, the amount of work done, and the number of meetings held.

During the year fifteen ordinary members have been elected, twenty-two have resigned, and the Council regrets to have to record the loss of four members (one honorary member, Dr. F. V. Hayden, one life member, and two annual subscribers) by death, thus making the number of members

	1887.	1888.
Honorary members	20	19
Life members	42	41
Annual subscribers	197	188
	259	248

The Council has to record the very serious loss the Society has sustained by the death of Mr. J. E. Littleboy, to whose services the Society has been so much indebted from its foundation, he having joined it in February, 1875, thus being one of the earliest members ; and since his first papers, "A Few Words on our Local Ferns" and "Notes on the Discovery of *Impatiens fulva* near Watford," read 11th November, 1875, the Society has been indebted to him for a variety of the most useful work ; more particularly as Ornithological Recorder, his reports on the ornithology of the county having shown a large amount of diligent and careful research, and having much helped in the work for which the Society was established. To his kindness, knowledge of the county, and hospitality, is due the success of many of the field meetings. The time he has devoted to the business of the Society, his constant attendance and assistance at the deliberations of the Council, can only be fully appreciated by those who have worked with him, and the Council cannot but express appreciation of what he has done, and regret for the loss sustained by the Society in consequence of his decease.

The following papers and lectures, which, with two exceptions, were by members of the Society, have been read or delivered during the year:—

Jan. 31, at Watford.—Gold Mining in Britain, with special reference to Recent Discoveries of Gold in Wales; by John Hopkinson, F.L.S., F.G.S., Treas. Geol. Assoc.

—— A Record of Water-level in a deep Chalk Well at Barley, Herts, 1864–86; by H. George Fordham, F.G.S.

—— Contributions to the Knowledge of the Entomological Fauna of Hertfordshire. No. 1.—Lepidoptera; by J. Hartley Durrant, F.E.S.

Feb. 21, at Watford.—Anniversary Address; by the President, F. M. Campbell, F.L.S., F.Z.S., F.R.M.S.

—— 28, at Hertford.—Some methods of Moth-collecting; by R. W. Bowyer, M.A.

March 20, at Watford.—Notes on Birds observed in Hertfordshire during the year 1887, and on the Birds frequenting the Tring Reservoirs; by the late J. E. Littleboy.

—— 27, at Hertford.—Some Reminiscences of Hertford in the 17th and 18th centuries; by R. T. Andrews.

April 16, at St. Albans.—The Meteorite of the 20th of November, 1887; by H. George Fordham, F.G.S.

May 8, at Watford.—The International Geological Congress, with special reference to the London Meeting in 1888; by John Hopkinson, F.L.S., F.G.S.

—— Report on Flowering Plants observed in Hertfordshire in 1887; by Ada Selby.

—— Report on Insects observed in Hertfordshire in 1887; by F. W. Silvester, F.R.Met.Soc.

—— Fish-fatality in the River Colne at Watford; by A. T. Brett, M.D.

Nov. 27, at Watford.—Rattlesnakes; by Arthur Stradling, C.M.Z.S.

—— at Hertford.—Three Weeks in Newfoundland; by F. W. Headley, M.A.

Dec. 18, at Watford.—The Geological Work of Water; by John Morison, M.D., F.G.S.

The following Field Meetings were held:—

April 28.—Pré Wood, St. Albans.
May 12.—Chandler's Cross, Watford.
—— 26.—St. Peter's, St. Albans.
June 2.—Aldbury and Ashridge Park.
—— 9.—Harpenden.
—— 16.—Broxbourne and Hoddesdon.
—— 30.—Rickmansworth and Chorley Wood.

The usual fungus foray was not held owing to the early frosts.

INCOME AND EXPENDITURE FOR THE YEAR ENDING 31*st* *DECEMBER,* 1888.

Dr.	£	s.	d.	Dr.	£	s.	d.
To Balance from 1887	87	19	7	By Printing 'Flora of Hertfordshire'	146	14	0
,, Entrance Fees	9	0	0	,, ,, 'Transactions'*	105	0	10
,, Subscriptions for 1886	3	10	0	,, Miscellaneous Printing	1	6	0
,, ,, ,, 1887	11	0	0	,, Printing [and Postage of] Circulars	11	9	3
,, ,, ,, 1888	64	0	0	,, Various [other] Postages	3	14	0
,, ,, ,, 1889	20	10	0	,, Expenses of Meetings	10	3	6
,, Sale of 'Transactions'	0	2	1	,, Library Expenses	1	8	0
,, Subscriptions for 'Flora of Hertfordshire'	11	0	0	,, Salary of Assistant	6	0	0
,, Sale of £203 4*s.* 6*d.* Consols (less expenses)	203	18	6	,, Stationery	3	2	8
				,, Various small expenses	1	17	6
				,, Purchase of £100 India 3 per cent. Stock	96	12	6
				,, Balance at Bank	23	11	11
	£411	0	2		£411	0	2

Audited and found correct this 19th day of February, 1889, { THOS. J. BROAD, HENRY CAYLEY.

* Including £46 13*s.* 9*d.* for the previous year.

The Society visited the Natural History department of the British Museum on April 21st, and is indebted to Mr. Fletcher for a demonstration on the collection of Meteorites.

The Society is indebted for hospitality kindly accorded, to Mrs. Phillips, at St. Albans; Mr. Upfield Green, at Micklefield; Mr. A. E. Gibbs, at St. Albans; Dr. Maclean, at Harpenden; and the President, at Hoddesdon.

The fourth volume of the present series of the Society's 'Transactions' has been completed, and the fifth volume has been commenced, two parts of the former and three of the latter, containing together 168 pages and two plates, having been published during the year.

The contents of the fourth volume cover a wide range of subjects. Of local papers there are in meteorology and phenology the usual annual reports, and a naturalists' calendar for North Herts; in geology there is an account of the earthquake of 1884, with details of its effects in Hertfordshire; in botany there are papers on our diatoms and carices; in zoology there are the usual annual reports on the insects and birds observed; and in pre-historic archæology an account is given of British and Roman remains found near Hitchin. There are also several short notes on the meteorology, geology, botany, and zoology of the county. In addition to these local papers the volume contains papers on the Solar System, on wild plants, on *Melicerta ringens*, on our social wasps, and on the Hessian-fly, which was first observed in Britain in our own county; and also the anniversary addresses delivered in 1886 and 1887. The thanks of the Society are due to Mr. William Ransom for the four plates illustrating his paper on British and Roman remains near Hitchin, and to Miss E. A. Ormerod for the use of the five woodcuts illustrating Mr. Campbell's paper on the Hessian-fly.

In conclusion the Council has to express the thanks of the Society to the Committee of the Watford Public Library for the accommodation afforded.

Additions to the Library in 1888.

Presented.

Title.	Donor.
British Association for the Advancement of Science. Report, 1887. 8vo. London, 1888	*The Association.*
Campbell, F. M. The Means of Protection possessed by Plants. (*Trans. Herts N.H. Soc.* 1888) . . .	*The Author.*
Cooke, M. C. (Ed.) Grevillea. Vol. xvi, Nos. 79-82. 8vo. London, 1888	*The Editor.*
Darwin, Erasmus. Zoonomia; or, the Laws of Organic Life. 2 vols. 4to. London, 1796	*Mr. J. Hopkinson.*
Elsden, J. V. On the Superficial Geology of the Southern Portion of the Wealden Area. (*Quart. Journ. Geol. Soc.* 1887.)	*The Author.*
Fletcher, L. An Introduction to the Study of Meteorites [2nd Ed.] 8vo. London, 1887	*Mr. J. Hopkinson.*
Foster, Le Neve. Cornish Tin Lodes, 1875-77 . .	*Dr. A. T. Brett.*

Title.	Donor.
Grover, J. W. [and others]. Water-supply from Wells. (*Proc. Inst. Civ. Eng.* 1887.)	*Mr. W. Whitaker.*
Klein, S. Lepidoptera. 8vo. Bath, 1887. . . .	*Dr. A. T. Brett.*
Ormerod, Miss E. A. Report of Observations of Injurious Insects for 1887. 8vo. London, 1888 . . .	*The Authoress.*
Piscarius. Artificial Production of Fish. 8vo. London, 1852	*Dr. A. T. Brett.*
Proctor, R. A. A New Star Atlas. 9th Ed. 8vo. London, 1882	*Mr. J. Hopkinson.*
Symons, G. J. (Ed.) Monthly Meteorological Magazine. Vol. xxiii. 8vo. London, 1888.	*The Editor.*
Whitley, C., and R. T. Andrews. A Perambulation of the Boundaries of Hoddesdon. 8vo. Hertford, 1888.	*The Authors.*
Zoological Society of London. Transactions. Vol. xii, part 7. 4to. London, 1888	*Mr. A. Stradling.*

Received in Exchange.

American Museum of Natural History. Reports, etc., for 1879, 1885, 1886, 1887. 8vo. New York, 1880-88.

Bath Natural History and Antiquarian Field Club. Proceedings. Vol. vi, No. 3. 8vo. Bath, 1888.

Belfast Naturalists' Field Club. Annual Report and Proceedings. Series 2, vol. ii, part 7. 8vo. Belfast, 1888.

Bristol Naturalists' Society. Proceedings. Vol. v, part 3. 8vo. Bristol, 1888.

Conchology, Journal of. Vol. v, Nos. 9-12. 8vo. London and Leeds, 1888.

Edinburgh. Botanical Society. Transactions and Proceedings. Vol. xvii, part 1. 8vo. Edinburgh, 1887.

———. Royal Physical Society. Proceedings. Session 1887-88. 8vo. Edinburgh, 1888.

Essex Naturalist. Vol. ii, parts 1-8. 8vo. Buckhurst Hill, 1888.

Glasgow Natural History Society. Proceedings. New Series, vol. ii, part 1. 8vo. Glasgow, 1888.

Lewisham and Blackheath Scientific Association. Proceedings, 1886-87. 8vo. Greenwich, 1888.

Liverpool Geological Society. Proceedings, Vol. v, part 4. 8vo. Liverpool, 1888.

Liverpool Naturalists' Field Club. Proceedings for 1887. 8vo. Liverpool, 1888.

London, Geological Society of. Abstracts of the Proceedings, Session 1887-88. 8vo. London, 1888.

———. Geologists' Association. Proceedings. Vol. x, Nos. 3-8. 8vo. London, 1888.

———. Quekett Microscopical Club. Journal. Second Series, vol. iii, Nos. 21, 22. 8vo. London, 1888.

———. Royal Meteorological Society. Quarterly Journal, Vol. xiv, Nos. 65-67. 8vo. London, 1888.

———. ———. The Meteorological Record. Vol. vii, Nos. 27, 28. 8vo. London, 1888.

———. Royal Microscopical Society. Journal. Ser. 2, vol. viii, parts 2-4. 8vo. London, 1888.

Manchester Geological Society. Transactions. Vol. xix, parts 13-20. 8vo. Manchester, 1888.

———. Literary and Philosophical Society. Proceedings. Vols. xxv-xxvii. 8vo. Manchester, 1885-87.

———. ———. Memoirs. Ser. III, vol. x. 8vo. *Ib.* 1887.

Marlborough College Natural History Society. Report for 1887. 8vo. Marlborough, 1888.

MIDLAND NATURALIST. Vol. xi. 8vo. Birmingham, 1888.
NATURALIST. New Series, vol. xiii. 8vo. Leeds, 1888.
NEW YORK STATE LIBRARY. Reports and Catalogues, 1885-87. 8vo. New York, 1886-88.
RUGBY SCHOOL NATURAL HISTORY SOCIETY. Report for 1887. 8vo. Rugby, 1888.
SCIENCE GOSSIP. Vol. xxiv. 8vo. London, 1888.
SMITHSONIAN INSTITUTION. Annual Report for 1885, part 2. 8vo. Washington, 1888.
SOMERSETSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY. Proceedings. Vol. xxviii. 8vo. Taunton, 1887.
UNITED STATES. DEPARTMENT OF AGRICULTURE. Tropical Fruits. 8vo. Washington, 1887.
———. ———. Adaptation of Fruits. 8vo. *Ib.*, 1888.
———. GEOLOGICAL SURVEY. Geology of Leadville, Colorado. With Atlas. 4to. Washington, 1886.
WILTSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY. Magazine. Vol. xxiv, No. 70. 8vo. Devizes, 1888.
YORKSHIRE GEOLOGICAL AND POLYTECHNIC SOCIETY. Proceedings. Vol. ix, part 3. 8vo. Halifax, 1888.
——— NATURALISTS' UNION. Flora of West Yorkshire. By F. Arnold Lees. 8vo. London, 1888.

PURCHASED.

BOTANY, JOURNAL OF. New Series, vol. xvii. 8vo. London, 1888.
ENTOMOLOGIST. Vol. xxi. 8vo. London, 1888.
GEOLOGICAL RECORD for 1880-84. Vol. i. 8vo. London, 1888.
MICHAEL, G. A. D. British Oribatidæ. Vol. ii. (*Ray Society.*) 8vo. London, 1888.
YEAR-BOOK of the Scientific and Learned Societies of Great Britain and Ireland. Fifth Annual Issue. 8vo. London, 1888.
ZOOLOGIST. Vol. xii. 8vo. London, 1888.

ORDINARY MEETING, 22ND MARCH, 1889, AT WATFORD.

H. CAYLEY, Esq., F.R.C.S., in the Chair.

The Rev. Arthur Johnson, M.A., and Mr. E. H. Loyd were elected Members of the Society.

The following papers were read:—

1. "A Naturalists' Calendar for the South-west of Hertfordshire." By John Hopkinson, F.L.S., F.G.S., etc. (*Transactions*, Vol. V, p. 129.)

2. "Report on Insects observed in Hertfordshire in 1888." By F. M. Silvester, F.R.Met.Soc. (*Transactions*, Vol. V, p. 134.)

3. "Notes on Birds observed in Hertfordshire during the year 1888." By John Hopkinson, F.L.S., F.G.S., etc. (*Transactions*, Vol. V, p. 139.)

ORDINARY MEETING, 25TH MARCH, 1889, AT ST. ALBANS.

JOHN HOPKINSON, Esq., F.L.S., F.G.S., etc., in the Chair.

Mr. H. Leslie Bates, L.R.C.P.(Lond.), Victoria Street, St. Albans; Mr. A. H. Boys, L.R.C.P.(Edin.), Chequer Lawn, St. Albans; Mr. Harry Hine, Holywell Hill, St. Albans; Miss Georgina Ormerod, Torrington House, St. Albans; the Rev. S. Spencer Pearce, M.A., Tower Hill, Much Hadham; and Mr. A. Webster, Linsters, Rickmansworth, were proposed as Members of the Society.

The following lecture was delivered:—

"Pre-historic Man in Britain." By Henry Hicks, M.D., F.R.S., F.G.S. (*Transactions*, Vol. V, p. 147.)

Ordinary Meeting, 29th March, 1889, at Hertford.

Augustus Hawks, Esq., Vice-President, in the Chair.

The following paper was read:—

"Further Reminiscences of Hertford during the 17th and 18th Centuries." By R. T. Andrews.

Ordinary Meeting, 12th April, 1889, at Watford.

George Rooper, Esq., F.Z.S., Vice-President, in the Chair.

Mr. H. Leslie Bates, L.R.C.P.(Lond.), Mr. A. H. Boys, L.R.C.P. (Edin.), Mr. Harry Hine, Miss Georgina Ormerod, the Rev. S. Spencer Pearce, M.A., and Mr. A. Webster, were elected Members of the Society.

Mr. W. D. Bowers, High Street, Watford, Mrs. Horsman, Kytes, Watford, and Mr. F. R. Webster, M.R.C.S., Chequer Street, St. Albans, were proposed as Members of the Society.

The following papers were read:—

1. "Report on the Rainfall in Hertfordshire in 1887." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. V, p. 155.)

2. "Meteorological Observations taken at The Grange, St. Albans, during the year 1887." By John Hopkinson. (*Transactions*, Vol. V, p. 161.)

3. "Climatological Observations taken in Hertfordshire in 1887." By John Hopkinson. (*Transactions*, Vol. V, p. 202.)

4. "Report on Phenological Phenomena observed in Hertfordshire during the years 1887 and 1888." By John Hopkinson. (*Transactions*, Vol. V, p. 177.)

5. "Notes on the Chalk Rock." By John Morison, M.D., F.G.S. (*Transactions*, Vol. V, p. 199.)

6. "The Study of the Injuries and Diseases of Plants." By Alfred T. Brett, M.D. (*Transactions*, Vol. V, p. 213.)

7. "List of Flowering Plants observed in Hertfordshire during the year 1888." By Ada Selby.

8. "Some Notes on the Lepidoptera of St. Albans and its Neighbourhood." By A. E. Gibbs, F.L.S. (*Transactions*, Vol. V, p. 181.)

9. "Note on the Rearing of Cuckoos at Cassiobury, Watford." By John Powell. (Communicated by Dr. A. T. Brett.) (*Transactions*, Vol. V, p. 215.)

Bye Meeting, 15th April, 1889, at St. Albans.

A few years ago several bye meetings for microscopical study were held at Watford, but hitherto there had not been one at St. Albans. On this occasion Mr. and Mrs. Hopkinson invited the members of the Society to "An Evening with the Microscope" at their residence, The Grange, the special subject proposed for study being the eyes of insects.

Microscopes were contributed by Mr. A. H. Boys, Mr. A. E. Gibbs, Mr. Hopkinson, Dr. Livingstone, Mr. E. H. Lowe, Mr. Makins, and Mr. Mowat, and the members and their friends present numbered about twenty-five. Numerous interesting objects besides eyes of insects were shown, and remarks on the structure and functions of the eyes of insects and of some other animals were made during the evening by the ex-President of the Society, Mr. F. M. Campbell, F.L.S., to whom a vote of thanks was accorded.

The sky being clear, and Saturn being favourably situated for observation, the opportunity was taken after tea to view this interesting planet through an equatorial telescope in the grounds, and the meeting was then brought to a close with a vote of thanks to the host and hostess on the proposition of Mr. Silvester seconded by Dr. Morison.

Ordinary Meeting, 26th April, 1889, at Watford.

Professor Attfield, Ph.D., F.R.S., etc., Vice-President, in the Chair.

Mr. W. D. Bowers, Mrs. Horsman, and Mr. F. R. Webster, M.R.C.S., were elected Members of the Society.

The following lecture was delivered:—

"Metal Mining." By Upfield Green, F.G.S.

The following papers were taken as read:—

1. "Report on the Rainfall in Hertfordshire in 1888." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. V, p. 161.)

2. "Meteorological Observations taken at The Grange, St. Albans, during the year 1888." By John Hopkinson. (*Transactions*, Vol. V, p. 193.)

3. "Climatological Observations taken in Hertfordshire in 1888." By John Hopkinson. (*Transactions*, Vol. V, p. 209.)

Field Meeting, 18th May, 1889.

BOXMOOR, BENNET'S END, AND NASH MILLS.

The Tertiary beds of the London Basin are traversed along the London and North Western Railway as far as Bushey Station, where the Upper Chalk first appears from under the Woolwich and Reading Beds which are seen in the Bushey cutting, and a chalk-pit on the right of the line, just beyond the station, shows the characteristic layers of flints. After crossing the valley of the

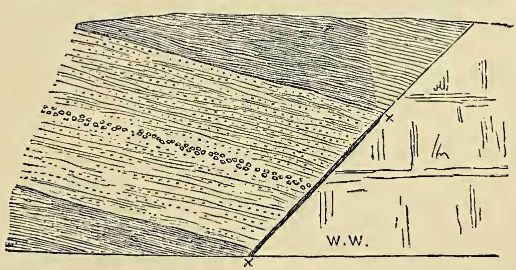
Colne and passing through the Watford tunnel, the line runs along the valley of the Gade as far as Two Waters, where the Gade receives its tributary the Bulborne, half a mile from Boxmoor Station.

Between this point and the station, but on the opposite or west side of the line, is the hill called Rough Down, in which a large chalk-pit is excavated. This has before been visited by the Society and also by the Geologists' Association, but on this occasion for the first time the inspection of it was made by members of the two Societies in a joint field meeting, the directors being the Treasurer of the Geologists' Association, Mr. Hopkinson, and the Secretary of the Hertfordshire Society, Dr. Morison.

The interesting feature of the pit is the occurrence in it of the Chalk Rock, a bed of hard cream-coloured chalk, on which remarks were made by the Directors. As an account of this bed, by Dr. Morison, appears in the present volume of the 'Transactions' (p. 199), it need not be further alluded to here.

After a few fossils had been found, the pit was left for the brick-fields at Bennet's End, the route taken being by Two Waters and across the fields. These brick-fields are at a considerable height on the opposite side of the valley to Rough Down. They are on an outlier of the London Clay and Reading Beds, through which a fault runs nearly north and south, the Chalk abutting against the basement-bed of the London Clay. This is not clearly seen now, the beds not being worked in proximity to the fault; but the following section by Mr. Whitaker, reproduced from his 'Geology of London' (p. 209) by permission of the Director-General of the Geological Survey, shows what was to be seen in 1861.

Diagram-section of a Pit near Bennet's End.



London Clay.
- *a* Roughly laminated brown clay, from 0 to about 6 feet.
- Basement-bed. (About 12 feet.)
  - *b* Brown loam, over 6 feet
  - *c* Flint-pebbles and oyster-shells, about 6 inches
  - *d* Brown loam, like *b*, 5½ feet

e Bluish-grey plastic clay of the Reading Beds, holding water.

f Chalk, abutting against the basement-bed of the London Clay.

xx Line of clay along the fault. (The right hand part of the section, lightly engraved, not actually seen.)

The basement-bed of the London Clay has here yielded many fossils, a list of which is given on pages 264 and 265 of Mr.

Whitaker's 'Memoir.' In the higher and more northerly part of these brick-fields a bed of brick-earth is now largely worked.

The route was now down the hill to the south into the valley of the Gade again, and as a rather longer time had been taken over the walk than had been anticipated, the party crossed the fields direct to Nash Mills, the residence of Dr. John Evans, F.R.S., Pres.S.A., who had very kindly invited both Societies to "tea and flint-implements." While "tea" included other refreshments, most welcome after the five miles' walk on a bright sunshiny afternoon, it was found that "flint-implements" implied a collection of antiquarian treasures which, for interest, rarity, and serial completeness in many of the departments represented, is without equal even in any public museum.

The following are the principal objects which were exhibited:—In the Library: Palæolithic or River-drift implements from England, France, Spain, India, and Africa; Greek, Roman, Saxon, and Merovingian glass; Rhodian and Damascus ware. In the Inner Library: Neolithic or surface implements, and those of modern savages from various parts of the world; bronze antiquities of various countries; Venetian and other glass, ancient pottery, etc.; arms and implements of modern savages. In the Dining-room: early gold ornaments; Roman, Saxon, Merovingian, and mediæval brooches and other antiquities; posy and other rings; mediæval seals; Hispano-Moresco pottery. In the Drawing-room: Greek and Roman coins and medallions; ancient British, Saxon, and English coins and medals; early plate; ancient needlework; Lambeth pottery, and various porcelain and pottery. To give some idea of the number of the objects exhibited it may be stated that there were about 500 rings, of which between 300 and 400 have inscriptions. Of local interest was a collection of nearly 200 coins struck at Verulam, which have been discovered in various parts of the kingdom. The splendid collection of Palæolithic and Neolithic flint-implements, however, attracted the largest share of attention.

Before leaving, the party assembled on the lawn, and Mr. Rudler, in the absence of the President of either Society, proposed a hearty vote of thanks to Dr. and Mrs. Evans for their kind and hospitable reception. The return journey was made from King's Langley station, Dr. Evans sending his carriages to convey most of the ladies there. The members of the Hertfordshire Society numbered about eighty and of the Geologists' Association twenty-five.

Field Meeting, 25th May, 1889.

HARPENDEN AND WHEATHAMPSTEAD.

The chief object of this meeting was to inspect the Slad and the Devil's Dyke, two ancient British excavations near Wheathampstead. The meeting was under the direction of Mr. A. E. Gibbs, and the route taken was from Harpenden Station over the Common, by Bamville Wood Farm into Sear's Lane, then through Thames

Wood, in which some time was spent botanising, to Ayers End and over No Man's Land Common. A lane from this Common leads past a farm to the Devil's Dyke, a dry hollow running nearly north and south for about half a mile. Its greatest depth is about thirty feet, and its width at the top about seventy feet, its sides sloping down at a rather steeper angle than 45°.

"A short quarter of a mile east of the Dyke," says Mr. Cussans,* "is a moat, running nearly parallel to it, about a third of a mile in length, locally known as the Slad. It is always, even in the driest summer, filled with water, and although it is never cleaned out, it is stated to be very deep in the centre. I find the depth, close to the bank, to be from four to five feet. How it is always supplied with water is a geological mystery. It stands on a high ridge of land, higher than the Devil's Dyke, which is always dry, and although the land on both sides certainly inclines towards it, yet the surface-drainage of that land is far too inconsiderable to account for the constant presence of water."

The party separated here without solving this mystery, some walking back to St. Albans, and the majority proceeding up the Dyke to Wheathampstead, where tea was partaken of, after which Harpenden Station was reached by way of the Grove.

Field Meeting, 1st June, 1889.
ST. ALBANS.

Assembling at St. Peter's Church, the members walked through St. Peter's Park across the fields into Sandpit Lane, and then through Beaumont's Avenue and again across fields into Camp Lane, returning along this lane to Messrs. Sander & Co.'s Orchid Nurseries. After inspecting the beautiful and valuable collection of orchids, the party assembled in the conservatory and the thanks of the members were conveyed by Dr. Brett to Mr. Sander for kindly throwing open his orchid houses to the Society.

The party then visited The Hollies, the residence of the Mayor, Mr. Richard Gibbs, who hospitably provided tea and other refreshments in a marquee erected for the purpose on the lawn. The botanical and entomological collections of his son Mr. A. E. Gibbs, the director of the meeting, were then inspected, and the meeting was brought to a close by a vote of thanks to the Mayor, on the proposition of Mr. Hopkinson.

Field Meeting, 6th June, 1889.
DIGSWELL AND HATFIELD.

Meeting at Welwyn Station, the party, including members from both the east and west of the county, under the direction of Mr. Hopkinson, crossed the valley of the Mimram and walked through Digswell Park, by the Church, and then through the Rectory grounds, into Sherrard's Park Wood. This is a favourite walk,

* 'Hist. Herts, Cassio Hundred,' p. 220.

and there is scarcely another in Hertfordshire that can vie with it in beauty, but the distant prospect from the high ground across the pretty Mimram valley is perhaps seen to greater advantage by taking the walk in the reverse direction.

Some time was spent in botanising in Sherrard's Park Wood, which was looking at its best, the rhododendrons which border the green drives in one part of the wood being in full bloom, and the ground being gay with wild flowers, the bugle giving it in places a rich carpet of blue.

Between this wood and Hatfield the Ordnance Map shows Hatfield Woodhall Woods, but these woods have for some time been disafforested and the ground is now cultivated as open fields. The sun was shining brightly, and there was a peculiar oppressive feeling in the air premonitory of thunder, and that very night Hatfield Woodhall Lodge, which was pointed out on approaching Mill Green, was struck by lightning and totally destroyed by fire.

At Mill Green the River Lea was crossed, and, skirting Hatfield Park, the members soon arrived at Hatfield, where they had tea before leaving by train for their several destinations.

In the course of the walk about 110 species of plants were seen in flower, amongst the most interesting being the spearwort (*Ranunculus Flammula*), guelder-rose (*Viburnum Opulus*), marsh valerian (*Valeriana dioica*), ivy-leaved toadflax (*Linaria Cymbalaria*), and twayblade orchis (*Listera ovata*). The marsh horsetail (*Equisetum palustre*) was seen in fruit near Woodhall Lodge Farm.

Field Meeting, 20th June, 1889.

BAYFORD AND COLE GREEN.

Assembling at the Shire Hall, Hertford, the party, under the guidance of Mr. R. T. Andrews, passed through All Saints' churchyard into Brickendon Lane, and crossed the fields to Bayford. Proceeding then by Bayford Hall Farm into Stocking Lane, the party soon arrived at Woolmers Park, the seat of Mr. W. H. Wodehouse, and by his permission the fine spring in the park was inspected.

This spring rises from the Chalk in considerable volume into a pool, known as Ackley Hole, picturesquely situated in a wood about a quarter of a mile from the residence of Mr. Wodehouse, and the water flows out of it in a constant and powerful stream, augmenting the River Lea. "The Duke of Bridgewater, who possessed this estate in the latter part of the last century," Cussans states,* "contemplated conveying this water to London in pipes, at his own cost, but was prevented, mainly through the action of the New River Company, from carrying his design into execution."

Continuing their walk through the park and crossing Cole Green, the members returned to Hertford by rail from Cole Green Station.

* 'Hist. Herts, Hertford Hundred,' p. 105.

Field Meeting, 22nd June, 1889.

BRICKET WOOD AND MUNDEN PARK.

Arriving at Bricket Wood Station by different trains, the members attending this meeting formed two sections; the first, led by Dr. Morison, walked through part of the wood and over the scrubs to the brick-fields where the boulder-clay is worked, and the second, under the guidance of Mr. Hopkinson, strolled more leisurely through the wood, botanising, and then took the road across the scrubs direct into Munden Park, joining the first section at Munden House.

Here the members were very kindly entertained by the Honourable Mr. and Mrs. Holland Hibbert, who, after refreshments had been partaken of, showed and explained the many interesting and valuable objects of interest which make their house so well worth a visit. They then conducted the members in detachments over their beautiful grounds, through which flows the River Colne, adding much to their picturesqueness.

Before leaving, a vote of thanks to their host and hostess was proposed by Mr. Hopkinson, who alluded to their kindness in inviting the Society after they had twice before prepared for visits which had been prevented by wet weather.

Field Meeting, 29th June, 1889.

TOTTERNHOE AND IVINGHOE.

The Chalk Rock, the top bed of the Middle Chalk, having been seen at Boxmoor on the 18th of May, this field meeting was arranged to enable members of the Society to examine another hard and fossiliferous bed in the Chalk—the Totternhoe Stone—which occurs near the middle of the Lower Chalk; and also at the same time to gain some knowledge of the peculiar features of the north-western escarpment of the Chalk.

The meeting was held in conjunction with the Geologists' Association, and was under the direction of Mr. Hopkinson. The members of the two Societies met at Stanbridge Ford Station in the morning, commencing here a walk of twelve or thirteen miles, two wagonettes conveying most of the ladies.

Totternhoe Knoll, on which is a British earthwork, was first ascended. The view from the summit, 524 feet above sea-level, is very extensive in clear weather, but to-day, though fine and warm, moisture in the air caused a haze which circumscribed it. When all were assembled, the Director said that he would attempt to give an outline of the principal geological features of the surrounding country, and would then ask others present, who had made a special study of the district, to fill in details.

On a clear day, he said, there would be seen in the distance on the north-west a range of hills gently rising from the almost level plain. These hills mark the outcrop of the Lower Greensand, rising from under the plain, which consists of the clayey beds of the Gault and of the Chalk Marl, the line of division between these beds running about half-way between Totternhoe Knoll and Stanbridge Ford Station, and following, at a distance of from half a mile to a mile, the first rise of the north-western flank of the hills they were on, from Houghton Regis to Totternhoe, and again past Ivinghoe Beacon on the west. Between the Gault and the Chalk Marl there was usually a narrow band of the Upper Greensand, but it did not appear to be present here. A bed of greenish sand at the base of the Chalk Marl, called the Cambridge Greensand, was really the lowest bed of the Chalk, for it contains fossils of the Chalk, and not those of the Upper Greensand.

The Chalk, formerly divided into Upper Chalk or Chalk-with-flints, and Lower Chalk or Chalk-without-flints, was now divided into Upper, Middle, and Lower Chalk. In adopting this triple division the palæontological zones were recognised, and the continental classification was conformed to. The Upper Chalk was left as it was, and it represents the *Senonian*; the Chalk below was divided into Middle Chalk, representing the *Turonian*, and Lower Chalk, representing the *Cenomanian*, and where this last division is made there was the greatest palæontological break in the whole of the Chalk.

Their walk was commenced on the Gault, the Chalk Marl was then passed over, and then the whole of the Grey Chalk, the last 20 or 30 feet of the ascent being up an artificial mound. The Totternhoe Stone also was crossed, for it occurs between the Chalk Marl and the Grey Chalk. After leaving the Gault, therefore, the whole of the Lower Chalk here represented had been traversed; and presently would be seen, in the quarries below, a section of the Totternhoe Stone and Grey Chalk. This, however, was partly white, and here about the upper half was so. The Chalk Marl was about 70 or 80 feet thick, the Totternhoe Stone at least 20 feet, including when present its middle bed of soft chalk, and the Grey Chalk about 80 feet, giving a thickness to the Lower Chalk here of about 170 or 180 feet.

Near the top of the hill above the quarries there was another hard bed called the Melbourn Rock, which forms the base of the Middle Chalk. Then, forming a great part of the downs up to from about 700 to 720 feet in altitude, was the great mass of Chalk-with-few-flints; its flints being chiefly near the top and not occurring in layers as in the Upper Chalk. A third hard bed, called the Chalk Rock, forms the summit of the Middle Chalk. It contains many fossils, the prevailing forms being Gastropoda, which are comparatively rare elsewhere in the Chalk. The Melbourn Rock was here about 10 feet thick, the Chalk Rock 5 feet or more, and the white chalk between these beds from 220 to 230 feet. It had hitherto been stated to be 350 feet in thickness in Beds and Bucks,* but

* See 'The Geology of the Neighbourhood of Cambridge,' by W. H. Penning and A. J. Jukes-Browne, p. 21 (1881). The reference here to "Whitaker, 1865, 1872," Mr. Jukes-Browne states, is to his section in his memoirs "On the Chalk of Buckinghamshire, and on the Totternhoe Stone," in 'Quart. Journ. Geol. Soc.,' vol. xxi, p. 398, and on 'The Geology of the London Basin.'

SECTION THROUGH TOTTERNHOE KNOLL AND KENSWORTH HILL, NEAR DUNSTABLE.

N.W. Totternhoe Knoll. Kensworth Hill. S.E.

U.C. Upper Chalk. *M.C.* Middle Chalk. *L.C.* Lower Chalk. *Gt.* Gault. *L.G.* Lower Greensand.

cr. Chalk Rock. *mr.* Melbourn Rock. *ts.* Totternhoe Stone.

Horizontal Scale: 1 inch = 1 mile. Vertical Scale: 1 inch = 1320 feet ($\frac{1}{4}$ mile).

from aneroid measurements he felt sure that here this was at least 120 feet too great.

Here and there in the course of their walk springs would be seen issuing from the Totternhoe Stone, which might easily be traced as it winds round the hills almost at their base. There was no such indication of the Melbourn Rock nor of the Chalk Rock, but the outcrop of the latter might be easily followed. The Five Knolls seen on the south were just below it; a little higher, to the right or westward, it crops out, and it forms the top of the escarpment for nearly a mile; at Kensworth Hill it is capped by nearly 80 feet of the Upper Chalk, and it keeps near the top of the ridge until it recedes from view; and finally it caps, as an outlier, the projecting point still further west, which is Ivinghoe Beacon.

Flexures in the Chalk, as shown in the section on p. xliii, were then alluded to, and outliers of the Middle on the Lower Chalk, and of the Lower Chalk on the Gault, were pointed out, showing what a vast amount of chalk must have been removed by denudation, and how the Chalk hills having at one time been much higher than they are now, might have caused a greater rainfall in past ages, and therefore a greater amount of denudation.

Mr. James Saunders, of Luton, then added some remarks about the Totternhoe Quarries. He said it was a curious fact that although the Totternhoe Stone had been known ever since Norman times as a building-material, yet it was not until within the last twenty years that the overlying Grey Chalk had been valued for the purpose of lime-burning. It was considered to be as good as any rock in the country for the production of grey lime, which was worth much more than white lime. The demand was so active that 18 or 20 kilns were in almost constant use, each holding about 120 tons of material worth £90 to £100. It would be noted on examining the quarries that the Grey Chalk was of considerable thickness, probably over 70 feet, and that at the base it was dark grey and in massive blocks, passing up gradually into a much whiter condition, where it broke up into smaller portions. At the present time the Totternhoe Stone was only exposed in one or two small sections, which would be inspected. But whether it was to be regarded as forming two distinct beds, or one thick mass gradually changing in the entire thickness, it was certain that the lower and upper parts were lithologically distinct, the former being the only portion adapted for building purposes, whilst the latter was used for making hearth-stones. The company working these quarries had orders for eighty thousand cubic feet of the building-stone, partly to be employed in the restoration (or rather re-building) of parts of St. Albans Abbey. Much of the bed would therefore be exposed after a time, when further information as to its composition might be obtained.

Mr. Saunders then read extracts from letters he had recently received from Mr. Whitaker and Mr. Jukes-Browne. Mr. Whitaker said that westward the Totternhoe Stone dies out, and in Wilts, etc., the Chalk Marl cannot therefore be divided from the rest of the Lower Chalk, the same being the case generally in the south. Mr.

Jukes-Browne wrote that he saw a fine section here in 1884, but did not recognize two beds of the stone. The base was not visible, being four or five feet below the exposed part, according to the workmen, and he estimated the thickness of the stone as 20 to 25 feet.

Mr. Worthington Smith, of Dunstable, then drew attention to the pre-historic antiquities of the neighbourhood. They were standing, he said, upon the beacon in the midst of an ancient British camp, the earthworks of which he pointed out. The hollow places around them, of which there were at least fifty in that camp, were the sites of the huts of the early inhabitants. In the neighbourhood of Dunstable he had excavated some of these, and had found flint-implements and flakes, and in one case a skeleton. Close by was a square camp, which, as its shape indicated, was of Roman origin.

Descending the beacon hill on the south side, the party walked round the Roman Camp, from the furthest end of which the mound is very conspicuous, though all that is seen of it here is artificial. From the Camp a further descent was made into the quarries, where a fine section of the Grey Chalk was seen and a few exposures of the Totternhoe Stone were examined. Some time was then spent in searching for fossils and several were procured.

Continuing the walk on the Downs, the disused workings, now grass-covered, were pointed out; and a little further on was seen the circular enclosure known as Maiden's Bower, the site of the old British town of Durocobrivæ, now a ploughed field with the remains of the ancient rampart forming a high bank around it. The road now being traversed was the Watling Street, and near this point it is crossed by the Icknield Way. Leaving Dunstable on the left, the Watling Street passes the Five Knolls, a series of early tumuli, and here all assembled to partake of luncheon.

From the quarries to this point the walk had been entirely on the Middle Chalk, in which were now seen, on the Dunstable side of the Knolls, extensive pits worked for lime; just below, looking towards Totternhoe, a coombe was traced downwards to where several springs issue from the Totternhoe Stone, the coombe therefore here merging into a river-valley; and towards Kensworth Hill, shallow openings, scarcely pits, by the roadside, exposed the Chalk Rock, which had been worked for road-metal.

This direction was now taken, and on arriving at the highest point of Kensworth Hill, 800 feet above sea-level, a few further remarks on the geological features of the surrounding country were made by the Director, and the party again separated, those riding returning to the Five Knolls and thence by the Icknield Way to Ivinghoe Beacon, and the walkers continuing on the Downs and following the outcrop of the Chalk Rock to a pit by the road near the top of the escarpment above Valence End Farm. Here at one time a fine section of the Chalk Rock was to be seen; but it is now covered up by rubble, the pit showing only the base of the Upper Chalk, and the next pit just below showing the upper beds of the Grey Chalk.

A descent was made down the steep face of the escarpment, past the site of old British huts, then the fields were crossed into a coombe, and a small stream issuing from one of the numerous springs in the Totternhoe Stone was followed as far as the Icknield Way, under which the stream flows.

On the way to Ivinghoe Beacon two other streams were seen rising from springs in the Totternhoe Stone, one of them proceeding from a most picturesque coombe just under the Beacon. The summit of this hill is 762 feet above sea-level, necessitating a climb of 350 feet from the Icknield Way,—from the Totternhoe Stone to above the Chalk Rock which caps the hill as an outlier,—and here the whole party again assembled.

The remainder of the walk presented nothing of special geological interest, but the stroll along Duncombe Terrace (by permission) was the most enjoyable portion of the day's walk. This is a private road which winds along the hillside, keeping to the same level, for about three miles, through woods with an opening here and there disclosing glimpses of the valley below and of the wooded hills beyond it. The private portion of this road ends at Moneybury Hill, where a Roman tumulus was inspected. From this point a descent was made to the village of Aldbury, where tea was partaken of, after which the walk was continued for another mile down the valley to Tring Station.

Field Meeting, 5th July, 1889.

WATFORD.

The chief feature of this field meeting was the reception of the members of the Society and their friends at Nascott House by one of their past Presidents, Mr. George Rooper, F.Z.S.

The walk was from Watford Station along the St. Albans Road into the Gullett Wood, and through that, Long Spring, and the Tunnel Woods, into the Hempstead Road, by which Nascott House was reached. It was too late in the year, and the weather was and had for some time been too dry, for these woods to furnish much of botanical interest, and there were no entomologists amongst the party, so the scientific result was *nil.* But nevertheless the walk was enjoyable, the trees providing a delightful shade, and as Mr. Rooper specially desired to regale the members with a plentiful supply of strawberries, an earlier period in the year would not have admitted of his hospitable wishes being gratified.

Although the number of members who took the walk was small, a large party assembled on the lawn in the grounds of Nascott House, and greatly appreciated the kind and hospitable attentions of Mr. and Miss Rooper.

Field Meeting, 19th October, 1889.

BRICKET WOOD.

Although wet weather conduces to the growth of fungi, it does not conduce to a good attendance at a field meeting, and on this occasion the fall of about two inches of rain during the previous fortnight, with over half an inch the same morning, and the likelihood of continued rain for the rest of the day, resulted in an unprecedentedly small attendance. In fact the party consisted of only Mr. Hopkinson and Mr. George Massee, F.R.M.S., but the result of their foray was the collection of a larger number of species of fungi than on any previous occasion.

The search was made in Bricket Wood, commencing near the Station and working towards the Watford and St. Albans road, and in two copses near the wood, one on either side of this road, and it was continued until it became too dark to distinguish the fungi amongst the fallen leaves.

Before leaving Bricket Wood one hundred species of fungi were seen, and the number was eventually made up to 103, including 45 now recorded for the first time in the county, and several rather rare forms. One species of *Lenzites* collected has this season for the first time been found in England, in Epping Forest and Windsor Forest as well as here, and will probably prove to be new to science.

The following is a list of the species, determined by Mr. Massee, those now first recorded for Hertfordshire having an asterisk affixed, and the rarer forms a dagger.

Hymenomycetes.

Agaricus (*Amanita*) *vaginatus*
,, ,, *rubescens*
,, (*Lepiota*) *carcharius* *
,, ,, *granulosus*
,, (*Armillaria*) *melleus*
,, (*Tricholoma*) *sejunctus*
,, (*Clitocybe*) *fragrans*
,, ,, *gallinaceus* *
,, ,, *laccatus*
,, ,, *bellus* * †
,, (*Collybia*) *dryophilus*
,, ,, *esculentus* *
,, ,, *rancidus* †
,, ,, *cirrhatus* * †
,, ,, *butyraceus*
,, ,, *clavipes* *
,, ,, *radicatus*
,, (*Mycena*) *stanneus* * †
,, ,, *galericulatus*
,, ,, *purus*
,, ,, *epipterygius*
,, ,, *ammoniacus* * †
,, ,, *galopus*
,, ,, *hæmatopus*
,, ,, *roridus* †

Agaricus (*Omphalia*) *sphagnicola* * †
,, (*Pleurotus*) *ostreatus*
,, (*Pluteus*) *cervinus*
,, (*Leptonia*) *lampropus* *
,, (*Entoloma*) *sericeus*
,, ,, *sericellus* *
,, (*Clitopilus*) *orcella* *
,, (*Pholiota*) *squarrosus*
,, (*Hebeloma*) *mesophæus* *
,, ,, *crustuliniformis*
,, ,, *fastibilis*
,, ,, *rimosus* *
,, ,, *asterosporus* * †
,, ,, *geophyllus*
,, (*Flammula*) *spumosus*
,, (*Crepidotus*) *mollis* *
,, (*Naucoria*) *melinoides*
,, (*Galera*) *hypnorum*
,, ,, *tener*
,, (*Tubaria*) *furfuraceus*
,, (*Stropharia*) *æruginosus*
,, ,, *squamosus*
,, ,, *semiglobatus*
,, (*Hypholoma*) *sublateritius*
,, ,, *fascicularis*
,, ,, *velutinus*

Agaricus (*Hypholoma*) *Candolleanus* *
,, (*Psilocybe*) *ericæus* *
,, ,, *semilanceatus*
,, ,, *spadiceus*
,, ,, *fœnisecii* *
,, (*Psathyra*) *semivestitus* * †
,, (*Panæolus*) *separatus* *
,, ,, *phalenarum* *
,, ,, *papilionaceus* *
,, (*Psathyrella*) *atomatus* *
Coprinus atramentarius
,, *micaceus*
,, *niveus*
,, *radiatus* *
Cortinarius brunneus *
,, *rigidus*
,, *ochroleucus* *
,, *cinnamomeus* *
,, *armillatus* * †
Paxillus involutus
Hygrophorus cossus * †
,, *hypothejus*
,, *pratensis*
,, *virgineus*
,, *niveus* *
Lactarius subdulcis
,, *turpis*
Lactarius blennius
Russula rubra
,, *ochracea* * †
,, *fragilis*
Marasmius ramealis
,, *epiphyllus*
,, *Hudsoni* * †
Lenzites betulina *
Boletus scaber
,, *chrysenteron*
,, *badius* *
Polyporus vaporarius
,, *versicolor*
,, *chioneus* * †
Dædalea quercina *
Telephora laciniata *
Corticium comedeus *
Peniophora cinerea
,, *velutina* *
Hymenochæta rubiginosa *
,, *tabacina* *

MYXOGASTRES.

Trichia scabra *
,, *abrupta* *

GASTROMYCETES.

Lycoperdon gemmatum
,, *pyriforme*

The following mosses, scale-mosses, and lichens were collected by Mr. Hopkinson and have been determined by Mr. A. E. Gibbs.

MUSCI.

ACROCARPI.

Dicranella heteromalla, Hedw.
Ceratodon purpureus, Hedw.
Funaria hygrometrica, L.
Mnium undulatum, Hedw.
Atrichum undulatum, L.
Polytrichum formosum, Hedw.
,, *commune*, L.

PLEUROCARPI.

Thuidium tamariscinum, Hedw.
Brachythecium rutabulum, L.
Eurhynchium striatum, Schreb.
,, *piliferum*, Schreb.
,, *prælongum*, Dill.
Rhynchostegium confertum, Dicks.
Hypnum cupressiforme, L.
,, *purum*, L.
Hylocomium brevirostrum, Ehrh.
,, *squarrosum*, L.
,, *triquetrum*, L.

HEPATICÆ.

Cephalozia bicuspidata, L.
Diplophyllum albicans, L.

LICHENES.

Cladonia pyxidata, Fr.
Evernia prunastri, L.
Parmelia caperata, L.
Physcia parietina, L.

ON THE INTERNATIONAL GEOLOGICAL CONGRESS, WITH SPECIAL REFERENCE TO THE LONDON MEETING IN 1888.

By John Hopkinson, F.L.S., F.G.S.

(Read before the Hertfordshire Natural History Society, 8th May, 1888.)

In the early days of geological research the geologists of each country worked independently, giving to groups of rocks names derived from the localities in which they were first found or where they were most largely developed in their own country, or naming them from peculiarities in the beds which frequently were only of local value. In geological maps, also, colours and signs have been adopted by each country, even in their national surveys, without any regard to the practice in other countries, and maps are coloured even in the same country on different systems.

The result of this independent working is that strata of the same geological age are known in different countries under names which have no relation to each other, and that a geological map frequently conveys no idea of the structure and age of the rocks of the country to which it refers without a careful study of its index of signs and scale of colours.

In our own country less inconvenience has perhaps been felt from this state of things than in others. In geological research Britain has always been to the fore. We have, in a small area, an epitome of the geology of Europe, and indeed of the world, such as no other country can show, and many names which have originated with us are now cosmopolitan, while we have adopted into our nomenclature only a very few names first given in other countries. There is, therefore, some foundation for the adoption of uniform names or equivalent expressions, regard being had to the language of the different countries; but very little, indeed scarcely any, progress has yet been made towards the adoption of uniform colours and signs for geological maps.

For the discussion and determination of these and other questions of international geological importance the International Geological Congress was inaugurated. At the Buffalo meeting of the American Association for the Advancement of Science, which followed the Philadelphia Centennial Exhibition of 1876, a number of geologists of various nations met and nominated a Committee to make arrangements for an International Geological Congress to be held at Paris in 1878, with the special object of deciding upon rules for the construction of geological maps, and for geological nomenclature and classification.

At this Paris Congress 21 countries were represented by 304 members, the geologists of other countries than France numbering 110, or 36 per cent. of the whole. Little more was done than to determine the course to be adopted in future, to decide that the second meeting should be held at Bologna in 1881, and to nominate International Committees to report to that meeting on (1) geological nomenclature, (2) colours and signs for geological maps, and (3) rules of nomenclature in palæontology.

At the Bologna Congress, duly held in 1881, the attendance was rather less, 17 countries being represented by 224 members, the number of foreign geologists, or those other than Italians, being 75, or 33⅓ per cent. of the whole. The first two days of this Congress were devoted to geological nomenclature, the next two to geological maps, the fifth to palæontological nomenclature, and the last to the formal closing of the Congress and the decision that the third triennial meeting should be held at Berlin in 1884.

Many of the resolutions passed at the Bologna Congress relate to the use of precise language. For example it was determined that the word "formation" should only be used in its original sense, as it is in France, where it is considered to be an abbreviation of "mode of formation." We may therefore correctly speak of eruptive formations, calcareous formations, marine formations, etc., but not of the Silurian or of the Eocene formation. With regard to the geological division of rocks, a name it is correct to give to any of the mineral masses which compose the crust of the earth, whether hard or soft, it was resolved that the term Group should be applied to the largest division, System to the next, Series to the third, and Stage to the fourth, a Group thus comprising a number of Systems, a System a number of Series, and a Series a number of Stages;* while the time-words corresponding with these were to be, in descending order of magnitude, Era, Period, Epoch, and Age. But perhaps the most important determination arrived at was that a geological map of Europe, on the scale of $\frac{1}{1,500,000}$ (about 23½ miles to the inch) should be constructed at a cost estimated at £2500, a sum which has been contributed by the various governments of Europe. This map is to be prepared at Berlin. The size will be about 12 feet by 10 feet, and it will be in 49 sheets so arranged that a number may be mounted together to show any required area.

The Berlin Congress was held in 1885, having been postponed from 1884 on account of the prevalence of cholera in the south of Europe in that year. It was attended by 255 members representing 18 countries, the foreign geologists numbering 92, or 36 per cent. of the whole, as at the Paris meeting. At this Congress papers were read on various geological subjects, many of which were not of international importance. The principal work done in furtherance of the main object of the Congress was in the

* The transposition of the terms Group and Series would make the names of the divisions more consonant with English ideas, and I hope that this alteration will be suggested and adopted at the London Congress.

determination of the names and extent of the divisions and the colouration to be adopted in the geological map of Europe. The divisions of the Cretaceous System and the classification of the Tertiary System were left for future consideration. The most important proposition brought forward was a scheme for the preparation and publication of a 'Nomenclator Palæontologicus,' to contain the names (with references) of all published species of animals and plants found in a fossil state. It was determined that the next triennial congress be held in London in 1888.

The present year will therefore witness the fourth meeting of the International Geological Congress, which will be held in London from the 17th to the 22nd of September. The number of members for this meeting already exceeds that of the largest of the preceding meetings, and the number of foreign geologists who have promised to attend also exceeds the largest number present on any former occasion. The success of the London Congress, so far as regards both the total number of members and the representation of foreign countries, is therefore already assured. But in this country there is one drawback. At the three preceding meetings, held in Continental cities, the Committees received government assistance, aid from the State railways, etc., which will not be given here. The expenses must therefore be met by private contributions, and it is estimated that at least £500 will be required. The whole of the subscription for membership (10*s.*) will be devoted to the printing of the publications relating to the London meeting, and these will be sent by post to all members whether they are present at the Congress or not. The privileges of membership will also include attending the meetings in London, having a voice in the deliberations at these meetings, and joining in excursions to places of geological interest.

With regard to the work of the Congress in London, the objects for which it was founded—(1) the Unification of Geological Nomenclature, and (2) the Unification of Geological Cartography—will form the chief subjects for discussion, the special points for debate being the classification of the Lower Palæozoic rocks, and of the Tertiaries. The latter will be of particular interest to Hertfordshire geologists, to whom strata of Lower Eocene age are so familiar. Special reports on the crystalline schists will also be prepared, and other questions of general or international interest will be discussed. The meetings will be held in the rooms of the University of London, Burlington House.*

During the week of the Congress there will be short excursions to Radlett and St. Albans, and to Watford, in our own county, to Eton and Windsor, Brighton, Kew Gardens, and to other places of interest; and during the week after the meeting (from September

* On the Organising Committee for the London meeting are eight honorary and four ordinary members of our Society. The Treasurer is Mr. F. W. Rudler, who has delivered a lecture before our Society at St. Albans, and the Secretaries are Mr. J. W. Hulke, F.R.S., and Mr. W. Topley, to the latter of whom all communications should be addressed at 28, Jermyn Street, London.

24th to 30th), to the Isle of Wight, North Wales, West Yorkshire, East Yorkshire (the coast), Norfolk and Suffolk, and perhaps to the Jurassic district of Central England.

As the Congress meets only once in three years, and there are many countries to visit, this meeting will in all probability be the only one which any of us here present will have the opportunity of attending in our own country. Of the advantages of attending it not the least will be those connected with its social character. It will give us an opportunity, such as we may never again have, of meeting the geologists of other countries and exchanging ideas with them; and by inviting the foreign geologists to our homes for the week of the meeting, and entertaining parties of them who may visit our neighbourhood to study British geology, we shall be able to extend to them that hospitality which an English man of science always receives when visiting foreign countries.

TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

I.

ANNIVERSARY ADDRESS.

By the President, F. Maule Campbell, F.L.S., F.Z.S., etc.

Delivered at the Annual Meeting, 21st February, 1888, at Watford.

Ladies and Gentlemen,—

While I was thinking whether I should take the phrase, "the survival of the fittest," as the subject of my address, I received my copy of the 'Flora of Hertfordshire,' just published by our Society, and, having turned over the leaves of our volume, I could not refrain from ejaculating: "This book is fit to live!" How much should we prize a similar book on the flora of a few centuries past, and what advantages will not distant posterity possess over us in the wealth of the literature of bygone days? What will the flora be at that period? Will wind-fertilised flowers be replaced by delicate adaptations to insect-fertilisers? Our garden flora has increased in beauty within the memory of the living, and some plants may yet colonise themselves in our woods and pastures. Will the coming wild flora so abound in brilliancy and grandeur, that the flora of the present time will be regarded only as a connecting link with the first entomophilous flowers which in all probability were green, such as now seen in the bryony (*Bryonia dioica*) and hellebore (*Helleborus viridis*)? Will the constant recurrence of the hues of green which we now find in blooms of general brilliancy become exceptional? We speak of the vegetation of the Carboniferous era as dull, consisting as it did of huge cryptogams—tree-ferns, equiseta, and lycopods—unillumined by a petal. Simple growths doomed to be wholly or partly displaced ever preceded those possessed of higher or more beautiful developments. Will our present flora at some distant period be regarded as dull if compared with that which may then exist? Many species not indigenous, which we now regard as common, will in all probability have died out, and botanists will turn over the leaves of our 'Hertfordshire Flora' to point out, as the cause, the many climatic changes which have taken place since it was written. With these thoughts I passed to our wild fauna, their dangers and their defences, and concluded my reverie by considering that plants, like animals, require protection. This gave me the subject which I have now the gratification to lay before you—THE MEANS OF PROTECTION POSSESSED BY PLANTS.

The "survival of the fittest" owes its place in English phraseology as much to its embodiment of truth as to the genius of its author. No community or species ever advanced without the working of this principle, and although in human affairs philanthropy strives to divert its consequences, namely "the destruction of the least fit," yet the sad thought remains, that such relief can be but temporary. Nature is just, but not merciful, for she heedlessly destroys the weak and incapable—

> "So careful of the type she seems,
> So careless of the single life."

But it is the universal application of the "survival of the fittest" which has given us on this earth so much beauty and produced both in animal and vegetable life so many adaptations to ends, of which not the least wonderful are the means of protection against danger.

Just as weak nations require special guarantees of their independence, so do weak organisms need special protective modifications, and instances of this occurring in plants are common. Entomophilous flowers have dangers peculiar to themselves, for their pistils and stamens may be injured by insects which consume their nectar but are unadapted for their cross-fertilisation. We find that obstacles are placed in the way of such unbidden guests.

We are now considering the protection of plants, and so much has been written on the *special* means of the protection of insects, that it will be as well, before proceeding further, to compare briefly their respective means of protection. Insects can evade danger by flight or immobility, though, when they move, they attract the attention of enemies. Plants by their fixity escape this danger, and unlike insects are independent of locomotion for finding their food. The roots of plants are comparatively free from attack, whilst the vital organs of the insect are more liable to serious injury or even to total destruction. The above considerations tend to show that insects require greater protection than plants, and as a rule they seem to possess it.

Many naturalists, and especially Darwin and Belt, have referred incidentally to the protection of plants. Wallace has entered upon the subject more fully in his 'Tropical Nature,' but the only author who has dealt with it in a systematic manner is Kerner.* The arrangement he adopted is different from the one I have chosen. All I shall now attempt is to give a few illustrations, mostly observed by myself, of various means of protection possessed by plants; and I shall try to render them in that suggestive form which is characteristic of a Presidential Address. We will first consider how far protection is obtained by concealment.

Protection by means of Concealment.

An object may escape notice in two ways. It may be of the same colour as its surroundings, or it may be hidden by being covered. Concealment in this latter sense is general in the case of the roots of plants, and occasionally occurs with flowers and seed-capsules, to which I shall afterwards refer. The leaves of plants are not hidden, for the due performance of their function requires exposure to both light and air. The function of vegetation in the economy of nature, namely, the decomposition of carbonic acid, the absorption of the carbon, and the return of the oxygen to the atmosphere, is confined to those portions of a plant which are green. The prevailing colour of most plants is therefore green, and when they grow together it is not easy to distinguish any particular plant, and what is not distinguished may easily be passed over. Unripe fruit, which is also green, is not readily discriminated from the leaves of the tree on which it grows. Where, however, green plants grow sparingly on a poor soil, they may easily attract Herbivora in search of food. It is true that such animals are generally found in places where there is an abundance of pasture, but there may be occasional seasons of drought when verdure is conspicuous, and some animals, such as the antelopes, which frequent rocky districts, appear to be largely dependent on their sense of sight for finding their sustenance. Instances of plants resembling the surrounding soil are rare, but they do occur. Thus it is believed that the stone mesembryanthemum of the Cape of Good Hope, which is of similar

* 'Die Schutzmittel der Blüthen gegen unberüfene Gäste,' and 'Die Schutzmittel des Pollens, etc.' A translation of the former is published under the title of 'Flowers and their Unbidden Guests.'

form and colour to the stones among which it grows, escapes the notice of cattle and wild herbivorous animals. Kerner draws attention to the colour of some silenes which open at night and display an inner surface of white, while when closed "they are curled up and expose their under side to view, which is of an inconspicuous colour."

An interesting case of "hiding" is seen in the hardy cyclamens. When the flower falls off in January, the top of the stalk bends so that the seed-capsule is held in a horizontal position. The stalk now slowly coils itself irregularly round the capsule, and, bending with the increased weight at its extremity, lowers the capsule gradually to the earth, where it is protected not only by the leaves of the plant but also by the coil of the decayed stalk. During the next few months the alternate contraction and expansion of the soil due to the different degrees of moisture and temperature, causes the capsule to become wholly or partly buried, and the safety of the seeds, which do not ripen until June, is secured. In gardens, the capsules are generally completely covered about the middle of February by the manure which is usually placed in late autumn on the ground. It is worth noting that the foliage of these plants is dense and falls only in the spring, so that if the stalks dropped with the capsules they would afford their capsules no such protection as they receive from the canopy of leaves and the soil. In hot-house varieties I have not seen this process, but I am informed that it does not there occur with them, and, if this be the case, it appears to me that they fail from want of vitality. A modification of this plan is seen in other plants. The flowers of *Trifolium subterraneum* are drawn underneath the ground, and *Arachis hypogea* and *Voandzeia subterranea* only produce subterranean seed-pods. Correæ de Mello * has described his experiments on these two *Leguminosæ*, and states that when the ovaries were prevented from penetrating into the ground either by the interposition of a resisting body or by raising the branch as in the case of *Arachis hypogea*, they did not enlarge, and remained in the same state until the plant perished. The branches of *Voandzeia subterranea* spread along the ground, and its flowers are just above the surface. Should, however, the ovaries of these two plants not penetrate the soil, the peduncle dries up and no pod is formed.

In the case of *Vallisneria spiralis* we find that the flower of the female plant is borne on a long spirally-twisted stalk which uncoils according to the depth of the water, so that the flower may float on the surface. After fertilisation has taken place, the stalk

* 'Journal of the Linnean Society,' vol. xi, p. 254.

recoils and drags the flower to the bottom of the water where it produces its berry. This is the more interesting from the flower of the male plant having but a short stalk. Mr. Daydon Jackson * describes, on the authority of a correspondent, the curious provision possessed by *Fumaria corymbosa* (Desf.) for placing its fruit in a secure place. The plant usually grows in the crevices of overhanging rocks, and after flowering the peduncle lengthens and bends *away from* the light towards any crevice which offers the greatest obscurity, so that the fruit is deposited in a spot adapted for the young plants. Mr. Jackson well adds that this fumaria "seems to perform an act of oviposition." The icy-leaved toadflax (*Linaria cymbalaria*) turns its capsules towards the wall or rock on which it is growing, and, when they burst by maturity, or by a gust of wind, the seeds are scattered and may then fall into any chinks in the wall.

A striking instance of protective concealment is seen in the cleistogamic flowers which are described thus by Darwin: †—"They are remarkable from their small size and from never opening, so that they resemble buds; their petals are rudimentary or quite aborted; their stamens are often reduced in number, with the anthers of very small size, containing few pollen-grains, which have remarkably thin transparent coats, and generally emit their tubes whilst still enclosed within the anther-cells; and, lastly, the pistil is much reduced in size . . . These flowers do not secrete nectar or emit any odour; from their small size as well as from the corolla being rudimentary, they are singularly inconspicuous. Consequently insects do not visit them, nor, if they did, could they find any entrance." Such flowers are invariably self-fertilised, and their loss of the chance of cross-fertilisation is compensated by the certainty of self-fertilisation and the comparative safety of the anthers and pistil. Some plants, such as *Viola odorata*, bring the capsules of their cleistogamic flowers beneath the ground, where the seeds are matured, while those of the perfect flowers are exposed to the attacks of birds and other enemies. Again, the flowers of the water-plant *Euryale ferox*, which are cleistogamic, are perfected below the surface.

I shall afterwards treat of seeds when separated from the parent-plant, but I have introduced the last few illustrations in this portion of my address inasmuch as the concealment of the seeds is due to the action of the plants themselves.

* 'Journ. Linn. Soc.,' vol. xix, p. 232.
† 'Forms of Flowers,' p. 310.

Protection by means of Objectionable Flavours.

Any one who has observed animals will know the preferences they have for certain food, and also how, when nothing else is procurable, they will frequently eat that which they usually avoid. My experience of herbivorous animals does not enable me to state what they would eat when driven by hard necessity. All I can venture to do is to name some plants of which they will not partake, either on the pasture or from the hand.

The general avoidance or refusal by an animal of any plant not bearing thorns, etc., shows it to be objectionable, or at least not so palatable as the food to which it is accustomed. In either case the plant may be said to be protected by its flavour. Many plants which are the staple food of some animals are never eaten by others, and the grasses, which are so acceptable to grazing animals, are neglected by most of the lepidopterous larvæ, even when starving. Grazing animals do not care to eat thick-leaved plants, such as the rhododendron, nor ferns, mosses, aconite, hellebore, hemlock, the greater celandine, poppies, spurges, gentians, the potato, meadow-saffron (falsely called the autumn crocus), the danewort (*Sambucus ebulus*), nor any of the Crassulaceæ. Yet we know that the potato is freely eaten by many animals, while the larva of the spotted elephant-moth feeds on the sea-spurge, that of the six-belted clear-wing moth on the stems of the stinking hellebore, and that of the *Haltica atropæ* on the deadly nightshade, the berries of which, according to Kerner, are taken with impunity by thrushes. Many lichens are exceedingly nutritious, and wild animals feed on them in winter in many countries. The *Cladonia rangiferina* is said to be in Lapland the winter food of the reindeer. Other species belonging to the genus *Gyrophora* are the "tripe-de-roche" of Canadian trappers, and were for a period the only sustenance of the members of Franklin's first Arctic Expedition. The Iceland-moss of our druggists is a preparation of a lichen (*Cetraria Icelandica*) which is consumed, after treatment, by the Icelander, his cattle, and domestic animals; with it also the Scandinavian fattens his swine. Yet it must be borne in mind that an obnoxious flavour which renders many species inedible extends to a greater or less degree throughout the whole group of lichens when in the raw state, and that they therefore may be protected from their enemies except in seasons of scarcity of food. The *Cladonia rangiferina* has to be rendered palatable to animals by pouring hot water over it, and then mixing with straw and salt.* Further, lichens may

* See 'Lindsay's Popular History of British Lichens,' p. 274.

be protected by other means besides their possession of a disagreeable flavour. Parry states that during his fourth voyage his men collected the *Cl. rangiferina* as provender for his reindeer, and adds that it required "a great deal of picking" to separate it from the moss among which it usually grows. Moss is not eaten by grazing animals, and it may therefore preserve the lichen with which it is closely interwoven.

It is not, however, in the leaves but in the flowers of plants that we find the greatest number of instances of protective flavouring, as in 1790 was suggested by Erasmus Darwin as follows:—"The flowers or petals of plants are perhaps in general more acrid than their leaves, hence they are much seldomer eaten by insects." * It is the flower which is the hope of the species, and we find every means used for its preservation. The methods may vary, but their object is unmistakable. Herbivorous animals have an abundance of food in the leaves of plants without their requiring the flowers, in the preservation of which they are also interested. They will eat with relish the leaves of many plants, but will resent the offer of their flowers, excepting those of grasses,† either with indifference or with aversion. The sweet-scented violets, honeysuckles, lilies, and pinks appear to them distasteful, and the eye-bright, rattleseed, poppy, and cowslip will be left untouched in the pasture and roadside. Kerner states that *Alchemilla vulgaris* is never touched, although the little blossoms are imbedded in green leaves, and the plant is growing in spots frequented by grazing animals. Some years ago I had a mare which would frequently snatch a rose from my buttonhole, and eat the leaves but drop the flower. Larvæ which feed on the leaves of a particular plant will rather starve than eat the flower. Over-fed pastures have but few flowers, in consequence of the animals being compelled to eat what they can find and not what they like; but any one who watches how they avoid flowers where there is an abundance of verdure, will realize their natural preferences. Buttercups and daisies are so plentiful in some fields that they are frequently seized with the grasses and afterwards dropped. The ray-florets of many of the Compositæ are distasteful,‡ and often contain matter which is excessively poisonous to insects. In the case of *Pyrethrum*, the ray-florets are more poisonous than the disc-florets in the ratio of about three to two.

* 'Loves of the Plants,' Canto iii.

† I refer to this exception in the conclusion of my address. The easy dissemination of the seeds of grasses may be regarded as one of the defences of the species.

‡ See Darwin's 'Forms of Flowers,' p. 6.

I have given a sufficient number of instances to show that very many flowers are distasteful to some animals, and it is quite possible that this may be the case to a greater or less degree with most, if not all, flowers when fresh.

Protection by means of Objectionable Flavours and Colour.

The value to a plant of an objectionable flavour as a means of protection is increased by its being accompanied by a colour which is easily noticeable. For although herbivorous animals when feeding may be largely guided by their olfactory sense in rejecting those plants which are the least palatable, yet they can see flowers at some distance and may recognise them either as inedible or at least not such agreeable food as the surrounding herbage. In such cases the animal may be expected to avoid the spot where the flowers grow, and the leaves of the plant, which might be acceptable food, would be spared. Such means of protection occur frequently amongst insects. The gayly-mottled currant-moth, which has a most disagreeable flavour, flies slowly in broad daylight and is never attacked by birds, but if it were dull-coloured it might be mistaken for an edible moth.

Flowers have much to gain by being prominent. Their modesty would be a false virtue, for the assertion of their presence by every means in their power is not only a protection but is necessary to the fulfilment of their function. Yet their beauty and conspicuousness are sometimes a danger. Sparrows have begun to attack the flower of the crocus in our town gardens. Man also in spite of all his artificial ways is still part of nature and has to be considered. It is he who has nearly exterminated the primroses near our large towns, and the ladies-slipper, Turk's cap-lily, and wild tulip from the country. The public cannot refrain from plucking a beautiful wild flower, and if the species be occasional they soon make it rare. Our botanists then become anxious to procure specimens, and soon none remain except in gardens and cabinets.

Insignificant flowers are sometimes rendered most conspicuous by the form and colour of the leaves which surround them. Such involucres serve not only as an attraction for insects, but also as a means of protection. In the case of *Poinsettia pulcherrima* the crimson leaves appear and disappear with the flowers. In common with other Euphorbiæ, many of which have similar though less conspicuous bracts, the juice is exceedingly acrid, and the richly-coloured leaves may play the part of "warning colours" to grazing animals. We know that the stimulation of the retina by the different rays of light, not only produces the sensation of colour, but also a general effect on the nervous system pleasurable or otherwise. We cannot therefore be sure that the great influence of certain colours on animals is not directly due to such causes. But, ridiculous as it may appear, when we consider that the red poppy of our fields is distasteful to all grazing animals, we may see some explanation of the anger which bulls and occasionally cows display at the sight of a red rag. It should be borne in mind that very gay flowers have rarely strong odours, so that animals might be expected only to detect their presence by the sense of smell when comparatively close to them. On the other hand, some inconspicuous flowers, like the violet, are very fragrant. White is a very observable colour, and the fact that white flowers are often highly scented would seem opposed to the theory I am advancing, for it may be urged that their powerful scent alone would warn animals of their proximity, and that the colour was unnecessary. But the effusion of odours of many flowers is intermittent, while most flowers which are white require fertilisation by nocturnal insects and are only sweet-smelling at night.

The brilliancy of vegetation is in its flowers. Their primary function is the continuation of the species, and plants derive the same benefit from their showy petals as many birds from the increased attractions of their plumage during the pairing season. Yet the colour of the flower may have for a secondary purpose the protection of itself and its plant, just as the long spiral stalk of the flower of the female *Vallisneria spiralis* is not only the means of securing the fertilisation of its ovary, but also of placing it in safety. Nature nearly always kills more than one bird with one stone.

Protection by means of Appliances.

The woody tissue of plants is clearly of protective service, and the same can be said of the epidermis, which is thicker on the upper surface of a leaf than on the lower, and is wanting in those parts which are constantly submerged. The upper part of a horizontal leaf is more exposed to danger than the lower, and is therefore more liable to injury. An examination of the two discloses that the cells of the upper surface are packed close together in a vertical position with their small ends uppermost, while the cells of the lower surface are arranged horizontally, and are generally separated by open spaces. This difference in structure is doubtless due to the greater exposure to light of the upper surface, the denser cellular stratum of which is a protection. In the case of vertical leaves, as in the Eucalypti, there is not much difference between the two surfaces. Thorns and prickles are common on many stems, branches, and leaves, and are often, as in the Labiates, found on the calyx. All these appliances are of good service. Many leaves with prickles, such as those of the holly, frequently have smooth edges when growing on the top and in the more inward parts of a well-grown plant, where they would not be touched by grazing animals. Thistles are greatly protected, and, in many cases, as in the common carline, the prickles of the involucre point downwards as well as upwards, thus preventing the access of soft-bodied animals. The armament of thistles is very necessary, for when crushed they are excellent food for horses and cattle. It is generally stated that they will be eaten by donkeys, but my experience leads me to think that this occurs only under the pressure of hunger. The upper flowers of the broad burweed (*Xanthium strumarium*) and other plants are protected by the prickly seed-vessels already formed by the lower flowers. Drought causes many plants to produce spines and thorns which are not found when they grow in wet places where they are more out of the way of grazing animals. Some plants have similar protection when young, but not when they reach a certain height. The pear-tree when wild has long thorns which become branches under cultivation, and the blackthorns, the thorns of which are so protective, are believed by some to be wild varieties of our thornless plum and damson trees. Many of our sedges and grasses, like the matgrass (*Nardus stricta*), are so stiff that cattle rarely touch them. The rough meadow-grass (*Poa trivialis*) when in stalk, and the prickly carex (*Carex muricata*), are avoided in consequence of their roughness. The genus *Festuca* contains some of our best and worst agricultural grasses, and Kerner mentions a species (*F. alpestris*) which is burnt by the shepherds in the district of Monte Baldo owing to its leaves ending in such sharp needle-points that grazing animals get their nostrils injured when searching for other plants growing with it. Stinging nettles are protected from most herbivorous animals, although donkeys will eat them, and cattle also when hard pressed for food. Rabbits will bite the leaves and stalks to clear their holes, but I have never heard of their feeding on them.

The protection of the leaves and branches by means of thorns and prickles in any plant extends also of course to the flower. But, as already stated, the entomophilous flower has its special dangers. Its nectar is relished by other insects than those suitable for its cross-fertilisation. An apterous visitor is likely to have the pollen that it is conveying rubbed off by the many objects with which it comes in contact, whereas the probability is remote of this occurring in the case of those that approach flying. It is therefore an advantage to plants if creeping insects are prevented from reaching the flower. Plants growing in water require no special adjustment for this purpose, and many, such as the common teasel, obtain on dry land the same result through their stalks being at one place or another surrounded by water which has collected in a concavity formed by their leaves. An interesting adaptation is seen in *Polygonum amphibium*, which usually floats in water, and roots at the lower nodes. Under such conditions the leaves and stalks are hairless, but should the pond or ditch dry up, the stalk soon becomes covered with glandular hairs excreting a viscid matter which is an effective barrier to crawling insects. A number of plants, and among them the viscid lychnis (*Lychnis viscaria*), the ragged Robin (*Lychnis flos-cuculi*), and the *Salpiglossis*, are protected in the same way. Indeed viscid stems, leaves, and calices are of frequent occurrence, and so effectual is the service that Kerner collected more than sixty species of insects from the flower-stems of *Silene nutans*. The same botanist mentions a curious experiment upon plants with a milky juice, such as *Lactuca angustana* and *L. sativa*. Having placed ants upon them, he says he found that the ants were glued down by the juice which had exuded through the punctures made by the hooks of their feet in the uppermost leaves. We also find plants abandoning as it were any defence from unbidden guests, and obtaining the safety of their flowers by placing a portion or the whole of their nectar on their leaves or stipules, just as a friend of mine places her plate-basket on the stairs to prevent her from being disturbed by robbers. In *Impatiens tricornis* the two stipules of each leaf are transformed into nectaries.

The ray-florets of the Compositæ, as seen in the daisy, fold inwards at night and during cold weather, so as to protect the disks. The closing of many flowers, such as the *Œnothera*, in the daytime, prevents visits from useless insects.

The object of the different positions of many leaves at night from what they hold during day, is to protect their more sensitive upper surfaces from cold. In *Trifolium repens*, for instance, the two lower leaflets rotate, so that their upper surfaces are in contact and their position becomes vertical. The terminal leaflet falls over the edges of these two leaflets with its lower surface uppermost, while its two sides slope from the mid-rib like a roof. Of the plants that sleep at night the Rev. G. Henslow has shown that many of the young leaves at an early stage assume the position of the old leaves when subjected to cold at night. The feebleness of youth in this way protects itself by a configuration similar to that which low temperature produces. In fact the position of many leaves at night is a kindred protection against temperature with the resinous covering of many buds.

It is scarcely necessary for me to do more than allude to the various means of protection which many flowers possess against the visits of winged insects which are not likely to cause their fertilisation.

Protection by means of Mimicry.

I use the word mimicry, not only for want of a better, but because it has been generally applied to the phenomena of which I am about to treat. All that is implied by the expression in such cases is that one object is so like another that an observer cannot distinguish the two without critical examination. It is clear that if an unprotected plant should resemble one that is protected, or some inedible substance, it might be passed over by its enemies. I cannot state that I have seen an instance of an animal apparently avoiding a plant from any resemblance to other objects that it may possess, but I will mention a few cases of mimicry which might well be supposed to *lead* to such an occurrence. Many plants in the Karoo have exposed tuberous roots which resemble so much the surrounding stones, that when not in leaf it is almost impossible to distinguish them.* The dead-nettle is exceedingly like the common stinging-nettle, and, when the two plants are not in flower, it is very difficult to distinguish the one from the other. The latter is, as I have already stated, avoided by many animals. The wood-ranunculus (*Ranunculus auricomus*), which is less unpalatable than many buttercups, as its pre-Linnean name *dulcis* denotes, may be protected from its resemblance to the common meadow-ranunculus (*R. acris*), which, as its botanical name implies, is acrid. The *Poa pratensis* or smooth meadow-grass is easily mistaken for the *Poa trivialis* or rough meadow-grass, so much so that, when in flower, experienced botanists frequently run the stalk through their fingers before naming the species. The young leaves of both grasses appear to be liked by grazing animals, but the many standing stalks of the rough meadow-grass show that its texture is recognised, and the stalk of the smooth meadow-grass may be preserved by its similarity of appearance. A more interesting case of mimicry occurs between the potentils and the buttercups, which frequently grow together. The resemblance is noteworthy, for the potentils

* See Wallace's 'Tropical Nature,' p. 223.

are an exceptional genus of the Rosaceæ, and, though astringent, are not so disagreeable as the buttercups, one of which, *R. sceleratus*, will blister the hand that gathers it. Young students frequently confound the flowers of the two groups, and if animals do the same we have an exact analogy to what occasionally occurs among insects. For instance a family of South American butterflies, the Heliconidæ, are of striking colouration, and, though slow-fliers of gregarious habits, are not caught by birds which feed on insects, owing, it is supposed, to the disagreeable flavour they possess. Now the Pieridæ differ from the Heliconidæ in distinct structural characters, and their colour is generally white. Yet they contain a genus, viz. *Leptales*, of which the greater number of species are spared by mimicking the Heliconidæ, not only in the form and colour of the wings, but also in the mode of flight.* Some of my hearers may think that the bee-orchid (*Ophrys apifera*) should be mentioned as an instance of protective mimicry, and that it may be avoided by ruminants from its resemblance to a bee just as our large wood-borer (*Sirex gigas*) may be spared on account of its marking being not unlike the well-armed hornet. I must confess, however, that the only similarity I can see between this orchid and a bee is in its hairy labellum, which is not unlike the abdomen of a humble bee. Yet it is just possible that the plant may derive from this appearance a protection superadded to that which I believe all flowers possess.†

Animals and plants have so many forms and colourations that we cannot be surprised if some of them are common to the two groups, and are repeated in widely-separated families of the same group. Protective mimicry implies, however, that protection arises from some similarity of appearance, and for this reason I do not include in this category plants like the Cacti and some of the Euphorbias, which, though quite distinct, resemble one another and possess the same means of protection, viz. thorns.

Protection of Seeds and Spores.

If the Poet Laureate had lived when the gigantic fauna and flora of the Carboniferous era were disappearing, he would have modified the lines which I quoted at the commencement of

* A paper in the 'Transactions of the Linnean Society,' vol. xxiii, p. 495, by Mr. Bates, who first drew attention to the object of this mimetic analogy, is accompanied by an illustrative plate.

† There is a doubt whether *Ophrys apifera* is visited by bees, and this is apparently confirmed by the special adaptations the plant possesses for its self-fertilisation. B. T. Lowne, however, informs me that he found on one occasion in the Isle of Wight many bees bearing its pollinia.

my address. Nature might then have been said to be careless of types, and careful of life. We might even now adopt this view when we consider that the food of many animals consists wholly or largely of seed, and that the enormous quantity consumed must deprive many species of plants of beneficial varieties. We know that the weakest or least fit of all animals are the first to become the prey of their enemies, and that oviparous animals, including the humblest insects, are careful where they place their eggs, so that the careless have less chance of a posterity than the careful. In both these cases the species derives some compensation for loss of numbers. But the destruction of seeds confers no such advantage on vegetation. It is difficult to think that the mere earthy colour of seeds can protect them from the quick sight of birds. But just as insects flee from danger and find shelter in the irregularities of the earth and under fallen leaves, so are light seeds carried by the wind to similar places of refuge. Nor are heavy seeds without protection. The nuts are green at first and are not easily distinguishable amongst the foliage. As they ripen they turn brown and fall, when their colour again protects them from enemies. The brilliant hues of many ripe berries and fruits are exceedingly conspicuous. They are invitations to a repast and are not strictly protective, though they serve to the dissemination of the species. They attract frugivorous animals which eat them, and, while the pulpous covering is digested, the hard kernel or pips, *i.e.* seeds, are dropped possibly many miles away from the parent plant with unimpaired or possibly with augmented vitality. Wallace * states that in the case of attractively-coloured fruits, the seeds are always of such a nature as to escape destruction when the fruit itself is eaten, and he mentions one curious case of an attractively-coloured seed which has no soft eatable covering, viz. the "rosary bean" (*Abrus precatoria*). It is a leguminous shrub or tree growing in many tropical countries, whose pods curl up and split open on the tree, displaying the brilliant red seeds within. It is very hard and glossy, and is said to be, as no doubt it is, very indigestible. The obvious suggestion is, that birds, attracted by the bright colour of the seeds, swallow them, and that they pass through their bodies undigested yet advanced a stage by the process, and so become dispersed. The same hardness protects the nutmeg, which is taken by pigeons for the sake of the mace which covers it. The seeds of the hips of roses are hairy and are therefore inconvenient food. Seeds "with wings," such as those of the maple, must be protected, at least from small birds, until they have

* 'Tropical Nature,' p. 226.

escaped from their capsules. The "shells" of walnuts have a disagreeable flavour, and so have the pips of the orange, while the pips of the apple not only have the usual power of the seeds of brilliant-coloured fruit of resisting digestive fluids, but they also are surrounded by a core. Many of the capsules of plants when ripe explode and scatter the seeds, as in the balsams. According to Wallace,* plants whose seeds are ejected by the bursting open of their capsules, as with the *Oxalis* and many of the Caryophyllaceæ and Scrophulariaceæ, etc., have their seeds very small and are rarely or never edible. Dried fruits and naked seeds can remain in salt-water for a considerable time with uninjured vitality, and can therefore be conveyed by the sea to distant shores where they may be removed by birds to the interior and there germinate. Prickly capsules are not only a means of protection but also of dissemination, on account of their liability to become attached to the hairy skin of animals.

I have already referred to the care some plants take of their seed, but one of the most interesting means of protection is the power some seeds possess of burying themselves. The beautiful feathers of the feather-grass (*Stipa pumata*) are the awns of the seed of the plant. As the awn becomes alternately damp and dry, so its feathery portion revolves, but if this movement be prevented, the seed will revolve. Now, when the seed is dropped, it remains in a vertical position, so that it rests on the ground with its point downwards, or if it should fall among vegetation it will be caught by its feather. Many seeds would thus be brought in contact with the earth, and twisted into the earth. The arrested revolutions of the feathery portion do not, however, entirely explain the burial of the seed, for the direction of the rotatory motion of the seed is changed, according as the feather is wet or dry. This is apparently successfully prevented by some small hairs on the seed which point upwards and resist the traction. Francis Darwin states that in one experiment "in three wettings and three dryings 28 mm. was buried in the sand. In another experiment a seed 16 mm. was completely buried in three wettings and three dryings." † The same process is seen in the oats, geraniums, and many other plants.

The spores of the Equiseta are specially adapted for falling in places suitable for their development. Each spore has two pairs of elastic filaments which are extended when dry, but close together even with the moisture of the breath. It can scarcely be imagined

* *Idem.*, p. 227.

† 'Trans. Linnean Soc.,' 2nd series, Botany, vol. i, p. 155.

that this provision is not of service in the dissemination of the plant, for the spores on being carried over a damp soil, where they flourish, will fall on account of their increased density. The spores of the Fungi are microscopic, and are easily dispersed by the faintest breeze. In the Phalloidei, however, the spores are involved in a slimy mucus which renders their diffusion by such means less probable. This mucus is, however, exceedingly attractive to insects, which possibly may swallow and drop the spores in the same way as birds do seeds.

Conclusion.

In concluding my Address, I feel that I have scarcely more than touched upon the threshold of a vast subject which must ever increase with the growth of man's knowledge of the mutual relations of plants to animals, combined with those of plants to one another.

Nettles are protected from herbivorous animals by the sting, but possibly their very abundance and comparative freedom from such interference have led to their being the food-plant of so many lepidopterous larvæ, which, in the imago stage, fertilize plants. The nectar on the leaflets of the bull's-horn thorn provides a bountiful supply of food to the ants (*Pseudomyrma bicolor*), which occupy its hollow thorns, and which form a standing army of defence against leaf-cutting ants, caterpillars, and grazing animals. Other ants (*Lasius flavus*) convey the eggs of aphides to their nests during winter, and, after sheltering them with the greatest care, place the resulting young ones during March on the young shoots of the daisy. Yet these ants, like others, must confer a benefit to all vegetation by removing the honey-dew from the surface of leaves. Grazing animals are the greatest enemies of the grasses, yet the finest grasses are found in pastures, without being placed there by man. Again, how would the rank growth of those plants be prevented if not by animals? And if not prevented, would not the air and light be shut off from the young shoots? May not the snails and slugs, which destroy indiscriminately so many young plants whether they be weak or strong, be the means of preventing the predominance of a few species? If this be the case, may not snails and slugs be regarded as enemies of the few and friends of the many? May not the larvæ of the saw-flies which attack our rosebuds prevent the plant from over-blooming? May not the aphides which flourish on sickly growths improve the species of the plant by eliminating the least fit? When, therefore, we speak of the means of protection possessed by plants, we feel that only increased knowledge can lead us to realise the extent of compensatory advantage the species may derive from the successful attacks of its enemies. *Fas est et ab hoste doceri.* Although plants and animals are protected, they are not secured against all attacks. Immunity from danger is incompatible with development. Each species has its Achilles' heel, which is vulnerable. The petals of the chamomile and fever-few are avoided by grazing animals, but they are devoured by the chamomile-moth. Nor is every living thing solely dependent on itself for protection. Seeds attract birds and the birds attract hawks, and in this way the hawks protect the seeds. So we find cats feeding on mice, mice destroying humble-bees' nests for the sake of the honey,—the humble-bees that are necessary to the fertilisation of the red clover, of which the mice eat the seeds.

What is the explanation of these apparent cross-purposes? Is it not that all the different forms of life with which we are surrounded are directly or indirectly mutually inter-dependent in this big universe, and that only now and again does our knowledge enable us to recognise the relations that exist between the separate links in the great chain of life? We are as ignorant now of the services rendered by organisms widely separated from each other, as our forefathers were of the mutual dependency between plants and insects. No species lives for itself alone, and each species has to sacrifice some of its members for another. Nature must ever be regarded as a whole. We may commence by limiting our observation to one particular species, but the further we pursue research, the more we shall find the subject of our study to be woven in with what we may call collateral issues—issues which are really essential conditions. We can discern them, but the knowledge of them is not within our reach. The higher we ascend the hill, the more we see the extent of regions that we can never hope to tread.

It was and will be ever thus. The recognition of our ignorance is the measure of our knowledge, and whatever may be the culture in time to come of the most learned of mankind, and to whatever clearness of intellectual vision they may attain, they will be so much the more able than ourselves to realize that they have but read a few syllables from the title-page of the Book of Nature.

II.

ON *WALCKENAËRA INTERJECTA*, A NEW SPIDER FROM HODDESDON.

By the Rev. O. P. Cambridge, M.A., F.R.S.

Read at Hoddesdon, 3rd November, 1887.

(Communicated by the President.)

A single example of the malė of this spider was found in an outhouse at Hoddesdon, and kindly sent to me by Mr. F. M. Campbell, of Rose Hill, and it appears to me to be new to science. It is nearly allied to *Walckenaëra elegans*, Cambr.,* from Nuremberg, but differs in several well-marked specific characters; chiefly in the form of the caput and of the palpi and palpal organs.

About the same time I received an adult example of each sex from Holland, where they were found by Major-General A. W. M. Van Hasselt, who kindly sent them to me.

Class ARACHNIDA.

Order Araneidea.

Family *Theridiidæ.*

Genus *Walckenaëra*, Bl.

Walckenaëra interjecta, sp. nov.

1. 2. 3.

Fig. 1. Profile of cephalothorax of male.

,, 2. Outline of left palpus from above on the inner side, showing the characteristic form of the radial joint (*a*) with its exterior terminal spine (*b*).

,, 3. Digital joint of right palpus looking upwards from the outer side.

Adult male: length $\frac{1}{12}$th of an inch.

General description.—Cephalothorax black-brown; legs yellow; palpi yellow, digital joint yellow-brown; abdomen black.

The *cephalothorax* has the *caput* very slightly elevated towards the ocular region, very much like that of *W. Beckii*, Cambr. The hind-central pair of *eyes* are about an eye's diameter from each other, and placed transversely at the fore-margin of the elevation; the hind-lateral eye (on each side) is more than a diameter's interval from each hind-central eye on its side; and there is a long and slightly-curved tapering indentation running backwards from between the hind-central and hind-lateral eyes on each side. The height of the clypeus is about equal to half that of the facial space.

* 'Proc. Zool. Soc.,' 1872, p. 766, pl. lxvi, fig. 23.

The digital joint of the *palpus* is large and has a small pointed prominent lobe at the base on the inner side, and is largely and roundly prominent on the outer side. The palpal organs are rather complex, and are furnished with three spines; one, slender, filiform, and of considerable length, issues from near their base on the outer side, and coils, freely, round and over to the inner side, recurving and ending in a very fine, free, hair-like point beneath its extremity; another issues from near the fore-end of the palpal organs, and is circularly-curved and sharp-pointed; the third issues from near the base of the last and is nearly straight, prominent, and almost equal in size from its base to its sharp point. The radial joint is short, about equal in length to the cubital; it is broad, obtuse, and, looked at from above and behind, somewhat semi-lunar shaped; its outer extremity is produced into a small, tapering, sinuous, sharp-pointed spine bent abruptly inwards just in front of the anterior edge of the joint. Close beneath the base of this spine is a very small thorn-like projection.

The *legs* are moderate in length and strength, not very unequal in length—4, 1, 2, 3,—and furnished with hairs only.

The *abdomen* is oval, clothed thinly with fine short hairs.

The female is slightly larger than the male, but similar in general form and colours. The caput, however, is less prominent, being only very slightly rounded above, behind the ocular region. The genital aperture is small, semi-circular, and placed at the hinder extremity of a largish, nearly circular, rather prominent area.

I am much indebted to Mr. Campbell and General Van Hasselt for permitting me to describe this interesting little spider, which belongs to a group of several others forming the genus *Cnephalocotes* of M. Eugène Simon. There seems to be but little foundation for the generic separation of this group from the genus *Walckenaëra* of Blackwall. The subdivision of *Walckenaëra*, however, is a question of great difficulty, owing to the characteristic portions of structure being those, commonly, of the male sex only.

III.

A RECORD OF WATER-LEVEL IN A DEEP CHALK WELL AT BARLEY, HERTS, 1864–1886.

By H. George Fordham, F.G.S.

Read at Watford, 31st January, 1888.

PLATE I.

I have recently obtained a copy of the record of a series of monthly observations of the level of the water in a deep well sunk in the Middle Chalk on its outcrop on the northern margin of the London Basin, in the village of Barley, about three miles south-east of Royston.

These observations have (with a few trifling breaks) been regularly made for nearly 23 years, from January, 1864, to October, 1886. They have come to an end through the illness and death of the observer, Mr. John Pearce, who died in May, 1887, at the advanced age of 84.

Records of the variations of underground water-level have as yet hardly received the attention they deserve; and although, within the last few years, observers have multiplied, and a certain amount of public interest in the subject of our underground water-supplies has sprung up, there remains a large field for research in this very practical branch of scientific observation.

A satisfactory knowledge of the amount and variation of the stores in our subterranean water-reservoirs, and of the relation of the supply to the rainfall as measured at the surface, can only be obtained by means of a series of observations spread over wide areas, and extending through a considerable period of time, and consequently such a regular and lengthy record as that kept by Mr. Pearce is of great interest and value.

It seems desirable that the record should be printed in the form in which it was kept by Mr. Pearce, and I have accordingly prepared the Table on page 21, giving his figures, as arranged by him, and adding only (1) the last column, showing the mean monthly level of the water for the 23 years; (2) a line at the bottom of the table, giving the mean height for each year; and (3) a statement of the annual rainfall at Royston, 1863 to 1886, kindly furnished to me by Mr. Hale Wortham. At the head of the table are notes of the position of the well, its height above the sea-level, and its depth.

I have also prepared a chart showing, for each year, the curve representing the alteration of the water-level from month to month; but, unless constructed on a large scale, such a chart for so many as 23 years becomes somewhat confused, and I therefore only represent in this way the mean monthly level, as given in figures in the last column in the table. In this the year begins on April 1st, at the commencement of the summer half-year, the date most convenient for the purpose.

Table of Observations of Water-level in Well at Barley, Herts, made by the late Mr. John Pearce, 1864-86, *showing the number of feet of water in the well on the first of each month.*

Well situated nearly in the middle of the village of Barley, on the north side of Mr. Pearce's house.
Level of curb 305 feet (about) above Ordnance-datum [nearest B.M. 317·0, about 80 yards distant].
Depth of well from curb, 165 feet; sunk entirely in the Middle Chalk.

	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	Mean 1864-86.
January	2	7½	30	42	36	20	28	6	11	51	29	12	—	51	48	48	61	—	68	63	62	20	32	34½
February	8	7½	47	56	46	35	36	11	14	60	28	13	40	57	54	60	54	69	69	—	—	18	48	39½
March	8½	9	59	60	51	55	39	12	22	69	27	15	48	66	57	69	57	72	69	—	—	19	51	44½
April	14	17	54	61	51	57	46	14	26	—	27	14	57	58	54	72	57	78	68	75	57	27	51	47
May	19½	17	54	61	49	55	42	17	40	62	27	15	51	52	53	—	54	75	—	—	—	27	51	43
June	24½	15½	50	60	43	53	37	18	42	57	24	16	49	51	54	78	53	72	66	—	—	30	57	45¼
July	20	10	48	56	36	51	30	18	42	54	19	16	50	60	52	75	48	69	60	66	48	30	54	44
August	12	9	43	50½	31	45	25	18	37	48	15	16	42	57	48	80	49	68	—	—	42	22	51	38½
September	6	7	40	48	28	42	20	14	33	45	12	17	39	51	43	78	48	57	48	—	36	22	45	35½
October	9	11	38	45	24	38	16	12	28	36	10	15	36	48	39	73	—	51	43	63	27	21	40	32½
November	7	15	33	42	21	34	14	9	25	33	10	16	28	42	33	72	57	50	40	—	—	17	—	30
December ... ... (1863)	8	26½	33	47	20	30	10	10	25	—	11	40	27	41	36	66	63	49	—	—	22	24	—	31
Mean level for year	11½	12¾	44	52¼	36¼	43	28½	13¼	28¾	51½	20	17	42½	53	47½	70	54¾	64½	59	—	—	23	48	39
Rainfall at Royston ... 17·87	16·67	29·33	26·48	24·86	22·62	24·56	17·16	19·07	28·52	21·09	17·79	26·36	26·78	27·22	23·36	30·00	27·39	24·03	26·20	27·37	16·68	24·40	25·12	24·05

It will be seen from the chart that the mean time of highest level is April 1st, there having been, after the autumn and winter rains, a sharp rise from the lowest point (November 1st). From April 1st to May 1st there is a slight fall, again in the following month a rise, and from June 1st a steady fall to November 1st. Taken generally, the movement of the water is a rise for five months (November, December, January, February, and March), and a fall for the remaining seven months, through the summer and autumn.

My own daily observations at Odsey, commencing at the end of 1878, have hardly, as yet, extended through a sufficient number of consecutive years to be worth publication; but, for the sake of comparison with the Barley record, I have worked out the mean monthly level for Odsey, and have represented it on the chart by a second line. This line shows that the same regular rise and fall occurs in the Odsey well, except that the mean highest level of water is one month earlier than at Barley, and that the summer and autumnal fall is unbroken by any upward movement.

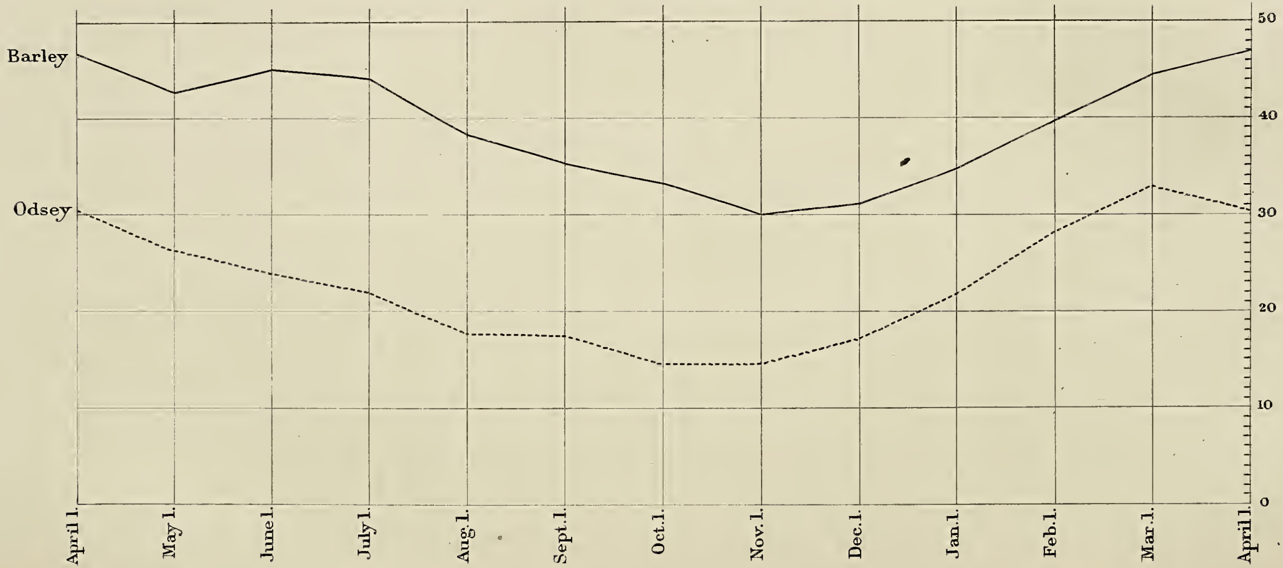
A detailed examination of the figures in the table, or of a chart representing them, shows great variations from the mean level in years of and those following excessive and small rainfalls, and it will be seen that the extreme variation in level has been as much as 78 feet—between 2 feet (January, 1864) and 80 feet (August, 1879). The greatest difference in any one year was in 1869—in January 20 feet, and in April 57 feet, a rise of 37 feet; and the least in 1871—in January 6 feet, and in June 18 feet, a rise of only 12 feet. The mean level for the year 1879 was 70 feet, and that for 1864 only 11½ feet; 1879 being also the year of heaviest rainfall for the period (30·00 inches), and 1864 being that of the smallest rainfall (16·67 inches), preceded by a small rainfall (17·87 inches) in 1863. In these comparisons the two imperfect years 1883 and 1884 are omitted.

At some future time, and in connection possibly with the publication of results of observations in the Odsey well, I hope to discuss the variations of water-level in the Chalk of North Herts more fully; but, in the mean time, so valuable a record as that for Barley should not, I think, remain unpublished.

Possibly the publication of this record in our 'Transactions' may induce members of the Society who have deep wells in the Chalk to set on foot a regular registration of the depth of water in them, either at monthly or shorter intervals. Any systematic observations of this character cannot but be of great value.

Chart shewing mean monthly water-level in wells at Barley and Odsey, measured in feet from the bottom of the wells.

Depth of wells:— Barley, 165 feet: Odsey, 104 feet.



IV.

SOME METHODS OF MOTH-COLLECTING.

By R. W. Bowyer, M.A.

Extracts from a paper read at Hertford, 28th February, 1888.

The subject which I have chosen for my remarks this evening is a very wide one, and must of necessity be very superficially treated. I have taken as my title the collecting of *moths*; *Lepidoptera* would have been better perhaps. I do not mean to exclude *butterflies* altogether, but in England they form a very minor division of Lepidoptera. In the first place, as regards number, butterflies are 64, compared with moths over 2000; of these 64 only few would occur in any particular district. The collecting of butterflies is necessarily limited by time of day and year, and by conditions of weather; whereas the collecting of moths begins in January and ends in December, it can be carried on by day or night, rain is often useful rather than a hindrance, and in-doors as well as out of doors the ubiquitous moth is to be found. When any one is once imbued with the passion for collecting, a field of wonderfully varied beauty and interest is gradually opened out to him. Then there can be no such thing as dullness or want of object, even in the constitutional walk, if only there is a hedge-row or a tree or two to examine.

I believe there is a very general idea that no one can take up the collecting of Lepidoptera unless he or she has begun in the years of boyhood or girlhood. That is neither my own view nor experience. It is a small per-centage of boys who go about with a net, catching many an unfortunate insect, who keep up the pursuit when they have grown up. When I went to Haileybury as a master, I was absolutely ignorant of the subject.

Having determined to commence, what is necessary in the way of apparatus? As regards books, I would recommend Greene's 'Insect Hunter's Companion,' which admirably describes all pre-liminaries—it is the best shilling's worth that I possess. Newman's 'British Moths and Butterflies' is first rate as regards the illus-trations; it has a print of each insect, not coloured, but wonderfully exact; the text however is too diffuse, and stress is not properly laid on the points of difference between insects which are only to be distinguished by minute markings. Stainton's 'Manual of Butterflies and Moths' is indispensable to the collector of small moths, *Micro-lepidoptera,* which Newman does not treat of; the text is concise, clear stress is laid on distinguishing markings, but there are woodcuts only here and there. A new edition would be a great boon, as the present one is out of date, and many additions have been made to the number of British species since it appeared. Armed with the first two of these books to begin with, and with the third as time goes on, not much more is needed. The Ray Society has, in 1885 and 1886, brought out two volumes of 'Larvæ of British Lepidoptera,' edited by Stainton, illustrated by magnificent plates, and a third volume will appear at the end of this year; but it must be many years before the subject will be completed.

As to apparatus, first of all is, of course, the net. Some form of folding-net is convenient, both for travelling and to avoid obtrusive observation when one has to pass through a town. Then setting-boards of various sizes; and a killing-bottle, as to the contents of which authorities differ. Some use bruised laurel leaves, which have the advantage of not stiffening insects and the disadvantage of bleaching those which are green. A most effective and convenient substance is a solution of cyanide of potassium poured into a bottle and solidified by plaster of Paris. These killing-bottles are easily and cheaply filled for oneself, with very little practice. Insects killed in this way become stiff: a good mode of relaxing, for a smoker, is to stupefy them by the cyanide, and then pierce the body with a needle which has been put up the stem of a well-used pipe. Anyhow a relaxing-box, of zinc, lined with cork, and moistened from time to time with hot water, is a *sine quâ non.* It may be taken as an axiom that no insect which is stiff can be set properly, *i.e.* without piercing the wings or removing the scales. Skilful setting can only be acquired by practice: it is well to remember that the wings of a moth should be moved on the setting-board by applying a fine pin *beneath*, not *above* them. A perfect and perfectly-set insect should bear the test of being looked at with a light behind it; punctures or want of scales can be then at once seen. It is better to use tracing-paper to cover the wings, than the commonly used triangular pieces of cardboard, which are apt to leave dents. The wings should be nearly covered with the paper; one can see through it whether they are set symmetrically or not. One thing I would add—avoid *mixed* pins. Beginners often buy from dealers a box of these mixed pins, and use the largest size for the smallest insects, and *vice versâ.* Pins should be kept apart by sizes; and an experienced collector knows these sizes by numbers as a sportsman knows his shot, and when he has caught a moth, knows at once what sized pin to use. Black pins are very generally in use now; they are a necessity for collectors of small insects. On the ordinary silvered, or even on gilt pins, with many species verdigris will form near the body of the moth, and gradually, by its pressure, distort the wings.

A collector must be provided with a good supply of chip-boxes, or, better still, with glass-topped boxes, and he should always have a few of these in his pocket for chance captures.

And now, being provided with apparatus, as to some of the chief methods of obtaining moths. First of all I would place the use of the eye. Wooden palings and tree trunks will, if searched, yield a large number of species which rest on them in the daytime. I have got so into the habit, that I cannot pass a tree or paling without running my eye over it. It is wonderful how training brings skill with it: you may often tell a non-collecting friend that a moth is sitting on a tree within a foot or two of him, and still he cannot find it, when to yourself it almost obtrudes itself on the eye. At Haileybury, on the palings round the park, large numbers of species have been found from time to time. I have known boys waiting for the college gates to be opened in the morning, and then making a rush for the palings. I am sure that on the palings round Panshanger many a rarity could be found: I wish they were within easier reach. In this mode of collecting one of the great charms of the subject is noticed, the wonderful harmonisation of the colouring and markings of moths with the objects on which they rest. A moth which appears in March, *Xylocampa lithorhiza*, requires an experienced eye to detect it as it sits on oak palings. Species which rest on lichen-covered trees may easily escape notice. One gets to observe that in the autumn, when the leaves are turning yellow, a large number of species are coloured yellow. In fact, the more one collects, the more interesting in this point of protective resemblances must the subject become.

In the course of a country walk many a moth may be caught which has been accidentally disturbed by the foot or stick and has then flown to some accessible resting-place. It is for occasions like this that one should always be supplied with little boxes.

When the net is brought into requisition, even in the daytime, large captures may be made. It is a great mistake to suppose that the line of distinction between butterflies and moths is that the former fly by day, and the latter by night. Many moths fly naturally in the daytime, in the sunshine, and are readily netted then; but, if hedges and trees are beaten with a stick, anything at rest waiting for dusk is easily dislodged and perhaps caught. Just at dusk, when one can see to collect without a lantern, and when a beating-stick is no longer necessary, I know of no more pleasant occupation than collecting while taking a stroll by the side of a wood on a warm summer evening.

It is of course after dark that the main part of moth-collecting begins. If you live in a favourable situation, you may never stir out at night and yet make an extensive collection; put a protected light at an open window, and plenty of insects will come. The powers of observation are much quickened even in this way; you get to know what kind of nights are good for moths, and when you may as well put out your light and go to bed. Sultry, cloudy nights with moist atmosphere are good, while a bright moonlight night will produce little. A drizzling rain means good sport; it takes a steady downpour to keep a moth at home; a sudden shower will often send them by dozens into a room. You will get to see how punctual some species are in their appearance; I have heard it said that a collector might often regulate his watch by the arrival of certain moths.

If you go out for a stroll with a hand-lantern, the interest is to my mind far greater. Many moths may of course be netted as they fly by the light, but a very effective way is to leave the net at home, take a large supply of chip-boxes, and search the natural baits for moths—different flower-heads. The common thistle and knapweed have a great and very seductive power; moths may be freely boxed from them in a perfectly quiescent state. Every one is familiar with the catkins of the great sallow, popularly known as the palm; but it would astonish those who have not had experience if they were to go to a sallow bush in full bloom, armed with an old umbrella or piece of cloth, and shake the bush into it. The moths will tumble literally by dozens in an almost stupefied state, and those wanted may be selected. There are a few common species out at that time of year which particularly frequent the sallow catkins, but here and there stragglers of good species may be taken. Last April I was in the New Forest with some friends who took interest in the subject, but were not collectors; they were astonished at the result of one shake of the tree, and told me that they saw more moths fall from that one shake than they had seen in their lives before.

Ivy-bloom in October is almost as productive, but in this respect my own experience has been small.

Some good collecting may be done in the suburbs of London and elsewhere at the public gas-lamps. I have seen one or two of the lamps near All Saints' Church in Hertford covered with moths, waiting peacefully, as it were, for admission.

Again, there are various forms of moth-traps in which the moth is attracted towards a light, from which, by various arrangements, it is hard to escape. I had in working order last summer one of these traps; I lit this every night before dusk, and got our watchman to put the light out and shut the apparatus up at daybreak; it was always interesting to go in the morning to see what was there. I made a list of considerably over a hundred species caught in this way; none of them rare, but several of moths which I had hitherto been able to take only sparingly and at long intervals.

I have still to mention one way of catching moths—that of sugaring. It is a method which has not many attractions for me personally; but it is a method by which many species have been first discovered in England, by which many species, before thought rare, have been taken commonly, and by which alone some insects are to be taken in abundance. To put it briefly, it is this: mix some coarse sugar, or treacle, with beer; add a little rum or a few drops of essence of pear or almond, or use simply the beer and sugar; and smear a small patch on the trunk, on the leeward side if it is windy, of trees in a more or less open position, just before dusk. After dusk go round with a lantern and boxes; if it is a favourable night, plenty of moths will be there, and can easily be boxed. It is a common idea that they get stuck to the sugar and can be taken the next morning. As a matter of fact they come soon after nightfall or not at all, stay a limited time, and then disappear. Some common moths, *Xylophasia polyodon* for instance, of large powers of consumption, come early and stay late, without any attempt to move; others are very unsettled and will fly off or fall to the ground when the light is thrown on them. Moths are very capricious in their nights; sometimes I have seen over thirty on a small patch of sugar, on other nights I have sugared as many as sixty trees without seeing a single moth. One gets a miscellaneous lot of animals at sugar—beetles, ear-wigs, woodlice, slugs, snails, etc.; and once I found a mouse enjoying a meal. Sugaring is much in vogue in the New Forest, and this is the great way of catching those splendid insects, the "crimsons."

So far I have dealt with some of the methods of catching the fully-developed insect, the "imago" as it is called. But moths caught in any of these ways are apt to be rubbed specimens and cannot stand the test of being looked at before a light. Of course many moths taken at rest on palings or trees have only emerged from the chrysalis a short time, and have not yet flown; they are thus absolutely perfect. To insure perfection it is necessary to obtain them in one of the early stages, *i.e.* as egg, caterpillar, or chrysalis; and I will, as a matter of convenience, treat the subject backwards.

All butterfly caterpillars, so far as I know, change into the chrysalis stage above ground. Many caterpillars of moths do so also, spinning cocoons of various natures in the crevices of tree-trunks, or under moss, or wherever they may be; but a large number, when full fed, bury themselves in the ground not far from the tree or plant on which they have been feeding, and there turn into a chrysalis. Some of these are not covered by cocoons, others have cocoons formed of particles of earth spun together, which are difficult to distinguish even when dug up. Many of these pupæ, as they are called, may be found by digging in suitable nooks at the roots of trees. Detached trees, with light soil around the roots, the north side being the best because the driest, will, if properly searched, yield a large number of pupæ. Lime trees are especially prolific: I believe that if any one were to dig to-morrow round the roots of those large lime trees in Balls Park, he would verify the truth of what I have said. Greene's little book deals very fully with the subject of pupa-digging. For myself, I have never had much luck, probably from want of skill and patience, not enough indeed to repay me for the back-aches I have had to endure afterwards.

It is when one deals with the caterpillar stage—the larva stage—that the most charming part of the pursuit is reached: it is here that the powers of observation have a delightful and varied field before them. I have spoken before of the resemblance of moths to the objects on which they rest: this is the case, to an infinitely greater degree, with larvæ, which have not the same means of escape from danger that a moth has, and which have therefore greater need for protection. The resemblance of many larvæ to little pieces of stick is marvellous, as they stand out from a twig, motionless and rigid. Even the knots are represented, and excrescences like fungoid growths. Other larvæ again, which rest on leaves, have their markings arranged to coincide in direction with the veins of the leaf. These protective resemblances are mostly confined to smooth larvæ. Hairy caterpillars, the "woolly bear" for instance, are protected from birds by these hairs and need no protection of colour. Many again have some acrid taste about them, which birds dislike, and they have no need to resemble other objects. If you were to take a handful of caterpillars and throw them to a chicken, you would find that those most like twigs would be considered the greatest delicacies. The conspicuously marked larva of the currant-moth, *Abraxas grossulariata*, would be untouched, or at all events uneaten, unless the chicken had been kept on short allowance of food. Indeed, you may see that if a larva, from smell or taste, is not a favourite food for birds, it is to its advantage that it should be as gaily coloured as possible, labelled as it were, "Don't touch me, I am not fit for food." It would be small consolation if, while being nasty to the taste, it were not easily distinguished. A bird might give it a peck, thinking it a delicacy, and then, finding its mistake, go away in disgust; the peck would be as fatal to the larva as a hearty meal made from it.

If one were to trust to the eye alone in collecting larvæ, the number found, of some species, would be very small. It is often in fact hard to re-find those already in your possession, and which you know are at rest on some small piece of the food-plant. Much indeed may be done by the eye and by mere chance collecting. Full-fed larvæ are constantly to be found when wandering about in search of some convenient corner to spin up in. But the way to obtain them in abundance is to beat for them. Put an old umbrella or some regular form of beating-tray under a bough, strike it sharply with a stick, and the larvæ will fall; they may even then be readily mistaken for little pieces of dried stick. Those which feed on low-growing herbage are to be obtained by "sweeping" for them, *i.e.* by drawing a strong net over their food-plants. These operations are in many cases best carried out at night, for many larvæ come out to feed at night only, while in the daytime they retire into inaccessible hiding-places.

One way of keeping caterpillars is to tie them in muslin bags, to sleeve them out as it is called, on a branch of their food-plant: they are then under natural conditions. There is a disadvantage in this that their habits are not so readily studied. I prefer to keep mine in cages, with earth at the bottom for burrowing species, and with their food placed in water. Fresh air and the natural temperature are a desideratum, and a shed out of doors is the best place to keep them in. It is best not to keep too many together, and to supply them constantly with fresh leaves: growing plants in small pots will often save much trouble. Two larvæ must be known by sight, which are cannibals to the worst degree; they are those of *Cosmia trapezina* and *Scopelosoma satellitia*. The latter is very easy to recognize, being velvet-black and to be found on the oak. That of *Trapezina* may easily escape notice at first among a miscellaneous lot; it is green and obscurely sprinkled with black markings, and is to be found on nearly every kind of tree and bush.

The descriptions in Newman's work of these two cannibals are very graphic and not at all overdrawn.

Finally the most interesting way of all is to rear your moth from the egg state. The eggs themselves are not in many cases easy to find; but, if a female moth is captured and kept alive for a day or two, she will as a rule deposit a supply of fertilised eggs. These will hatch out at varying intervals of time, generally giving warning by change of colour. A jam-pot, with a bit of glass as a cover, is an admirable receptacle for these young larvæ: it is well at first to avoid changing the food too often, and leaves keep fresh in this way for some days; as the larvæ grow, they may be changed to more suitable cages. It is interesting to watch the changes of skin, which occur several times in the course of growth. Perhaps what has been a sombre-looking larva will appear some morning in a gaily-coloured garb; and in many cases, after a moult, the first meal is made off the old skin.

A collector of moths must be to some extent a botanist; he must know by sight and name most of the common wild flowers—otherwise if he were told that a certain caterpillar was to be found on a plant, which he would not know if he saw it, he would be handicapped in his proceedings. And, if one knows plants by sight and name, it is but a little step further to examine their structure, and here is one more wide field of beauty and interest opened out, some of the charms of which your President treated of in a very attractive way last week.

I will only mention one or two more of the pleasures of the pursuit. One of these is the chance of obtaining rarities, for it is often due to chance that they are obtained. Last autumn our porter brought to me a large moth which he had picked up in the quadrangle: I thought at first sight that it was the common "red underwing," but it gave a flap of its wings and I saw violet instead of red, and I knew that I had a great prize—*Catocala fraxini*.

When one looks over the drawers of one's cabinet, the sight of this or that insect often brings back to the mind pleasant associations connected with its capture. To those who have the reputation of being collectors it is interesting to see the variety of insects brought by friends and neighbours, as presents or to be named. My position renders me peculiarly accessible to presents of this nature. When one of our boys comes with a little box and says, "I have brought a moth, but I expect it is a common one," there is always the chance that it may be rare, and the certainty that the mere looking at it will be a pleasure.

I must now bring my paper to an end. I am afraid I have treated a wide subject in a very discursive manner; but I hope you will have seen that it is one of deep and varied interest to myself, and if I have imparted this interest, in however slight a degree, to any of you, one of the main objects I had in view will have been attained.

Appendix.

List of Macro-Lepidoptera caught near Haileybury.

Diurni.

- Gonepteryx
  - rhamni
- Pieris
  - brassicæ
  - rapæ
  - napi
- Anthocharis
  - cardamines
- Leucophasia
  - sinapis (once)
- Satyrus
  - megæra
- Satyrus
  - egeria
  - janira
  - tithonus
- Satyrus
  - hyperanthus
- Chortobius
  - pamphilus
- Vanessa
  - urticæ
  - polychloros
  - cardui
- Vanessa
  - io
  - atalanta
- Argynnis
  - aglaia (once)
  - euphrosyne
- Melitæa
  - artemis (once)
- Thecla
  - quercus
- Polyommatus
  - phlæas
- Lycæna
  - alexis
  - agistis
  - argiolus
  - arion (once)
- Syricthus
  - alveolus
- Thanaos
  - tages
- Hesperia
  - sylvanus
  - linea

Nocturni.

- Smerinthus
  - ocellatus
  - populi
  - tiliæ
- Acherontia
  - atropos
- Sphinx
  - ligustri
- Deilephila
  - galii (once)
- Chærocampa
  - porcellus
  - elpenor
- Macroglossa
  - stellatarum
  - fuciformis
- Zeuzera
  - æsculi
- Cossus
  - ligniperda
- Hepialus
  - hectus
  - sylvinus
  - humuli
- Zygæna
  - loniceræ
  - filipendulæ
- Nudaria
  - senex
- Calligeria
  - miniata
- Lithosia
  - mesomella
  - complana
  - complanula
  - griseola
- Lithosia
  - aureola
- Euchelia
  - jacobeæ
- Chelonia
  - caja
  - villica
- Arctia
  - fulginiosa
  - mendica
  - lubricipeda
  - menthastri
  - urticæ
- Liparis
  - auriflua
  - salicis
- Orgyia
  - pudibunda
- Orgyia
  - gonostigma (once)
  - antiqua
- Trichiura
  - cratægi
- Pœcilocampa
  - populi
- Eriogaster
  - lanestris
- Bombyx
  - neustria
  - quercus
- Odonestis
  - potatoria
- Lasiocampa
  - quercifolia
- Saturnia
  - carpini

Geometræ.

- Uropteryx
  - sambucata
- Epione
  - apiciaria
- Rumia
  - cratægata
- Venilia
  - maculata
- Angerona
  - prunaria
- Metrocampa
  - margaritata
- Eurymene
  - dolobraria
- Pericallia
  - syringaria
- Selenia
  - illunaria
  - lunaria
- Odontopera
  - bidentata
- Crocallis
  - elinguaria
- Ennomos
  - tiliaria
  - fuscantaria
  - angularia
- Himera
  - pennaria
- Phigalia
  - pilosaria
- Amphidasia
  - prodromaria
  - betularia
- Hemerophila
  - abruptaria
- Cleora
  - lichenaria
- Boarmia
  - repandata
  - rhomboidaria
  - roboraria
- Tephrosia
  - extersaria
- Pseudoterpna
  - cytisaria
- Geometra
  - papilionaria
- Iodis
  - vernaria
  - lactearia
- Phorodesma
  - bajularia
- Hemithea
  - thymiaria
- Ephyra
  - porata
  - punctaria
  - omicronaria
- Asthena
  - candidata
  - luteata
- Acidalia
  - scutulata
  - bisetata
  - trigeminata
  - interjectaria
  - incanaria
  - subsericeata
  - remutata
  - imitaria
  - aversata
  - emarginata
- Timandra
  - amataria
- Cabera
  - pusaria
  - exanthemaria
- Corycia
  - temerata
  - taminata
- Macaria
  - liturata

Halia
wavaria
Strenia
clathrata
Panagra
petraria
Fidonia
atomaria
Aspilates
strigillaria
Abraxas
grossulariata
Ligdia
adustata
Lomaspilis
marginata
Hybernia
rupicapraria
leucophæaria
aurantiaria
defoliaria
Anisopteryx
æscularia
Cheimatobia
brumata

Oporabia
dilutata
Larentia
didymata
pectinitaria
Emmelesia
affinitata
alchemillata
albulata
decolorata
Eupithecia
venosata
centaureata
subfulvata
castigata
exiguata
tenuiata
absynthiata
vulgata
rectangulata
Lobophora
hexapterata
viretata
Thera
variata

Ypsipetes
elutata
impluviata
Melanthia
rubiginata
ocellata
Melanippe
procellata
rivata
subtristata
montanata
fluctuata
Anticlea
rubidata
badiata
derivata
Coremia
propugnata
ferrugata
unidentata
quadrifasciaria
Camptogramma
bilineata
Phibalapterix
tersata

Phibalapteryx
vitalbata
Scotosia
dubitata
Cidaria
miata
picata
corylata
russata
ribesiaria
testata
pyraliata
fulvata
dotata
Eubolia
cervinaria
mensuraria
palumbaria
Anaitis
plagiata
Chesias
spartiata
Tanagra
chærophyllata

Cuspidates.

Platypteryx
lacertula
hamula
falcula
Cilix
spinula

Dicranura
vinula
furcula
bifida
Stauropus
fagi

Petasia
cassinea
Pygæra
bucephala
Ptilodontis
palpina

Notodonta
camelina
ziczac
trepida
chaonia
dodonæa

Diloba cæruleocephala

Noctuæ.

Thyatira
derasa
batis
Cymatophora
diluta
ridens
or
Bryophila
perla
Acronycta
tridens
psi
aceris
megacephala
Leucania
conigera
lithargyria
comma
impura
pallens
Nonagria
fulva
Gortyra
flavago

Hydræcia
nictitans
micacea
Axylia
putris
Xylophasia
rurea
lithoxylea
polydon
hepatica
Dipterygia
pinastri
Neuria
saponariæ
Heliophobus
popularis
Charæas
graminis
Cerigo
cytherea
Luperina
testacea
Mamestra
anceps

Mamestra
brassicæ
persicariæ
Apamea
basilinea
gemina
unanimis
fibrosa
oculea
Miana
strigilis
fasciuncula
furuncula
arcuosa
Grammesia
trilinea
Caradrina
alsines
morpheus
Rusina
tenebrosa
Agrotis
segetum
suffusa

Agrotis
saucia
exclamationis
corticea
nigricans
porphyrea
ravida
Triphæna
ianthina
pronuba
orbona
fimbria
Noctua
augur
C-nigrum
triangulum
rhomboidea
brunnea
festiva
rubi
baja
xanthographa
Tæniocampa
gothica

Tæniocampa
- rubricosa
- stabilis
- instabilis
- munda
- cruda

Orthosia
- lota

Anchocelis
- lunosa
- pistacina
- rufina
- litura

Cerastis
- vaccinii
- spadicea

Scopelosoma
- satellitia

Xanthia
- citrago
- cerago
- silago
- gilvago
- ferruginea

Tethia
- subtusa

Cosmia
- trapezina
- diffinis

Dinanthœcia
- capsincola
- carpophaga
- conspersa

Hecatera
- dysodea
- serena

Epunda
- viminalis

Miselia
- oxyacanthæ

Agriopis
- aprilina

Phlogophora
- meticulosa

Euplexia
- lucipara

Aplecta
- herbida
- nebulosa

Aplecta
- advena

Hadena
- protea
- dentina
- atriplicis (once)
- oleracea
- pisi
- thalassina
- genistæ

Xylocampa
- lithorhiza

Xylina
- rhizolitha

Calocampa
- exoleta

Cucullia
- verbasci
- umbratica
- chamomillæ

Heliodes
- arbuti

Erastria
- fuscula (once)

Brephos
- parthenias

Abrostola
- urticæ
- triplasia

Plusia
- chrysitis
- gamma
- iota
- V-aureum

Gonoptera
- libatrix

Amphipyra
- tragopogonis
- pyramidea

Mania
- typica
- maura

Catocala
- fraxini (once)
- nupta

Euclidia
- mi
- glyphica

MAP SHOWING THE AREA AFFECTED BY THE

Area of disturbance

Places of v

Points of e

TEORITE OF THE 20TH OF NOVEMBER, 1887.

arked shock ——·——·—— Westley-Lamborne track

ons ·················· Barrington-Wantage track

MAP SHOWING THE AREA AFFECTED BY THE METEORITE OF THE 20TH OF NOVEMBER, 1887.

● Places of well-marked shock

✶ Points of explosions

▭ Area of disturbance

-·-·-·- Westley-Lamborne track

.... Barrington-Wantage track

V.

THE METEORITE OF THE 20TH OF NOVEMBER, 1887.

By H. George Fordham, F.G.S.

Read at St. Albans, 16th April, 1888.

PLATE II.

Introduction.

The shock experienced over a considerable area in central England on the morning of Sunday, the 20th of November, 1887, was, naturally enough, in the first instance regarded as arising from an earthquake.

Upon this assumption an investigation of the phenomena observed was commenced so far as Hertfordshire was concerned, with a view to the communication of the results to this Society, and their publication in our 'Transactions.'

So soon, however, as some little inquiry had been made, it became apparent that the shock and sound noticed came from the air rather than from the earth; and when, also, information was received that a meteor had been actually seen from Hertford, no doubt remained that what had been attributed to an earthquake had in reality resulted from the passage, across the district affected, of a meteorite, and one probably of some magnitude.

Such an occurrence has never, so far as I am aware, been recorded in the United Kingdom with any attempt at detail, and the interest arising from the novelty of the phenomena observed must be my excuse for the length of this report.

In dealing with letters, and other original communications, which embody statements of the various impressions made upon observers by vibrations of the air, set in motion either by the passage of the meteorite through the atmosphere or by an explosion or explosions of the meteorite itself, I have thought that the only satisfactory course would be to print all the material parts of these statements *in extenso*, authenticating them with the signatures and addresses of the observers. At the same time I have cut out all sentences and phrases the absence of which does not affect the meaning of material statements. In doing so it has been necessary, in some few instances, to make trifling insertions of words to carry on the sense. The result of this is that, here and there, a sentence commences or ends abruptly, or is a little wanting in sequence, and this must be attributed to my excision of matter not necessary for my present purpose, and not to any act of the original writer. While thus omitting much that is not strictly relevant to the subject of this report, I give, in its original form, every scrap of information that I have been able to gather together.

The general result of the information obtained is that a sound, variously described, was heard about 20 minutes past 8 on the morning of Sunday, the 20th of November, over an area extending east and west from near Bury St. Edmunds in Suffolk, to Upper Lamborne on the western border of Oxfordshire, south to Watford and Reading, and north to St. Neots, Risely in the north of Bedfordshire, Sulgrave in Northamptonshire, and an isolated point near Leamington; the sound being accompanied in many places by a movement of the air of sufficient force to cause windows to rattle and light objects to move. Bury St. Edmunds and Upper Lamborne are on an E.N.E. and W.S.W. line about 105 miles apart.

The sound was heard in 153 distinct localities, distributed amongst the following 11 counties:—Suffolk, 1; Essex, 6; Cambridgeshire, 19; Huntingdonshire, 3; Bedfordshire, 34; Hertfordshire, 43; Northamptonshire, 2; Buckinghamshire, 16; Warwickshire, 1; Oxfordshire, 15; and Berkshire, 13.

From Hertford, and from Solihull near Birmingham, about the same time, a meteor was seen: from Hertford passing towards the westward, from a point about N.E. to a point about W.N.W., and from Solihull at a point reported to be due S. of that place. Elsewhere the foggy state of the atmosphere appears to have prevented the meteorite from being seen.

In the 'Meteorological Magazine,' December, 1887,* Mr. Symons has collected much information under the title "A Bolide exploded over Central England," and the subject is further noticed in subsequent numbers of the 'Magazine.'† I am much indebted to Mr. Symons for allowing me to make use of the materials collected by him. I have also to thank the editors of those local newspapers in which I have been allowed to publish appeals for notes and particulars of the effects of the sound of the meteorite, and those correspondents who have responded to my requests for such information. In particular I have to express my obligation to Mr. William Munday, of Baldock, who has supplied me with many notes, principally from North Herts and South Beds.

The following letters, paragraphs, etc., are arranged by counties, the counties themselves being taken as nearly as possible in the order in which the meteorite or the sound arising from it reached them, and the particular localities referred to in each county being arranged from north to south. Notes and insertions in brackets are made where they are necessary or desirable to make the context intelligible, or to elucidate points referred to. The statements of the two observers who saw the meteorite itself have been placed at the head of the observations, as being of special importance.

When two or more communications, referring to the same locality, have been received from the same individual, they are placed in order of date, the signature and address being appended to the last only. All dates of letters, etc., are omitted, except in reference to newspaper paragraphs.

* Symons's 'Monthly Meteorological Magazine,' vol. xxii, pp. 161–169.

† *Ibid*, vol. xxii, pp. 177, 178; and vol. xxiii, pp. 20–23, and 48. See also a paper "On the Detonating Bolide of November 20th, 1887," by G. J. Symons, F.R.S., 'Proceedings of the Royal Society,' vol. xliii, p. 263.

Observations and Notices.

Hertford.—At 8·20 on the morning of the 20th ult., my daughter [Miss Anne Dear], who was in her room, called to her mother, who was downstairs, to notice a falling star. The morning was dull and foggy. I was out of doors at the time, and, on coming into the house, she asked me if it were not an unusual occurrence for a shooting star to be visible by daylight. On questioning her as to its appearance, she described it as a brilliantly luminous body, travelling across the sky from a N.E. to W. direction. In its passage a portion became disconnected and fell, the main body continuing its flight further. The time occupied from first to last 3 or 4 seconds. She did not hear any report.—*F. C. Dear, Ivy Cottage, Port Vale, Hertford.*

[Ivy Cottage stands on the side of a hill sloping to the S.W., and almost in the mouth of a disused sand-pit, cut into the hill above: the hill rises sharply, and the ridge above the pit bounds the view to the N. From a window on the first floor, facing about N.N.W., there is a distant view to N.N.W., and to the W. of that point until it is cut off at about W.N.W. by a projecting portion of the house. The meteorite was first seen from this window by Miss Dear just over the ridge above the quarry at about N.E., and at an elevation of about 20°. It passed across the whole view from the window, disappearing behind the projection of the roof at an elevation of about 13°. At a point about N.W., a piece of the meteorite appeared to fall, but without any apparent diminution of size in the main mass. The meteorite appeared to travel slowly—so much so that the observer ran to another window, expecting to see it pass further to the westward, but it had disappeared.]

Solihull.—I saw the meteor from here, and, being broad daylight, I thought it very unusual. It seemed to drop from a clear patch in the sky, and much to resemble a rocket with light blue and red sparks dropping from it. I am about 5½ miles from Birmingham, S.E. The meteor seemed to drop rather more S. I did not hear any report or unusual noise.

The time, as near as possible, was 8·20 a.m.; it may have been 2 or 3 seconds past, not more. The star itself I did not actually see before it collapsed. I can compare it to nothing but an ordinary sky-rocket just at the *moment after* it has spent itself in the air. It was in full S. direction, and did not appear far away.—*W. J. Whitrod, Rose Cottage, Olton, Solihull.*

SUFFOLK.

Westley.—[The sound] was distinctly heard here by some of my men, who told me they had heard a blow-up in the S.W. at 8·20 a.m., and that the pheasants crowed in all directions, the same as they did at the Erith explosion. They described it as a double explosion.—*Robert Burrell, Westley Hall,* [2 miles W. of] *Bury St. Edmunds.*

ESSEX.

Ickleton (Cambs).—The time was 8·16 a.m., as nearly as I can settle. I think it was only a noise, and not a vibration of the earth. I find, too, that it was more distinctly noticed along the ridge from Elmdon and Heydon to Chishill. All, as far as that place, maintain that it was W. of them; saying it was Royston way or Hitchin way.—*Thomas S. Cayzer, Ickleton, Great Chesterford.* [Royston is from Ickleton 10° S. of W., from Elmdon and Heydon 7° N. of W., and from Chishill 15° N. of W. Hitchin is W.S.W. of all these places.]

Saffron Walden.—Some people in the town here thought the sound came from the neighbourhood. My stable-boy, who heard the sound very distinctly, pointed further S. than Hitchin when I asked where the "explosion" seemed to have taken place. Mr. Gibson's shepherd thought it was an earthquake. He was out in the fields, and there appeared to be some disturbance, inasmuch as he considered the branches of the trees were considerably agitated. —*Wm. Murray Tuke, Saffron Walden.* [Hitchin is 13° S. of W. of Saffron Walden.]

At Saffron Walden, about a quarter past eight, a rumbling noise, as of distant thunder or the discharge of artillery, was heard in the town, and also in the neighbourhood of Wenden, 2 miles S.W., and Arkesden, 4 miles S.W. The vibration was felt by persons in bed.—'*Meteorological Magazine,*' vol. xxii, p. 168 (December, 1887).*

CAMBRIDGESHIRE.

Newmarket.—Shock felt here.—'*M. M.,*' p. 169.

Cambridge.—The shock was felt in Cambridge.—'*M. M.,*' p. 169. The shock was not felt here [*i.e.* in the Observatory]. I was engaged at that time taking the usual meteorological observations for my telegram to the Meteorological Office, London, and should have been sure to have noticed it.—*H. Todd, Observatory, Cambridge.*

Bourn.—The shock was felt here.—'*M. M.,*' p. 169.

Comberton.—A shock felt by the Rev. W. J. Tillbrook [vicar of Comberton].—*Letter from Cambs Constabulary Office, Cambridge.*

Gamlingay.—Several persons heard a noise like a great explosion in the distance, and several ran out of their houses, thinking it was an earthquake. The time, as near as I can make it out, was about 8·30 a.m.—*J. Fowler, Gamlingay, Sandy.*

Wimpole.—The shock was felt very distinctly.—'*Herts & Cambs Reporter,*' Nov. 25.

Croydon.—The shock was noticed here.—'*Beds Times,*' Nov. 26.

Great Shelford.—The police-constable stationed at Great Shelford states that his house was shaken by some unusual motion of the earth, and that he has been informed by several people that they had the same experience. Time about 8 a.m.—*Letter from Cambs Constabulary Office, Cambridge.*

* Cited hereafter as '*M. M.*'

I believe the time to have been 8·20. The morning was fine and clear—the air very still. I was walking slowly along, when suddenly my attention was arrested by a noise different in character from any noise that I am familiar with. I stood still and listened, and in a moment it flashed upon me that it must be an earthquake or an explosion. It left a distinct impression of something having happened in the distance. It is difficult to describe the length or duration of the sound; it lasted, as far as I can tell, while you might count 10 with deliberation; and it came to me from the S.W. of Shelford, in the direction of Royston. I experienced nothing but the sound.—*Letter from a Lady residing at Shelford.* [Royston is due S.W. from Shelford.]

Barrington.—There were two shocks, at 7·50 and 8·20 respectively. I was in church at the time, but did not perceive the first shock, as the bells were then being rung, nor did any of the ringers. Others of the congregation, however, then on their way to church, describe it as being stronger than the latter shock, which took place during the stillness of the service, and was very perceptible. A heavy muffled roar seemed to spread beneath our feet, accompanied by a distinct trembling of the ground. The whole church shook, and the doors rattled under this tremor, which certainly passed from S. to N. On feeling it I was reminded of the old stories current in these parts as to the cannon at Waterloo being thus heard here as if from underground, and concluded that it must be a heavy explosion very far away. Others thought that a high wall bounding the churchyard had fallen. One old labourer describes the sensation "as if a load of turnips were shot down at my door."—*Edward Conybeare*, [vicar of Barrington,] *Barrington Vicarage, Cambridge.*

Shepreth.—I was just going out, when I heard a peculiar noise very much like a long, heavy roll of thunder a *long distance* off, which ended with a distinct boom! boom! (twice). I went back *at once* into my house, and looked at the clock (it was then about 8·20). I thought it very probable some explosion similar to that at Erith some years ago had occurred. My idea at the time was that the noise came from S.E., or perhaps more correctly S.S.E. In fact I am certain in my own mind such was the case. There certainly did *not* seem any "quake" of the earth, and (if I may so express it) the noise seemed to be more in the air than in the earth. A friend of mine named Jenkins, who keeps the Shepreth gate-house on the G.N.R., heard the noise when in his house, and thought some heavy vehicle had driven up to the gate. This would again point to the fact that the noise came from S.E. or S.S.E.—*S. S. Clear, Shepreth, Royston.*

Thriplow.—Several persons here, about 8 o'clock, heard the unaccountable rumbling sound, and thought it to be some serious calamity in London. The most distinct report of it came to me from one of my shepherds. He tells me the underground sound came from the W., and shook the earth and trees, causing the small birds to startle off.—*Joseph I. Ellis, Thriplow, Royston.*

Whaddon.—The shock was felt very distinctly.—'*Herts & Cambs Reporter*,' Nov. 25.

Melbourn.—As I was walking from Melbourn to Royston, when on the top of the Melbourn Hill I was suddenly caused to stand still by hearing a great booming noise; it sounded in the direction of Royston Heath (but far beyond it). I heard five distinct explosions as it were, the first two went off quickly, the other three following in succession, with about a second intervening between; after the last burst it seemed to come rolling along until it reached to where I was standing, shaking the ground under my feet. I noted the time, which was 8·20 a.m. I thought to myself if it was not so foggy I must see the things shake around me. It seemed to be a long way off and yet close to at the same time. The duration of [the sound] from the first boom to the end of the last was from 8 to 10 seconds.—*A. J. Jarman, Melbourn. Royston.* [Royston Heath is due S.W. from the locality referred to.]

The sound was heard by others here.—*William Munday, Baldock.**

Bassingbourn.—The shock was very distinctly felt here.—'*Herts & Cambs Reporter*,' Nov. 25.

Tiles, slates, and windows are said to have been shaken here.—*W. M.*

Guilden Morden and Steeple Morden.—The sound was described as a deep detonation, like a loud explosion at a distance. It caused considerable alarm.—*W. M.*

Ickleton.—(See Essex, p. 36.)

Royston.—Shortly after 8 o'clock many inhabitants in Royston, and in places for many miles round, were surprised by a phenomenal occurrence, which can only be accounted for as a slight shock of earthquake. The various reports received all agree very closely as to the time, and generally as to the character of the shock; the time being, as nearly as can be fixed, 8·20 a.m. Being on a Sunday morning—and an unusually dark morning—a large proportion of the inhabitants had probably not left their beds, and the shock was of so short duration that the occurrence was not therefore so carefully observed as it might otherwise have been. All accounts agree that there was a distinct rattling of windows and doors, and even a loosening of slates, and in one or two cases there was a fall of articles from shelves which could not be very well accounted for in any other way. Several persons also noticed that it was accompanied by something akin to the report of a distant explosion. In a few cases mention is made by persons of something resembling faint shocks at an earlier and a later hour than the one generally experienced.—'*Herts & Cambs Reporter*,' Nov. 25.

The time I have entered in my diary when [the shock] occurred is 8·15 a.m.—*John P. Nunn, Royston.*

Ashwell Station.—The sound was noticed by a platelayer on the railway.—*H. G. F.*

* Cited below as *W. M.*

HUNTINGDONSHIRE.

St. Neots.—The shock was felt in this neighbourhood by many persons. Mr. Clark (coachman to Mr. C. P. Rowley, of Priory Park), who was crossing the fields leading from St. Neots to Priory Hill, thought that the sound and the accompanying vibration of the earth must have been caused by a large explosion of dynamite. Some men in the employ of Mr. Isaac Hall, of Eynesbury, thought that the sound was caused by thunder, but were somewhat startled by the peculiar sensation experienced by the shaking of the earth simultaneously with the noise they had heard.—'*M. M.*,' p. 168.

Waresley.—The shock was noticed at Waresley. The pheasants in Waresley Wood were so alarmed that many of them flew away, whilst the remainder gave evidence of fright.—'*Beds Times*,' Nov. 26.

BEDFORDSHIRE.

Risely.—The shock was distinctly felt and heard at Risely. There was a distinct trembling of the earth, accompanied by a loud rumbling noise not unlike the report of some distant explosion. A shepherd who was near a large wood says that at the time of the rumbling noise the pheasants in the wood were much excited and alarmed, flying to and fro and calling.—"*A Constant Reader*," *Sharnbrook. Letter in* '*Morning Post*' of Nov. 24.

Blunham.—A supposed shock of earthquake was noticed in this village, but happily no damage is reported.—'*Beds Times*,' Nov. 26.

Bedford.—The evidence of a grocer's wife in Bedford is interesting. She told me that at about 8·30, while her son and herself were at breakfast, they heard "a rumbling noise, rather quick, like thunder, and yet it was not thunder, more like trains shunting, and lasting so long that you quite heard it like—shunt! shunt! shunt!" The sound was to the front of the house, coming up S.E., and passing away to the westward.—*A. C. G. Cameron, Bedford.*

Sandy.—One man sprang out of bed and ran to the window, thinking something had happened very near. A man on the railway, and another on the road near Girtford, give Bedford as the direction [whence the sound proceeded]. Another on the road to Biggleswade gives Old Warden as the point.—*W. M.* [Bedford is a little N. of W. from Sandy. Old Warden is S.W.]

Potton.—A slight shock was observed here at 8·20, the general direction being apparently from W. to E.—'*Herts Express*,' Nov. 26.

The earthquake was plainly felt in this town, but no damage was done. The [movement of the] ground is described as resembling the motion made by a railway-train, but without the noise. A man passing Potton railway-station reports that the bridge shook as though a train was passing under, and that the glass at the station rattled. It was at first thought that an explosion of an extraordinary nature had occurred.—'*Beds Times*,' Nov. 26.

Sutton.—The shock was noticed here.—'*Beds Times*,' Nov. 26.

Wrestlingworth.—The shock is reported to have been severe.—'*Beds Times*,' Nov. 26.

Cardington.—The villagers heard a distant rumbling, which they attributed to some great explosion.—*A. C. G. Cameron, in* '*Beds Times*' of Nov. 26.

Kempston.—The shock, experienced about 8·20, was felt by several persons in different parts of this parish. Some report that the noise resembled an explosion at a distance, and then died away as low rumbling thunder.—'*Beds Times*,' Nov. 26.

Harrowden.—The shock was felt here.—'*M. M.*,' p. 168.

Biggleswade.—The shock was distinctly noticed here at about 8·20. Many persons heard a noise resembling a distant explosion, and doors and windows were shaken. Others who were in the fields felt the earth trembling —'*Herts Express*,' Nov. 26.

Southill and Warden.—The shock was felt and heard.—'*Beds Times*,' Nov. 26.

Dunton.—My informant says: "The sound came with a ring. I am sure it was in the air; it sounded to me in the direction of Biggleswade."—*W. M.* [Biggleswade is 6° N. of W. from Dunton.]

Edworth.—The sound appeared to come from the direction of Langford.—*W. M.* [Langford is slightly N. of W. from Edworth.]

Clifton and Shefford.—Some point to Ampthill. Some say the sound came all round them. Some that it died away in the E. The sound is described as "like a volley of big guns."—*W. M.* [Ampthill is slightly S. of W. from Clifton and Shefford.]

Ampthill.—[One person] heard a loud report. [Another] heard a noise like an explosion at a distance and felt the vibration of the earth. [And a third], in a cottage a short distance to the S.W., also heard a report and felt the earth tremble, and said the crockery all jingled. The result to this house most noticeable was that afterwards the doors of the rooms at each end of the house would not shut properly, neither would the shutters; all the locks got mis-placed, and a marble mantel-piece was cracked, and the back of a stove.—[*Miss*] *R. E. Field, Fielden House, Ampthill.*

Noise heard and vibration felt, supposed to be due to a distant explosion.—'*M. M.*,' p. 167.

Clophill.—The shock was felt here.—'*M. M.*,' p. 168.

Westoning, Flitwick, and Flitton.—The shaking was so very distinct, that almost a panic, for a time, seemed to seize several of the people, who knew not how to account for it. Its character may be correctly judged of when it is stated that the bulk of the people inclined to the belief that what they had heard and felt was the effect of an explosion somewhere or other.—'*M. M.*,' p. 167.

Silsoe.—Doors, windows, and in some cases slates on buildings, were made to rattle. The shock was felt by many persons about 20 minutes past 8, and from two or three places there are reports of a second shock at a later hour in the morning.—'*Beds Times*,' Nov. 26.

Lidlington.—A loud noise, apparently caused by an explosion, was heard; it was generally supposed to be due to the explosion of a boiler in the neighbourhood of Brackley.—'*M. M.*,' p. 168. [Brackley is 25 miles distant, slightly S. of W., from Lidlington.]

STOTFOLD.—The shock was distinctly felt here, and it was thought that an explosion had taken place at the Arlesey Brick-fields.—'*Herts Express*,' Nov. 26.

Some give the [Arlesey Lunatic] Asylum, and some point a little further N. [as the direction from which the sound appeared to come, which would be from S.W. by W. to W.S.W.]—*W. M.*

ARLESEY.—Some think it [the sound] was W.N.W.—*W. M.*

STONDON.—Heard most distinctly. One man thinks it was at Ampthill.—*W. M.* [Ampthill is about N.N.W. of Stondon.]

WOBURN.—Rumbling noise heard.—'*M. M.*,' p. 167.

BARTON.—The noise was heard here.—*Arthur A. Armstrong, Kimpton, Welwyn.*

LEIGHTON BUZZARD.—A curious sensation was felt here by many persons. By some it is described as a rumbling noise, accompanied by a clattering of the window-frames and loose articles in the houses. To others it seemed more like the vibration accompanying an explosion; but it is the general idea that it was not caused by thunder. By some persons it was thought to be a slight shock of earthquake.—'*M. M.*,' p. 167.

DUNSTABLE.—Shortly after 8, a most uncomfortable, and, to many, alarming noise, accompanied by a shaking sensation, was heard and felt by various persons in and around Dunstable. Many persons thought, at first, it must be very distant thunder; but when the rattling of doors and windows followed, together with the clinking of plates and other crockeryware standing upon shelves, this idea was at once abandoned, and it was the almost unanimous opinion that an alarming explosion had occurred somewhere in the district. —'*M. M.*,' p. 167.

I was standing near my garden-door at 8·20 a.m. when the quiet was suddenly broken by a heavy smothered crash, followed by reverberations as in a clap of thunder of rather short duration. I felt no shaking of the ground, but many persons here felt it, and the shaking is stated to have been very marked near DAGNALL [Bucks], between here and Hemel Hempstead. The sound was like the falling in of an immense mass of rock—followed by echoes —in a cavern. Some persons say they heard a second, but much less loud, crash, later in the morning, but this was not heard by me.—*Worthington G. Smith, Dunstable, in* '*Nature*' of Dec. 8.

WHIPSNADE and STUDHAM.—The noise was very distinctly heard, but the shaking sensation appears to have been most felt at Whipsnade in this [the Dunstable] district.—'*M. M.*,' p. 167.

HERTFORDSHIRE.

HINXWORTH.—Those who were out of doors at 8·15 or 8·20 are mostly agreed that the sound came from the direction of Arlesey Siding.—*W. M.* [Arlesey Siding is S.W. from Hinxworth.]

ASHWELL.—Noise heard in the house as of a door slamming. Sound appeared to come from nearly due S., or slightly W. of S. Time 8·24 a.m.—*E. Snow Fordham, Elbrook House, Ashwell.*

Shock like that of an explosion of gunpowder. It appeared as if a volume of air struck the windows of the house, which rattled. It seemed to come from S.E. by S. Time 8·20 to 8·25 a.m.—*Henry Raikes, Ashwell Brewery.*

Noticed also by a man (John Lee), who was in his garden near the Spring Head, and the sound appeared to him to come from S.E. by S.—*H. G. F.*

Royston.—(See Cambridgeshire, p. 38.)

Therfield.—Felt very distinctly.—'*Herts & Cambs Rep.*' Nov. 25.

Bygrave.—Sound appeared to come from W.—*W. M.*

Barkway.—Heard here.—*R. P. Greg*, [F.S.A., F.G.S., F.R.A.S.,] *Coles, Buntingford.*

Baldock.—About 8·20 the shock was plainly felt and heard by many persons in the town. In some cases windows were very violently shaken, and beds were also felt to move. After sifting the reports of those who heard it there seems no doubt that it was a slight shock of earthquake, the rumbling noise being unmistakably underground.—'*Herts & Cambs Reporter*,' Nov. 25.

It was thought that the gas-works had blown up, as windows were shaken and beds were felt to move.—'*Herts Express*,' Nov. 26.

I have several lines [of direction of sound] on the map from Baldock, Bygrave, and just round, and most of them go very near to the [Arlesey Lunatic] Asylum; two pass a little more W. One person was quite sure [the sound] was thunder; another, who had resided in China, was sure it was an earthquake. One was sure it was a fiery meteor, for he had heard one before, and helped to dig one out. The curate, the Rev. G. W. Griffith, was conducting service in the church; he says [the noise] sounded like something heavy falling on the lead roof, and that one of the windows shook. —*W. M.* [The Arlesey Asylum is W.N.W. from Baldock.]

Buckland.—Our letter-carrier heard the explosion distinctly, and was much alarmed. He was on his rounds at the time, and thought the sound came from the other (southern) side of Buntingford. The noise was also heard by one or two women in the village; and one, I believe, said she felt her house shake.—*Henry F. Burnaby*, [rector of Buckland,] *Buckland Rectory, Buntingford.*

Chipping.—Heard here.—*R. P. Greg, Coles.*

Clothall.—Shock distinctly felt by several labourers.—*F. Fox-Lambert*, [rector of Clothall,] *Clothall, Baldock.*

Pirton.—About 20 minutes past 8, I heard a sound as of distant thunder, accompanied by slight crackling of slates overhead and considerable trembling of the ground under my feet, which lasted perhaps some three or four seconds.—*Azel Young, Pirton, Hitchin.*

Throcking.—The explosion was very distinctly heard in S.W. at about 8·20 by several people in the parish.—*C. W. Harvey*, [F.R.Met.Soc., rector of Throcking,] *Throcking Rectory, Buntingford.*

Buntingford.—Several persons here heard a noise described as [like] the sound of a large gun. The sound seemed to most to have come from the direction of Cambridge, though opinions widely differ. —*J. S. Butcher, Buntingford.* [Cambridge is about N.N.E. of Buntingford.]

Cottered.—Heard very distinctly here.—*W. M.*

Hitchin.—The shock was noticed at Hitchin soon after 8 o'clock, as the milkmen were going their rounds, and several of the men bear testimony to underground rumblings.—'*Herts Express*,' Nov. 26.

A slight shock of earthquake was experienced here at 8·30 a.m. In this immediate neighbourhood it was thought that an explosion had taken place, but within a few miles I fancy the characteristics were more marked. Five miles to the S.W. the sheep and cattle seem to have been quite panic-stricken; six miles to the N.E. the window-panes rattled quite in accordance with the usual descriptions of slight earthquakes.—*W. Lucas, Hitchin, in* '*M. M.*,' p. 166.

A noise was heard at times varying from 7·50 to 8·20 a.m. Those persons recording the time as between 7·50 and 8 seem to me so trustworthy that I imagine there may have been two noises. All persons noticing the noise describe it as producing a different impression to that usually accompanying thunder. This fact leads such persons to doubt its origin, and ascribe the noise to other causes within the range of their knowledge; thus some say it was like the passage of a traction-engine, [or of] an iron water cart, a railway-collision, an explosion, the fall of some buildings, etc., though, of course, its comparison with thunder is pretty general. More than one witness declares the noise came from the air, as thunder would, and in no case can I obtain distinct evidence of earth-tremor, though a concussion, such as I have experienced on the firing of heavy guns, appears to have been noted, and is generally related as a "shock." The actual direction from which the noise proceeded must remain doubtful, the position of the persons noting it, doubtless, producing different impressions. On the whole it appears to have come from the S.E. quadrant of the compass, the inclination being more S. than E.—*William Hill,* [F.G.S.,] *The Maples, Hitchin.*

Furneux Pelham and Stocking Pelham.—The sound was heard by several people [at both places]. I only know of one person at Albury who heard it, that is the policeman. He tells me he heard it on Patmore Heath, and described it as the noise of a fog-signal used on the Thames in foggy weather.—*John Caton, Albury, Little Hadham.*

Coles.—My gardener's son says he heard the noise, like thunder, lasting several seconds, the loudest crack being at the end. It appeared to proceed from the S.S.W.—in the Hertford direction, say.—*R. P. Greg, Coles.* [Hertford is due S.S.W. from Coles.]

Cumberlow Green.—A man going from Red Hill to Walkern heard [the sound] when he got just past Cumberlow Green Farm, and is quite sure it was in the direction of Baldock. He met a man at Cromer Bottom, and began talking about it. The man at Cromer is sure it was more in the direction of Hitchin.—*W. M.* [Baldock is N.W. by W. from Cumberlow Green; Hitchin is 6° N. of W. from Cromer.]

Ardeley.—Heard very distinctly.—*W. M.*

Offley.—On the high ground near Offley a sound as of low thunder was heard, accompanied by a vibration of the ground, and after an interval other distinct vibrations without any rumbling noise.—'*Herts Express*,' Nov. 26.

About 8·20 a.m. I was standing in the porch of this house looking at the sky, S.E., when I was startled by a low rumble, which was preceded by a sharp crack. Then followed in an instant a trembling of the ground, like a wave from N.E. towards S. The sound had also come from the N. (the back of the house). Another moment, and then followed a fainter wave, or earth-trembling.—*Henry A. Harper*, [*Eagle's Nest,*] *Offley.*

STEVENAGE.—Heard here.—*W. M.*

WALKERN PARK.—My nearest neighbour heard it, and two men not more than about half a mile away heard it distinctly.—*A. Menhinick*, *Walkern Park*, *Stevenage.*

WOOD END, ARDELEY.—Heard very distinctly.—*W. M.*

STAGENHOE.—Most of the people in the house of my cousin at Stagenhoe felt or heard the disturbance distinctly. One man, who was walking under a wood close by, heard it, and the pheasants in the wood all uttered cries. Another man, who was watering the horses at the pond, says that they started at the sound, and a flock of sheep in a boggy meadow close by rushed about the field in a very excited manner. The sound came from the direction of Luton, which would be about W. from Stagenhoe. It appears to have been heard distinctly all up the Mimram Valley, at the head of which is Stagenhoe.—*Thomas B. Blow*, [F.L.S.,] *Welwyn.* [Luton is 8° S. of W. from Stagenhoe.]

WHITWELL.—Heard here.—*W. M.*

KNEBWORTH.—The shock was very loud, and perceptibly felt by several people. The report was so loud that my wife thought a small outhouse in our back yard was falling down, and ran out of the house to see. The sound caused me to look up quickly to the ceiling, for it appeared as if something had struck the roof of the house. It caused it to vibrate but slightly. To all appearance the sound seemed to reach us from the S.E., and travelled N.W., and that would be in a direct line from Hertford to Knebworth. Other people in the village who heard it describe it as a muffled "bang."—*John Kipling*, *The Gardens*, *Knebworth*, *Stevenage.* [Hertford is S.E. of Knebworth.]

WATTON.—There was a sort of vibration, disturbing the birds in the woods, and causing windows to chatter. Many believed we should soon hear of some serious explosion.—*D. Peck*, *Watton*, *Hertford.*

CODICOTE.—Two men [here], without having seen each other, agree in regard to the *direction* of the sound they heard and its character. They were both in the open air at the time. They agree in stating that the sound came from the S.W. of this village. If you draw a line shortly south of Ayot St. Lawrence and going towards Harpenden, that is the direction they are both very precise in stating the sound came from. They also say the sound was very peculiar, something between the sound of a distant explosion and the roll or rumbling of thunder at a distance. One says it seemed to affect him as if shaken, but the other, and the more intelligent of the two, was not conscious of being shaken, but it seemed strangely to affect him. This man thought at first it must be the sound of the Midland train going over the viaduct or large bridge across the valley to the N. of Harpenden, but he soon became satisfied it was a very different sound from that. A woman, who lives not far from him (at the N. end of Codicote), was somewhat astonished and alarmed at the sound, and rushed into the house to her husband, saying the sound was so peculiar—"different from thunder, as it rolled over such a space." A young man living not far from my house says he heard the strange sound from the S., like the rumbling of a distant explosion or thunder.—*E. Wallis Jones, The Manse, Codicote, Welwyn.* [Ayot St. Lawrence and Harpenden are both W.S.W. of Codicote.]

Kimpton.—Both myself and my wife heard the noise, which I thought was a distant clap of thunder. We were in the house at the time. The sound reached us from an easterly, or perhaps a little south-easterly, direction, and appeared to me to travel across to a westerly or north-westerly direction. The noise appeared to be like several barrels being rolled along at some distance off.—*Arthur A. Armstrong, Kimpton.*

Ayot St. Lawrence.—Several people about us felt the shock. The shepherd at Ivory's Hill Farm heard a rumbling noise, and [thought] that London had been blown up. I heard of it the same day, and the time was fixed as "when you were in church;" and as far as our locality is concerned, the shepherd's remark would seem to point to London as the direction from which the rumbling noise came.—*Herbert Athill,* [rector of Ayot St. Lawrence,] *The Rectory, Ayot St. Lawrence, Welwyn.* [London is S.S.E. of Ayot St. Lawrence.]

Long Marston.—The report was noticed here.—'*M. M.*,' p. 165.

Welwyn.—I heard a sound from the S.E. direction, which I at first thought was thunder. It would be about a quarter past 8 a.m. It seemed to me to roll from S.E. towards S.—*John Pointer, White Hill Farm,* [about ¾ of a mile nearly S.W. of] *Welwyn.*

I heard what I at the time thought was a distant roll of thunder, but could see no cloud. Later in the day I heard other people talking about it, some of whom thought a dynamite explosion had taken place.—*Geo. J. Buller, Welwyn.*

At about 8·20 a.m. I heard a loud rumbling sound, which appeared to be in a direction S.W. by S. from here. I attributed it to shunting operations going on at Ayot railway station, for the noise was very like detached trucks being violently banged together. Soon after, I saw a man named Ewington, who immediately said: "Did you hear that clap of thunder?" Indicating with his finger a direction from S.W. to N.W., he said, "It rumbled all the way down Hitchin way."—*J. A. Kite,* [L.R.C.P.Edin.,] *Welwyn.* [Ayot (St. Peter) Station is S.S.W. from Welwyn; Hitchin is N.N.W.]

[At] 8 o'clock, or thereabouts, I was surprised at suddenly hearing what I at first thought was the noise of a traction-engine passing down the road in the direction of Welwyn; but as the sound so quickly passed, I concluded it was the noise of a heavily-laden goods' van driven rapidly by. I went to the window and looked in the direction of the passing sound, but, to my surprise, could see nothing. The direction which the sound appeared to take was N. or N.N.W., and its duration [was] something less than half a minute.—*E. Roberts, National School, Welwyn.* [The school is on a hill on the S. outskirts of Welwyn.]

Digswell.—I was by the side of the river here in the garden at 8 o'clock, or thereabouts, when I heard a noise at the S. end of the viaduct of the G. N. Railway. It was so violent that I feared that part of it was falling. This occurred twice in a few minutes, the first [sound] being the most terrific. I then repaired to the stable, [and said to] my man: "Did you hear a noise a few minutes ago?" He said: "Yes, [it] pretty well made these slates chatter." On going into the house, I inquired of my wife, and she said the window-frames chattered. There are others here who heard it also.

The noise I heard was nearly due W. of me, slightly S. My opinion is the explosion was high up in the air, and not so very far distant, making such a clatter or echo as it did in the south end of the viaduct here.—*Ralph E. Iredale, Digswell Mill, Welwyn.*

[Welwyn Viaduct is a brick structure, running due N. and S. across the Mimram Valley. Digswell Mill lies in the valley on the E. side of, and close to, the viaduct. The S. end of the viaduct would be about W.S.W. from the garden referred to.]

Harpenden.—A milkman heard the explosion, or, as he says, "explosions" (more than one). He thought there were some guns being fired.—*A. E. Gibbs,* [F.L.S.,] *St. Albans.*

Wheathampstead.—A few minutes after 8 o'clock I heard a strange and unusual noise, like a clap of thunder when some tree or building happens to be struck by the electric fluid; so striking was it, that it alarmed two of my servants. It came from the E. and passed on to the W. towards No-Man's Land Common, and shook the house at my farm at No-Man's Land, and greatly alarmed the inmates. It appears to have had great force at this point.—*C. H. Lattimore, Wheathampstead Place.* [No-Man's Land is 1 mile S. of Wheathampstead.]

Aldbury.—The shock was distinctly felt at Aldbury, 3 miles N.E. of Tring. Mr. Grange's shepherd boy was so startled that he bolted home, and the sheep were equally startled, though they did not resort to a stampede.—'*M. M.*,' p. 166.

Hatfield.—A man from Hatfield told me he thought there must have been an explosion in London that morning, for soon after 8 o'clock he heard a "great rattling noise."—[*Mrs.*] *E. S. Buttanshaw, Edworth Rectory, Biggleswade.* [London is about S.S.E. from Hatfield.]

Colonel Daniell, Chief Constable of Herts, informs me that the shock was also noticed by some of the inmates of his house at Hatfield.—*H. G. F.*

St. Albans.—Whilst walking in the neighbourhood of St. Albans I was somewhat startled by a low rumbling sound as if of thunder, which seemed to be a great distance off. The morning (to the best of my recollection) was frosty, accompanied with a little fog, and thinking it strange for such a time and occasion, I stopped, and heard another report from the same direction, but this time more soft and of shorter duration. The sound appeared to me to be in the direction of London; in fact, I thought some great explosion had taken place there. The time was about 8·20.—*T. H. Westell, Dalton Street, St. Albans.*

I am informed that the shock was also noticed at King's Langley and at Watford.—*H. G. F.*

NORTHAMPTONSHIRE.

Sulgrave.—A [visitor] at Mr. Cave's at Sulgrave, about 10 miles N.E. of Banbury, heard a similar noise ["a rumbling noise (like distant cannon)"], and from the same direction (S.E.).—*F. A. Bellamy,* [F.R.Met.Soc.,] 82, *Southmoor Road, Oxford.*

Brackley.—A sound like the report of a cannon was heard here between 8 and 9 a.m. Various conjectures are rife as to the origin of the sound, which is attributed in some quarters to an earthquake, while others are of opinion that it was caused by an explosion. There appears to be no testimony as to any vibration or shock accompanying the sound.—'*M. M.*,' p. 166.

BUCKINGHAMSHIRE.

Bow Brickhill.—The sound was heard here.—*John Mathison, Addington, Winslow, in 'M. M.*,' p. 165.

Buckingham.—The explosion—for such it is described by those who heard it—was very loud; indeed, in many instances persons were much frightened, it being believed that what was heard was the report of a serious dynamite explosion in the metropolis. In the surrounding villages, too, considerable consternation was caused by the explosion. Some attributed it to thunder, and others to earthquake, whilst there are those who believe it to have been caused by meteoric influences. One person says it was a sharp distinct report as of cannon, and yet somewhat differing from the report of cannon.—'*M. M.*,' p. 166.

Addington.—Shortly after 8, perhaps a quarter past, I was startled by what seemed to be the loud report of a big gun away to the S.W., and the sound reverberating along the hills in an easterly direction. The report was sharp, loud, and of short duration. I did not think it thunder, but fancied it was an explosion of some sort; being in the direction of Bicester, I thought of the gas-works there. Many people about here heard the sound. Some fancied [it] was up in the air above head, my impression was that it was near the horizon, and about S.S.W. from where I stood. I find that different persons have different ideas as to the direction. To me it was decidedly S.S.W., some say just the opposite quarter. —*John Mathison, Addington, in 'M. M.,'* p. 165.

LINSLADE.—At Linslade, 4 miles S.E. from Fenny Stratford, a rumbling noise was heard, and windows rattled.—'*M. M.*,' p. 165.

IVINGHOE.—[Charles Smith, a drover, of Gosmore, near Hitchin,] was driving sheep towards Dunstable along the road from Tring. When near "Ivinghoe Aston" Hill, at about ¼ past 8, a loud noise occurred which did not seem to be quite like thunder, but rather like a sudden explosion not very far away to the S.E. The sheep, which were proceeding quietly, suddenly headed back, crowded together, and appeared frightened. The morning was densely foggy, and *nothing was seen.* No earth-tremor was noticed, but I gather from his description that he, like others, was sensible, at the time, of concussion of the air.—*William Hill, Hitchin.*

DAGNALL.—The noise was distinctly heard here.*—'*M. M.*,' p. 165. [Dagnall is about 6 miles N.E. of Tring, Herts.]

BIERTON.—The report was noticed here.—'*M. M.*,' p. 165.

BRILL.—Sound heard.—'*M. M.*,' p. 165.

AYLESBURY.—An explosive sound, which those who heard it attributed to an earthquake, was heard here as nearly as possible at 8·15 a.m. To those who heard it, especially persons who happened to be out of doors at the time, the sound was very distinctive and even startling. Most persons in Aylesbury who testify to the occurrence compare the report to that of a clap of thunder, without the customary rolling sound, and as a rule we have heard it described as apparently overhead.—'*M. M.*,' p. 165.

The explosion was loud at CHEARSLEY, LONG CRENDON, and SHABBINGTON.—'*M. M.*,' p. 165.

WENDOVER.—At Butler's Cross a cow could hardly be got to proceed further. In the main, however, people seem to feel a sort of regret that they did not notice [the sound].—'*M. M.*,' p. 164.

TOWERSEY.—The explosion was loud here.—'*M. M.*,' p. 165.

PRINCE'S RISBOROUGH.—Sunday's earthquake was distinctly felt by many persons in the town and neighbourhood. It mostly seems to have been noticed as a somewhat peculiar thunder, though one person felt the vibration as if it proceeded from the direction of Watlington along the Chiltern Hills.—'*M. M.*,' p. 164. [Watlington is S.W. by W. of Prince's Risborough; both these towns lie N. of the Chiltern Hills, which run parallel to the line joining them.]

SAUNDERTON.—A flock of sheep was observed to be very frightened. —'*M. M.*,' p. 164.

WARWICKSHIRE.

CUBBINGTON.—My gardener told me that about 8 a.m. he and one of my labourers heard a rumbling sound as of distant thunder. —*J. Yeomans Robins, West Hill, Cubbington, Leamington.*

* See also *ante*, p. 41, under "DUNSTABLE."

OXFORDSHIRE.

Sandford St. Martin.—Sandford St. Martin, near Great Tew, lies in a valley similarly to Oxford. Mr. J. Wiggins heard [there], at 8·20 a.m., a rumbling noise similar to distant cannon, to right of Steeple Aston, S.E. of this position; [there was] a thick fog at the time. He thought it was a dynamite explosion in London. The postman also thought it was an explosion from a S.E. direction. Others in the village were of similar opinion.—*F. A. Bellamy, Oxford.* [Steeple Aston is about 10° S. of E. from Sandford St. Martin.]

Heyford.—In a letter from a friend at Aynhoe the following passage occurs:—"That noise was near Heyford. There was a motion of the earth experienced. It was not thought to be thunder, being so sudden and only one sound." He adds that it startled all the pheasants—they generally call out when it thunders.—*John Mathison, Addington.*

Bicester.—A singular phenomenon, which appears to have been a shock of earthquake, was observed here, and in several of the surrounding villages, at about 8·20. The effect is variously described as resembling a distant explosion and as somewhat like a clap of thunder. Some conjectured that a terrible dynamite explosion had taken place in London, whilst an extensively-prevailing report on Monday attributed the noise to an explosion which was said to have taken place in connection with the gas-works at Baron Rothschild's seat at Lodge Hill.—'*M. M.*,' p. 164.

Kirtlington.—I heard a report in the atmosphere such as I never heard before. It brought me quite to a stand still. I looked up to see, but only heard the report as of a big gun. It was in the direction of Bicester, about N.E. The vibrations moved to the S. The wind was still before the report, but after [it] the trees by my house were moving.—*George Norridge, The Laundry, Kirtlington.* [Bicester is about E.N.E. from Kirtlington.]

Oxford.—Many inhabitants were startled shortly after 8 o'clock by a rumbling sound like that of a distant explosion. Some persons appear not to have experienced anything unusual, but others state that doors and windows were made to rattle, and a noise was heard resembling the passing of a heavy vehicle. Reports have been received from villages in the neighbourhood to the same effect.—'*M. M.*,' p. 164.

I heard an extraordinary explosion [while] in my house in North Oxford. It seemed rather to come from above than below the earth, similar to a clap of far-off thunder, or a distant sound of a moving train.—*A correspondent in* '*M. M.*,' p. 164.

I happened to be walking at the time mentioned [8·20 a.m.], and heard a fine rolling sound, which appeared to begin just opposite where I was, and rolled away to the eastward, till I could no longer hear it. The tone of the roll was very grand. I looked up into the sky, expecting to see some appearance of thunder-clouds, but there was nothing unusual to be seen. I felt no tremor.

I was walking from the Cherwell towards the Museum, along the walk parallel to South Parks Road, and was about opposite the opening leading to Mansfield College, when I first heard the sound, which rolled away towards Headington Hill to the eastward, till I could no longer hear it. It seemed to begin in full tone about over Mansfield College.—*Rowland Wheeler*, 4, *Bevington Road*, *Oxford.*

[Note:—I have very carefully ascertained the positions of the objects mentioned in this letter from Mr. Wheeler, and find that the sound was first heard a little to the N. of E., and was last heard a little to the E. of N.E.—*F. A. Bellamy*, *Oxford.*]

THAME.—At a farmhouse near here the occupants rushed out, as they thought that a chimney-stack was falling. An observer says: "A very unusual sound, like the rumbling of a distant explosion."—'*M. M.*,' p. 164.

GARSINGTON.—People at Garsington report the stopping of clocks at the time.—*James C. Ross*, [vicar of Baldon,] *Baldon Vicarage*, *Oxford.*

TETSWORTH.—Loud explosion.—'*M. M.*,' p. 164.

BALDON.—A very loud report, which I heard at 8·20 a.m., seemed due to a thunder-clap, though it sounded very like a big cannon-shot, or an explosion; the sound seemed to come from a S.E. direction, that quarter being full of foggy cloud at the time.—*James C. Ross*, *Baldon Vicarage*, *in* '*M. M.*,' pp. 163, 164.

PYRTON.—Time of explosion: 8·20 a.m. Direction of report: three people point to a direction about E., or rather to the N. of E. The general idea in this neighbourhood was that Westminster Abbey had been blown up, showing that the sound came rather from that direction. Character of report: One person describes it as that of a double-barrelled gun going off *very quickly*, only he says it was like a very big cannon (I give his own words). Another says it was like the explosion of dynamite, which they use on a neighbouring estate to blow up roots of trees, etc. Another likens it to thunder. No vibration. The village of Pyrton lies about 1 mile N. of Watlington.—*Cecil Hamersley*, *Pyrton Manor*, *Tetsworth.*

ASSENDON.—I thought it was Hounslow Powder Mills blown up. The sound of the explosion was terrific; it caused the birds and [other] animals to cry out in terror. It caused concussion of the earth, and felt like an upheaval, then a prolonged rending sound, with three slight reports towards the end. The atmosphere was foggy, clear over-head, dense looking N. and S. This place is in a valley between the spurs of the Chiltern Hills.—*James Ratty*, *Assendon*, *Henley-on-Thames.* [Hounslow is about E.S.E. of Assendon.]

SONNING COMMON.—The postman from Henley to this place, crossing CROWSLEY PARK, felt the effect, and fancied it to be thunder. At the "Bird-in-Hand" public-house, 4 miles N. of Reading, it was more distinctly fancied to be an earthquake, for much notice was taken of the singular disturbance among the poultry. Here, half a mile N. of the "Bird-in-Hand," my housekeeper reported to me thunder. Generally speaking, it would seem to have occurred to two out of three as an over-head rather than an underground disturbance. My dog barked, no one being by, and she is a very silent one. This I heard myself.

I find that at Priest's Farm, half a mile E. of the "Bird-in-Hand," the labourers were surprised at the action of ducks and fowls, all jumping and *looking up*. The effects were noticed at Wyfold Court (supposed to be thunder), and at Stoke Row.—*Superintendent Berdmore, Sonning Common, Henley-on-Thames.*

BERKSHIRE.

Wootton and Shippon.—Doors, windows, and slates rattled at Wootton and Shippon, and at Shippon a man rushed out of doors, thinking that the house was falling.—'*M. M.*,' p. 163.

Abingdon.—The shock was distinctly felt at Abingdon. I was in church at the time (8·20 a.m.), when there came a loud report as of an explosion, and all the members of the congregation, who were kneeling at the moment, looked up startled, expecting to see some catastrophe in the church, but all was quiet there. The prevailing idea then was that a dynamite explosion must have taken place in or near London.—"*C. L.*" *Letter in 'Morning Post'* of Nov. 23.

Marcham.—Doors, windows, and slates rattled.—'*M. M.*,' p. 163.

Pusey.—The noise was heard here.—*S. W. Silver*, [F.R.Met.Soc.,] *Letcomb Manor, Wantage.*

Drayton.—Very loud explosion, windows shaken.—'*M. M.*,' p. 163.

Wallingford.—A clergyman in the neighbourhood of Wallingford specially mentioned it [the meteor-explosion] to me.—*Richard Hooper*, [vicar of Upton,] *Upton Vicarage, Didcot.*

Wantage.—It was supposed that the Abingdon gas-works had blown up; a terrific explosion was heard; doors, windows, and even slates rattled.—'*M. M.*,' p. 163. [Abingdon is N.E. from Wantage.]

Letcomb.—[Time] about 8·15 a.m. The facts I collect do not go beyond this—that a noise almost stunning in effect was heard. A groom was out on a sick horse; although deaf, he felt or heard *something*, and the horse was so upset that he almost threw his rider.—*S. W. Silver, Letcomb Manor.*

Upton.—I was told by many persons in this neighbourhood that they heard the meteor-explosion.—*Richard Hooper, Upton Vicarage.*

Bisham.—Loud noise heard at Bisham, four miles N.N.W. of Maidenhead.—'*M. M.*,' p. 163.

Upper Lamborne.—I distinctly heard what I took to be the report of a large cannon. It was as if it came from the N.W. My carter also heard the sound, and he asked me if it was thunder. It was just 8·20 a.m.—*David Albury, Upper Lamborne, Swindon. Letter reprinted from 'Reading Mercury' in* '*M. M.*,' p. 163.

Reading.—At 8·18 I heard a sound like a heavy explosion, or [the report of] a big gun, very distant, followed, as I fancied, by a slight rumbling.—"*L. B.*" *in* '*M. M.*,' p. 162.

Discussion of Observations.

In discussing the observations recorded above, and in endeavouring to deduce from them the course and altitude of the meteorite, and the cause of the sounds and shock experienced, it will be convenient to deal separately with the several distinct points upon which information has been collected, under the following heads:—(1) Area affected; (2) Area of well-marked aërial disturbance; (3) Apparent direction from which disturbance reached various localities; (4) Summary of deductions from evidence of effects of aërial disturbance; (5) Visual observations of meteorite; (6) General summary.

(1) *Area affected.*

On referring to the map accompanying this paper (Plate II), it will be seen that a somewhat irregular area is defined by the localities from which a record of the sound of the meteorite has been received. It shows, however, a well-marked elongation upon a line E.N.E. and W.S.W., of which Bury St. Edmunds and Upper Lamborne are the extreme points, this line being about 105 miles in length. The two most easterly points at which the sound was observed, Westley near Bury St. Edmunds, and Newmarket, are, it should be noted, single instances of observation, separated by a considerable space from one another and from any other localities in which the sound was heard. At Newmarket the sound must have been very slight. At Westley there is evidence of direction and of a defined sound, but, apparently, of very distant origin.

Taking the Westley–Upper Lamborne line as the major axis of the area of aërial disturbance, and following the assumed course of the meteorite from E. to W., the first wide and general prevalence of the sound occurs on a N.N.W. and S.S.E. line terminating at Cambridge and Saffron Walden, 14 miles apart. To the westward the sound was very generally noticed, and the recorded observations become numerous, the area affected widening to about 32 miles between Risely and a point a little N. of Hertford. To the W. of Risely, as far as Sulgrave, in Northamptonshire, the sound has not extended so far to the N.W.; Bedford, Bow Brickhill, and Buckingham marking its north-western limits. On the S., however, it has, throughout Herts, reached as far as Hatfield, St. Albans, and Watford. Between Bow Brickhill and Watford the distance is about 27 miles; Bow Brickhill being 11 miles distant from the imaginary Westley–Lamborne line, and Watford 16. Westward of Watford again for some distance the shock has extended but little to the S.E., the neighbourhood of Wendover being the limit. At the same time there is an increased extension to the N.W. as far as Sulgrave, and to an isolated point near Leamington (Cubbington), the latter as much as 50 miles N.N.W. from Wendover. More to the westward the area affected is again enlarged, making an irregular figure, of which Bisham near Maidenhead, and Reading are extreme S.E. points, and Bicester, Sandford St. Martin, and Oxford define its limits to the N.W., the distance from Sandford to Bisham being 38 miles, and from Oxford to Reading 24 miles. The area then diminishes to 6 miles in width between Pusey and Wantage, and extends finally in a narrow band to its termination at Upper Lamborne.

The colouring on the map will give a better idea of the extent of the area affected by the meteorite than any verbal description. It will be seen that, omitting the extreme E.N.E. and W.S.W. points, and the isolated Warwickshire observation, we have, between the Cambridge–Saffron Walden and Oxford–Reading lines, a parallelogram about 70 miles in length by 25 miles wide, containing 1750 square miles.

Assuming that the state of the atmosphere, at the time of the passage of the meteorite, was equally favourable to the dispersal of any aërial vibration in any direction from any one point,—and the reports we have show that such a condition prevailed, on the *surface* of the earth at all events, the wind being very slight (from the N.E.), and the air more or less foggy,—a simple explosion at one point would result in a circular area of sound-distribution. The elongated figure, in fact, presented, can only be accounted for by a series of explosions occurring at different points along the course of the meteorite, or by a sound arising from the passage of the meteorite through the air, or by a combination of the sounds produced by these two causes. If the *area* affected by disturbance set up from whatever cause along the track of the passing meteorite is alone considered, we are naturally driven to assume that track to lie over the major-axis of the area in which the sound is recorded, viz. on the Westley–Lamborne line already referred to. We know from the Hertford observation that the meteorite passed from E. to W. upon or near this very line, which, subject to a consideration of other facts observed, seems therefore a probable course. Upon or very near this line are Royston, Baldock, Hitchin, Dunstable, Aylesbury, Thame, Abingdon, and Wantage. Its nearest point to Hertford would be 13½ miles distant from, and about N.N.W. of that town, and it would pass about 7 miles off and to the S.S.E. of Oxford. From Solihull to Upper Lamborne is about 61 miles, in a direction a few degrees E. of S.

(2) *Area of well-marked aërial disturbance.*

A further development of the map, by the marking in of the localities in which the sound of the meteorite was specially loud and definite, will, in some respects, help us in fixing its course; although it seems probable that local circumstances have, in some cases at any rate, done much to increase the volume of sound reaching particular observers.

Of 50 localities in which the disturbance occasioned by the meteorite was specially definite, 8 (Gamlingay, Barrington, Shepreth, Melbourn, Guilden Morden, Steeple Morden, Bassingbourn, and Royston) are in the S.W. of Cambridgeshire; 1 (Waresley) is in Huntingdonshire, on the Cambridgeshire border; 13 (Potton, Sandy, Wrestlingworth, Biggleswade, Lidlington, Ampthill, Silsoe, Flitton, Flitwick, Westoning, Leighton Buzzard, Dunstable, and Whipsnade) are in Bedfordshire, in the centre and S.W. of that county; 9 (Ashwell, Baldock, Pirton, Knebworth, Welwyn, Digswell, Wheathampstead, No-Man's Land, and Aldbury) are on or near the N.W. border of Hertfordshire; 8 (Buckingham, Linslade, Ivinghoe, Dagnall, Aylesbury, Wendover, Prince's Risborough, and Saunderton) are in Buckinghamshire; 4 (Kirtlington, Oxford, Thame, and Assendon) are in Oxfordshire; and 7 (Wootton, Shippon, Marcham, Abingdon, Drayton, Wantage, and Letcomb) are in Berkshire.

Upon examining the map, it will be seen that the distribution of these places is consistent with a course upon the line already suggested, or very near it. The majority of them are situated on, or within five miles of such a line; there being, however, a small area in Herts, in the neighbourhood of Welwyn, and one place (Assendon) in Berkshire outside the five miles limit to the S.E. of the line, while to the N.W. there is a well-defined group of places in Bedfordshire, in the district of Potton and Biggleswade, as well as four other localities further to the westward, outside that limit. Two of these (Buckingham and Kirtlington) are as much as 15 miles to the N.W. of the line. This would tend to show that the course of the meteorite lay a little N.W. of the Westley–Lamborne track, and was inclined slightly more to the S.

If the area of well-marked disturbance is alone regarded, the track would probably be best defined by Barrington near Cambridge, and Wantage; being thus five miles to the N.W. of the already-determined track at its E. extremity, and two miles at its W. end. Such a line would pass between Leighton Buzzard and Dunstable, exactly over Aylesbury and Thame, and a little to the S. of Abingdon. It would still be well to the S.W. of the group of places round Ampthill in Bedfordshire, where there was a considerable shock experienced, that is to say about five miles from the centre of the group.

The assumption that the track of the meteorite is to be properly marked by a straight line on the map is, however, hardly to be justified absolutely. It is not impossible that its course may have been affected by explosions, or that the mass of the meteorite may even have divided into several fragments, which may have pursued divergent courses. Thus, possibly, by subsequent explosions of fragments at different points, several centres of aërial disturbance may have given rise to the sounds heard in various places.

The observation at Hertford does not go further than that a portion of the meteorite fell at one point on its course, and there is no other evidence as to the breaking up of the meteorite itself, except that furnished by the observation from Solihull, which seems to point to the final explosion terminating its existence.

Subject therefore to the possibility just referred to, with respect to which we have practically no evidence, we have no option but to assume that the course of the meteorite may be laid down on a straight line, a conclusion which I accordingly adopt.

(3) *Apparent direction from which the disturbance reached various localities.*

It is naturally difficult to obtain trustworthy information as to the course taken by sound-waves radiating from a point high in the atmosphere. There are several causes which may operate to vitiate any exact conclusion as to the direction from which a sound so originating reaches the observer, apart from the general difficulty of distinguishing the direction of a sound incidental to the imperfection of our organs of hearing. The sound-wave, too, may pass through several distinct strata of air before it reaches the earth; in each stratum the conditions in respect to humidity, and otherwise, may be different; in each there may be a movement in a different direction, and of different velocity; the sound-waves may thus become subject to a certain amount of deflection and change of character. They may also, it appears, lose in force.* These possible influences cannot be altogether disregarded in the case of an explosion taking place at a great height in the atmosphere, and may perhaps be of greater importance in the case of a series of explosions, either at various altitudes, or approximately in the same plane of altitude. So also they may come into play when a sound is created by the rush of a solid body passing with extraordinary velocity through the air. Then again the waves may be modified, deflected, or echoed by the configuration of the surface of the earth, or by objects upon it. There seems a good deal of evidence of various effects arising from such causes in the preceding letters and other communications.

The position of the observer will necessarily affect his power to estimate the direction of the sound. Clearly, observations from within buildings are of little value, except where a wave of air appears to strike one side of a house, or windows facing in one direction alone. There is also a natural tendency to associate vague sounds with some expected event, to which such a sound is, or may be thought to be, appropriate. Of this again there are a number of examples in the reports; some observers associating the sounds noticed with an explosion in London, and others with such local events as the passage of a train over a bridge, and similar causes. In spite of these difficulties, it is well worth while examining the reports which have been received bearing upon the direction from which the sounds and shock occasioned by the meteorite appeared to reach observers in different districts. Without going into elaborate detail here, it will be enough to point out the general results.

In a district to the eastward of the meridian of Bedford

* In the article "Thunderstorm" in the 'Encyclopædia Britannica,' by Professor Tait of Edinburgh, it is stated, in explanation of "summer lightning," that when that phenomenon is due, as it often is, to a thunderstorm in the higher strata of the atmosphere overhead, "the reason why we hear no thunder" is "not so much the distance from the spectator as the fact that sounds generated in rarer air lose rapidly in intensity as they are propagated into denser air."—'Encyclopædia Britannica,' 9th ed., vol. xxiii (1888), p. 330.

almost all observers who give any definite idea of direction agree that the sound came to them from the westward. The principal observations are : — *Suffolk,* — Westley, S.W. : *Essex,* — Elmdon, Heydon, Chishill, and Saffron Walden, W. and W.S.W. : *Cambridgeshire,*—Shelford, S.W. ; Thriplow and Ickleton, W. ; Melbourn, S.W.: *Bedfordshire,*—Sandy and Girtford, W. and S.W.; Dunton, Edworth, Clifton, Shefford, and Lidlington, W. ; Stotfold, S.W. by W. to W.S.W. ; Arlesey, W.N.W. ; and Stondon, N.N.W. : *Hertfordshire,* — Hinxworth, S. W. ; Bygrave, W. ; Baldock, W.N.W. ; Throcking, S.W. ; Coles, S.S.W. ; Cumberlow Green, N.W. by W. ; Cromer, W. ; Stagenhoe, W.; Codicote, W.S.W. ; Digswell, W. It is true that the observations made at several places in these counties are at variance with this general westerly direction, but they are neither so weighty nor numerous as to invalidate the assumption to be derived from the observations indicating a westerly origin for the sound of the meteorite. It is also important to notice that in general in this eastern section of the area of disturbance, the noise is described as like a long, heavy peal of thunder, or roar, or as a number of successive explosions ; in one case (Melbourn) as many as five are distinguished.

In the remainder of the area of disturbance (*i.e.* to the westward of the meridian of Bedford) a different character is given to the noise and shock experienced, while uniformity of direction is entirely wanting. Instead of a prolonged sound, we have here one sharp shock, as of a single explosion, very generally likened to the report of a cannon. At points on the borders of this area to the N. and S. (*e.g.* Sulgrave, Oxford, and Reading), a rumbling, or continuous sound is, it is true, reported, but these localities were probably at a considerable distance from points of explosion.

The little information I have as to centres of sound-origin in this western district is conflicting, and establishes no general direction. It is consistent, however, with the theory that several explosions may have occurred upon the course of the meteorite within the district.

(4) *Summary of deductions from evidence of effects of aërial disturbance.*

It appears, then, probable that the meteorite, following a course approximate to that laid down as the Barrington–Wantage line, passed over the eastern section of the area of disturbance without, in that part of its track, giving rise to any sound, of a clearly defined character at least. The theory that there was no explosion until the meteorite reached a point further to the westward is supported by the fact that nothing of a nature to point to such an explosion was observed from Hertford, while there is evidence of a breaking up of the meteorite at one point (further to the west). If this be so, the shock and sound experienced in the eastern section had their origin at some point or points on the course of the meteorite to the westward of the meridian of Bedford. In that western section there seem to have been several explosions, and there may have been in addition a sound arising from the rapid motion of the meteorite through the air; of this latter phenomenon there is little or no evidence, and I am more inclined to refer all the effects observed to a series of explosions, whether of the main mass of the meteorite itself, or of liquefied air carried in advance of the moving solid body, it is impossible to say. Such a series of explosions, whose shock would be transmitted eastward in successive sound-waves rapidly following one another, would clearly account for the sounds recognised to the eastward; while in the area more immediately adjacent to the locality of explosion, several explosions might perhaps be so nearly identical in time as to reach an observer as a single sound-shock, or the concussion set up at the point nearest the observer might be so much more powerful as to render other sounds for the moment indistinguishable. We are in some general difficulty in accounting for the variable loudness of the shock experienced in different, but adjacent localities; and especially is it difficult to give satisfactory grounds for the violence of the shock noticed in certain isolated districts at some distance from the assumed track and localities of explosions; for instance we have a group of places near Welwyn, in Hertfordshire, from which I have reports showing a considerable aërial disturbance. And yet this district is at least 12 miles from the assumed track of the meteorite, and is isolated, in a measure, from other localities in which similar effects are recorded. Probably the configuration of the ground here and elsewhere has affected the question; and with regard to this point I may mention one instance which may serve as an illustration of what may be, possibly, more or less worth consideration. I refer to the reports from Mr. Iredale, of Digswell Mill.* Welwyn Viaduct is a high, brick structure, running due N. and S., and carrying the Great Northern Railway across the valley of the Mimram. The mill and garden referred to in Mr. Iredale's letters lie on the E. side of, and almost under, this viaduct. It is probable that a sound-wave coming from the W. would be to some extent pent in by the sides of the valley, and upon reaching the transverse partial barrier of the viaduct might be caught and echoed in its arches in the manner described. The very distant and isolated extension of the sound to Cubbington, near Leamington, so far to the N. or N.W. of the assumed localities of explosions, is curious.

The effect of the shock upon animals, both wild and domesticated, should be noted. In a number of cases pheasants are reported to have crowed, or to have given other signs of uneasiness. It appears that at Westley the crowing of pheasants was noticed at the time of the Erith gunpowder-explosion; but Mr. Mathison's Aynhoe correspondent remarks that pheasants generally call out when it thunders, and this is true also of dogs.

In considering the sound-effects in the western section, subject as such a matter must be to many qualifications, the fair conclusion seems to be that we have on the course of the meteorite three

* P. 46, *ante*.

principal centres of sound-distribution. The first is approximate to the group of places in Bedfordshire which may be called the Ampthill group, Ampthill being the most central place; and I shall presently endeavour to associate with this locality the point at which our Hertford observer saw a portion of the meteorite detached. The second is at Thame; and the third in the neighbourhood of Abingdon, or between that place and Wantage. The explosion near Abingdon, or possibly a fourth and final subsidiary explosion, I identify with that which was observed from Solihull.

With regard to the character of the sound, it ought perhaps to be remarked that the velocity of meteorites is usually so considerable, that with the means at the disposal of ordinary observers the difference of time as regards the impact of sound-waves at various points would not be ascertainable or perhaps distinguishable, and thus, so far as aërial shock is concerned, no light is likely to be thrown on the time in which the meteorite passed over any given space. Nor, in any case, unless the reports of particular explosions could be identified, could any information as to the course or elevation of a meteorite based upon the known velocity of sound be of any value.

I ought perhaps to refer to the alleged tremor of the earth, and of buildings, reported from a good many places. The aërial shock was in many instances sufficient to shake windows, doors, and the slates of buildings; and it seems probable that this shock and its effects have, in many cases, been translated by an effort or impulse of imagination into a tremor of the earth.

There is one other point,—the statement made by several persons that there were other shocks both prior to, and later than, that of 8·20 a.m. These reports cannot be disregarded, although they can have no possible explanation in connection with the meteorite, the special subject of this paper. It is possible, of course, that other meteorites reached the earth on the morning of the 20th November, and some of them may have penetrated the atmosphere in the district from which our reports come. As we have no facts upon which to build such a theory, I do not propose to offer any definite explanation of these alleged earlier and later shocks.

(5) *Visual observations of the meteorite.*

I have only been able to find two persons who actually saw the meteorite, and their observations are naturally of great interest. The more important, that at Hertford, is very clear and detailed. I have personally visited the house from which the meteorite was seen, and have obtained Miss Dear's account of what she saw from her own lips, observing and noting the points of the compass and angles of elevation as pointed out by her for the first appearance, etc., of the meteorite. The points of the compass as given below are corrected for the deviation of the magnetic needle from the true north. The first appearance was at about N.E., at an elevation of about 20°. A line N.E. from Hertford passes through Albury and Saffron Walden, near Bury St. Edmunds, and over East Harling in Norfolk. This line would cut the extension of the suggested Barrington–Wantage track at East Harling, at a distance from Hertford of 62 miles, giving an elevation for the meteorite at that point of 23 miles. Allowing for error in fixing the angle of observation, which may perhaps be hardly large enough, it is possible that the meteor may have been first seen at a height above the earth as great as 30 miles over a point in the south of the county of Norfolk. A line from Hertford due N.W., the point which Miss Dear identifies as that at which a portion of the meteorite was detached, passes through Ampthill at a distance of 24 miles, cutting the Barrington–Wantage line at a point on the borders of Hertfordshire and Bedfordshire between Pirton and Barton, 18 miles from Hertford. Thus we have a close association of what was no doubt an explosion breaking off part of the crust of the meteorite, with a group of places round Ampthill at which the shock of an explosion was seriously felt, and to which point there is a singular convergence of lines of direction of sound from a number of places to the westward. According to the Hertford observation the meteorite was last seen on its westward course at W.N.W. This point would, on the Barrington–Wantage track, be about 3 miles N. of Dunstable, 21 miles distant from Hertford. The estimated angle of elevation being for this point but 13°, we should have a vertical height above the earth's surface of only 5 miles. This seems far too low an elevation to be consistent with the passage of the meteorite 44 miles further to the westward to an assumed point of final explosion near Wantage. These two assumed terminal points of the Hertford observation (East Harling and Dunstable) are about 71 miles apart, and a comparison of the assumed elevation (23 and 5 miles) would give a course inclined to the earth's surface at an angle of 14°, and which would reach the earth 20 miles beyond Dunstable, *i.e.* two miles short of Thame. It is impossible therefore to assume so low an elevation in the neighbourhood of Dunstable. If double the height is allowed to be possible, consistently with some considerable error in the angle of elevation, and if some latitude is allowed in fixing the point of the compass at which the meteorite was last seen—making it further W.—the meteorite may have been last seen from Hertford as far W. as Aylesbury and at an elevation of 10 miles. Taking the whole course at the greatest elevation that can reasonably be assumed, at all consistently with the greatest allowance of error in the Hertford observations (*i.e.* 30 miles at East Harling, and 10 miles at Aylesbury, nearly W. of and 31 miles distant from Hertford,—these points being 85 miles apart), the angle of inclination of the course of the meteorite to the surface of the earth would be a little more than 13°, which would give an elevation at Wantage, 30 miles W. of Aylesbury, of 3 miles. This, or even a slightly lower course throughout, is not improbable, and there would be nothing to urge against its probability, were it not for the Solihull observation. As to this I have not been able to verify the direction (given as S.), and I have no information as to the angle of elevation. Assuming that the explosion—

apparently seen from Solihull—was at about S.S.E., over Abingdon, or slightly further W., over Wantage, and was, in fact, the final explosion terminating the meteorite's existence, and the distance from Solihull being about 58 miles, it is hardly probable that what was seen was at a smaller angle of elevation than 15°, which would give a vertical height at Abingdon or Wantage of 12 miles.

If the Solihull report is to be relied on, and the above assumptions are also to be accepted, the Hertford and Solihull reports can only be approximately harmonized by either placing the track of the meteorite upon a line passing through or even to the N. of Oxford, or assuming on the Barrington–Wantage line a course more nearly parallel to the earth's surface at an elevation such as 20 miles at East Harling and 10 at Aylesbury, which would give an elevation of 6½ miles at Wantage. For simplicity's sake in the preceding rough calculations the earth's surface is regarded as a plane, and the meteorite's course as a straight line.

There is also the possibility, not to be altogether disregarded, of the breaking up of the meteorite in Bedfordshire, and the adoption of divergent tracks by the fragments, and such an hypothesis might perhaps help to explain the report from Solihull, without any modification of the theory of the main Barrington–Wantage track being necessary.

It will be seen from the preceding considerations that there are a good many elements of doubt in any conclusions as to the track to be laid down, and the elevation to be assumed at different points on the meteorite's course.

(6) *General Summary.*

I have now pointed out the several deductions which seem fairly to arise from the consideration of the various reports. It is difficult to bring them into complete harmony, but, nevertheless, the conclusion to be derived from a general survey of the whole of the evidence seems to be (1) that a meteorite of considerable magnitude passed across central England at a very high velocity at 8·20 a.m. on the morning of November 20th, 1887; (2) that its track may be laid down approximately on the map as passing over East Harling, Newmarket, Barrington, Aylesbury, Thame, and Wantage; (3) that its elevation was, at East Harling, between twenty and thirty miles, and was in the latter part of its course between five and ten miles; (4) that at points in the neighbourhood of Ampthill, Thame, and Abingdon and Wantage, explosions took place which account for the sounds and shock reported by numerous observers; and (5) that the explosion in the Abingdon–Wantage district terminated the course of the meteorite by the final dissipation of its mass either in solid fragments or as gaseous products of its combustion.*

No fragments resulting from an explosion have been as yet discovered; but there may still possibly be such a discovery, and

* See discussion in 'Metereological Magazine,' vol. xxii, p. 162 (Editorial Notice), and p. 177 (letter of Mr. James G. Wood), and also vol. xxiii, pp. 20 and 48 (article by the present author).

for some years to come, at all events, it will be worth while examining any peculiar stone found in the districts noted, in case it may turn out to be a fragment of the meteorite.

Appendix.

It may not be amiss to direct attention to some of the more accessible sources of information as to meteorites. I give below a few titles and references which may be useful. The article in the last edition of the 'Encyclopædia Britannica' is probably the best exposition of the subject for the general reader.

It appears from that article that the region of *luminous* meteors may be regarded as being between forty and eighty miles above the earth's surface. Of meteorites which descend deep into the atmospheric envelope of the earth, and even reach its surface, furnishing solid fragments, an average of about six to eight per annum has been recorded during the last fifty years. Of meteors visible to the naked eye it is computed that many millions come into our atmosphere during each day. It is also stated that the average velocity of meteorites, as computed from good observations, is nearly thirty miles *per second.*

The last recorded stone-fall in England is that near Middlesbrough, on 14th March, 1881, when a small stone was seen to fall in broad daylight, and was picked up. There was a report previous to the fall, heard over a considerable area. A very interesting fall, in Johnson County, Arkansas, U.S.A., is reported in 'Nature,' of 15th December, 1887. It occurred on 27th March, 1886, and in this case also there was a very loud report, heard at great distances from the place where the fall occurred.

References.

Article "Meteor, Meteorite," by Professor H. A. Newton, LL.D. 'Encyclopædia Britannica,' 9th ed., vol. xvi (1883), p. 107.

"Researches on the Spectra of Meteorites. A Report to the Solar Physics Committee," by J. Norman Lockyer, F.R.S. A paper read before the Royal Society, Nov. 17, 1887. 'Proceedings of the Royal Society of London,' vol. xliii (1888), p. 117. See also "Researches on Meteorites," I. 'Nature,' vol. xxxvii, p. 55 (No. 942, Nov. 17, 1887); and II. *ibid.*, p. 80 (No. 943, Nov. 24, 1887); and "The Constitution of the Heavenly Bodies," in 'The Times' of Nov. 18, 1887.

"An Introduction to the Study of Meteorites, with a List of the Meteorites represented in the Collection," by L. Fletcher. British Museum (Natural History), Mineral Department, 1887. The following eleven British meteorites are represented in the Collection, viz. those of:—

Wold Cottage, Thwing, (Yorkshire)	date of fall	Dec. 13, 1795.
High Possil, near Glasgow	,,	April 5, 1804.
Mooresfort (co. Tipperary)	,,	August, 1810.
Adare, Faha, etc. (co. Limerick)	,,	Sept. 10, 1813.
Newstead (Roxburghshire) *	found in	1827.

* See 'Brit. Assoc. Report' for 1863, p. 337.

North Inch of Perth (Perthshire)	date of fall	May, 17, 1830.
Aldsworth, near Cirencester (Gloucestershire)*	,,	Aug. 4, 1835.
Killeter (co. Tyrone)	,,	April 29, 1844.
Dundrum (co. Tipperary)	,,	Aug. 12, 1865.
Rowton, near Wellington (Shropshire)†	,,	April 20, 1876.
Middlesbrough (Yorkshire)‡	,,	March 14, 1881.

"On Periodic Meteors," by Professor Baden Powell, F.R.S. 'Report of the British Association' for 1847, 'Transactions of Sections,' p. 15 (including a Table of Meteor Showers from 1841 to 1846).

"A Catalogue of Observations of Luminous Meteors," by Professor Baden Powell, F.R.S. (in continuation of the Table in the preceding paper). Continued annually in the 'Reports of the British Association' for 1848 to 1859.

"Reports of the Committee on Observations of Luminous Meteors." 'Reports of the British Association' for 1860 to 1881. These annual Reports are in continuation of those of Professor Baden Powell (who died June 11, 1860).

"A Catalogue of Meteorites and Fireballs from A.D. 2 to A.D. 1860," by R. P. Greg, F.G.S., 'Report of the British Association' for 1861, p. 48, with supplements,—I, p. 93; II, *ibid.* for 1867, p. 414; and III, *ibid.* for 1869, p. 282.

"On the Fall of an Aërolite near Middlesbrough, Yorkshire, on March 14th, 1881," by Professor A. S. Herschel, F.R.A.S. 'Brit. Assoc. Report' for 1881, p. 296.

"A Chapter in the History of Meteorites," by Walter Flight, D.Sc., published in parts in the 'Geological Magazine,' New Series, Dec. II, vol. ii (January to December, 1875). A fall of stones near Wantage, 9th April, 1628, is recorded (p. 266) from Wallington's 'Historical Notices,' vol. i, p. 13. The account is reprinted in the 'Meteorological Magazine,' vol. xxii, p. 169.

"On the Meteoric Iron which fell near Cabin Creek, Johnson County, Arkansas, March 27th, 1886." 'American Journal of Science,' vol. xxxiii, June, 1887; and 'Nature,' Dec. 15th, 1887, p. 159.

* See 'Brit. Assoc. Report' for 1857, p. 140.
† See *ibid.* for 1876, p. 166.
‡ See *ibid.* for 1881, p. 296.

VI.

CONTRIBUTIONS TO THE KNOWLEDGE OF THE ENTOMOLOGICAL FAUNA OF HERTFORDSHIRE. No. 1.—LEPIDOPTERA.

By JOHN HARTLEY DURRANT, F.E.S., Memb. Soc. Ent. de France.

Read at Watford, 31st January and 8th May, 1888.

DURING the past year I have devoted some considerable time to collecting notices of the occurrence of Lepidoptera in our county. I think it will be found that the following compilation contains *nearly all* the references to Hertfordshire. At present I am unable to obtain access to other works likely to add to our list, but I hope to give a continuation of this paper at no distant date.

To prevent re-duplication of work I give a list of the serials and separate works which I have searched, with the number of species mentioned in each as occurring in Hertfordshire.

Haworth, A. H.—'Lepidoptera Britannica,' 1803-29. (0 ref.)
Stephens, J. F.—'Illustrations of British Entomology' (Haustellata), vols. i-iv, 1828-34. (192 ref.)
**Wood, W.*—'Index Entomologicus,' etc., 1839.
**Humphrey, H. N., and Westwood, J. O.*—'British Moths and their Transformations,' 2 vols., 1854.
*———, ——— 'British Butterflies and their Transformations,' 1857.
Crewe, Rev. H. Harpur.—"The Prominent Moths of Buckinghamshire," 1869.—'Quart. Mag. High Wycombe Nat. Hist. Soc.,' vol. ii, pp. 97–104. (1 ref.†)
Newman, E.—'An Illustrated Natural History of British Moths,' 1874. (0 ref.)
———. 'An Illustrated Natural History of British Butterflies,' 1874. (6 ref.)
'The Entomological Magazine,' 1833–38. (0 ref.)
'The Entomologist,' 20 vols., vol. i, 1840, vol. ii, 1864, to vol. xx, 1887. (21 ref.)
'The Entomologists' Annual,' 20 vols., 1855–74. (7 ref.)
'The Entomologists' Weekly Intelligencer,' 10 vols., 1856–61. (7 ref.)
'The Journal of Entomology,' 2 vols., 1862–66. (0 ref.)
'The Entomologists' Monthly Magazine,' 24 vols., 1864–87. (24 ref.)
'Transactions of the Watford Natural History Society and Hertfordshire Field Club,' 2 vols., 1875–80. (31 ref.)
'Transactions of the Hertfordshire Natural History Society and Field Club,' 4 vols., 1880–88. (1065 ref.)

The arrangement followed is that of Doubleday's List, and wherever the nomenclature has been altered the original name is given in brackets. The species are given under localities with a view of obtaining fresh additions to each town by showing residents how little is known of their district.

* References are not given to these works, as they are copied from Stephens.

† *Notodonta cucullina*, W. V.—"I once beat two larvæ from a maple-bush in Herts."—Rev. H. Harpur Crewe.

I.

Lepidoptera recorded as occurring in Hertfordshire, by J. F. Stephens, in 'Illustrations of British Entomology' (Haustellata), vol. i, 1828; vol. ii, 1829; vol. iii, 1829; vol. iv, 1834.

Hertford.

Pieris brassicæ, L. (Pontia chariclea, St.)–i, 18.
,, rapæ, L. (Pontia metra, St.)–i, 20.
Argynnis lathonia, L.–i, 38. "In plenty [in] August and September, 1818."
Vanessa c-album, L.–i, 42. "Abundant prior to 1833."
,, antiopa, L.–i, 45.
Apatura iris, L.–iv, 381. "July, 1833."
Lycæna agestis, W. V. (Polyommatus agestis, W. V.)–i, 95.
,, alsus, F. (Polyommatus alsus, F.)–i, 86.
Syricthus alveolus, Hb. (Thymele alveolus, Hb.)–i, 98.
Thanaos tages, L. (Thymele tages, L.)–i, 99.
Hesperia sylvanus, F. (Pamphila sylvanus, F.)–i, 102.
,, linea, F. (Pamphila linea, F.)–i, 101.
Smerinthus ocellatus, L.–i, 112.
,, tiliæ, L.–i, 114.
Sphinx ligustri, L.–i, 121.
Chærocampa elpenor, L. (Deilephila elpenor, L.)–i, 131.
Macroglossa stellatarum, L.–i, 134.
Sesia myopiformis, Bkh. (Ægeria mutillæformis, Lasp.)–i, 143.
Hepialus sylvinus, L.–ii, 8.
Procris statices, L. (Ino statices, L.)–i, 106.
Nudaria mundana, L. (Nudaria munda, L.)–ii, 84.
Calligenia miniata, Forst. (Callimorpha miniata, Forst.)–ii, 90.
Lithosia mesomella, L. (Setina eborina, F.)–ii, 100.
,, griseola, Hb.–ii, 96.
Callimorpha jacobææ, L.–ii, 90.
Chelonia villica, L. (Arctia villica, L.)–ii, 72.
Arctia fuliginosa, L. (Phragmatobia fuliginosa, L.)–ii, 74.
Orgyia antiqua, L.–ii, 61.
Pœcilocampa populi, L.–ii, 44.
Eriogaster lanestris, L.–ii, 45.
Bombyx rubi, L. (Lasiocampa rubi, L.)–ii, 39.
Lasiocampa quercus, L. (Lasiocampa roboris (?), Schrk.)–ii, 42.
Odonestis potatoria, L.–ii, 52.
Gastropacha quercifolia, L.–ii. 53.
Saturnia carpini, Bkh. (Saturnia pavonia, L.)–ii, 37.
Ennomos tiliaria, Hb. (Geometra tiliaria, Hb.)–iii, 165.
Asthenia luteata, W. V. (Emmelesia luteata, W. V.)–iii, 302.
Timandra amataria, L. (Bradypetes amataria, L.)–iii, 202.
Strenia clathrata, L.–iii, 303.
Panagra petraria, Hb. (Lozogramma petraria, Hb.)–iii, 259.
Fidonia atomaria, L.–iii, 148.
Aspilates citraria, Hb.–iii, 208.
Ligdia adustata, W. V. (Xerene adustata, W. V.)–iii, 251.

Emmelesia affinitata, St.–iii, 297.
,, alchemillata, L. (Emmelesia rivulata, W. V.)–iii, 298.
,, decolorata, Hb.–iii, 297.
Eupithecia nanata, Hb. (Eupithecia angustata, Hb.)–iii, 289.
Thera variata, W. V.–iii, 272.
Melanthia ocellata, L. (Harpalace ocellata, L.)–iii, 222.
Melanippe procellata, W. V. (Xerene procellata, W. V.)–iii, 250.
Coremia propugnata, W. V. (Cidaria propugnata, W. V.)–iii, 220.
,, unidentaria, Hw. (Cidaria unidentaria, Hw.)–iii, 215.
,, quadrifasciaria, L. (Cidaria quadrifasciaria, L.)–iii, 216.
Phibalapteryx tersata, W. V.–iii, 256.
Scotosia rhamnata, W. V.–iii, 260.
Cidaria suffumata, W. V. (Lampropteryx suffumata, W. V.)–iii, 234.
,, prunata, L. (Steganolophia prunata, L.)–iii, 232.
,, dotata, L. (Electra spinachiata, Hw.)–iii, 240.
Pelurga comitata, L. (Larentia chenopodiata, L.)–iii, 212.
Eubolia cervinaria, W. V. (Larentia cervinata, W. V.)–iii, 211.
,, palumbaria, W. V. (Phasiane plumbata, F.)–iii, 210.
,, bipunctaria, W. V. (Larentia bipunctaria, F.)–iii, 212.
Drepana falcula, W. V. (Drepana falcataria, L.)–iv, 6.
Dicranura furcula, L. (Cerura furcula, L.)–ii, 17.
Petasia cassinea, F.–ii, 32.
Ptilodontis palpina, L.–ii, 28.
Thyatira derasa, L.–iii, 48.
Acronycta megacephala, W. V.–iii, 38.
Leucania conigera, W. V. (Mythimna conigera, W. V.)–ii, 151.
Nonagria fulva, Hb. (Leucania pygmina, Hw.)–iii, 78.
Xylophasia rurea, F.–ii, 177.
Mamestra persicariæ, L.–ii, 196.
Apamea gemina, Hb. (Hadena remissa, Hb.)–ii, 182.
,, oculea, L. (Apamea furca, Hw.)–iii, 11.
Miana fasciuncula, Hw.–iii, 15.
,, furuncula, W. V. (Miana humeralis, Hw.)–iii, 14.
,, arcuosa, Hw. (Acosmetia arcuosa, Hw.)–iii, 124.
Grammesia trilinea, W. V.–ii, 152.
Caradrina morpheus, Naturf. (Caradrina morpheus, Ochs.)–ii, 157.
Agrotis saucia, Hb. (Agrotis æqua, Hb.)–ii, 115.
,, corticea, W. V. (Agrotis corticea, Hb.)–ii, 114.
Triphæna interjecta, Hb.–ii, 106.
Noctua augur, F. (Graphiphora augur, F.)–ii, 131.
,, c-nigrum, L. (Graphiphora c-nigrum, L.)–ii, 136.
,, triangulum, Ochs. (Graphiphora triangulum, Hfn.)–ii, 133.
,, festiva, W. V. (Graphiphora festiva, W. V.)–ii, 135.
Trachea piniperda, Esp. (Achatia piniperda, Kob.)–iii, 20. "April, 1810. The first British specimen."
Tæniocampa gracilis, W. V. (Orthosia sparsa, Hw.)–ii, 142.
Orthosia ypsilon, W. V. (Orthosia upsilon, W. V.)–ii, 149.
,, lota, L.–ii, 148.
,, macilenta, Hb. (Orthosia macilenta, Hw.)–ii, 148.
Anchocelis rufina, L. (Xanthia rufina, L.)–iii, 68.

Anchocelis lunosa, Hw. (Orthosia lunosa, Hw.)–ii, 147.
,, litura, L. (Orthosia litura, L.)–ii, 146.
Cerastis vaccinii, L. (Glæa vaccinii, L.)–ii, 162.
Hoporina croceago, W. V. (Xanthia croceago, Hw.)–iii, 68.
Tethea retusa, L.–iii, 57.
Cosmia diffinis, L.–iii, 61.
,, affinis, L.–iii, 61.
Hecatera dysodea, W. V. (Polia dysodea, W. V.)–iii, 32.
Polia flavicincta, L. (Polia flavocincta, W. V.)–iii, 32.
Epunda viminalis F. (Bombycia viminalis, F.)–iii, 58.
Agriopis aprilina, L. (Miselia aprilina, L.)–iii, 25.
Hadena protea, Hb. (Polia seladonia, Hw.)–iii, 33.
,, genistæ, Bkh.–ii, 184.
Xylina rhizolitha, W. V. (Xylina rhizolitha, Hb.)–ii, 170.
Cucullia verbasci, L.–iii, 86.
Heliodes arbuti, F. (Anarta heliaca, W. V.)–iii, 112.
Acontia luctuosa, W. V. (Acontia luctuosa, Hb.)–iii, 113.
Brephos parthenias, L.–iii, 137.
Abrostola triplasia, L.–iii, 97.
Plusia iota, L. (Plusia percontationis, Ochs.)–iii, 102.
Amphipyra tragopogonis, L. (Pyrophila tragopogonis, L.)–ii, 165.
Phytometra ænea, W. V.–iii, 121.
Hypena proboscoidalis, L.–iv, 11.
Herminia barbalis, L. (Pechipogon barbalis, L.)–iv, 15.
Pyralis fimbrialis, W. V. (Hypopygia costalis, F.)–iv, 27.
,, glaucinalis, L.–iv, 26.
Aglossa cuprealis, Hb.–iv, 24.
Pyrausta purpuralis, L.–iv, 35.
Herbula cespitalis, W. V. (Pyrausta cespitalis, F.)–iv, 34.
Botys fuscalis, W. V. (Margaritia fuscalis, W. V.)–iv, 56.
Ebulea crocealis, Tr. (Margaritia ochrealis, F.)–iv, 53.
,, verbascalis, W. V. (Margaritia verbascalis, W. V.)–iv, 54.
Scopula lutealis, Hw. (Margaritia institalis, St.)–iv, 57.
Crambus perlellus, Sc. (Crambus argyreus, F.)–iv, 318.
,, geniculeus, Hw. (Crambus inquinatellus, W. V.)–iv, 327.
,, chrysonuchellus, Sc.–iv, 326.
Ilythyrea carnella, L. (Oncocera carnella, L.)–iv, 314.
Myelophila cribrella, Hb. (Oncocera cardui, Hw.)–iv, 314.
Tortrix xylosteana, L. (Loxotænia xylosteana, L.)–iv, 77.
,, sorbiana, Hb. (Loxotænia sorbiana, Hb.)–iv, 71.
Dictyopteryx holmiana, L. (Loxotænia holmiana, L.)–iv, 81.
Ptycholoma lecheana, L.–iv, 142.
Antithesia salicana, L. (Antithesia salicella, L.)–iv, 90.
Aspis udmanniana, L. (Notocelia udmanniana, L.)–iv, 138.
Sericoris lacunana, W. V. (Sericoris obsoletana, St.)–iv, 133.
Hypermecia augustana, Hb. (Loxotænia cruciana, L.)–iv, 80.
Pædisca profundana, W. V. (Ditula wellensiana, Hb.)–iv, 85.
Ephippiphora nigricostana, Hw. (Spilonota nigricostana, Hw.)–iv, 96.
Coccyx strobilana, L. (Pseudotomia strobilella, L.)–iv, 99.
,, argyrana, Hb. (Pseudotomia atromargana, Hw.)–iv, 99.

Dicrorampha alpinana, Tr. (Pseudotomia strigana, F.)–iv, 101.
Catoptria ulicetana, Hw. (Pseudotomia aurana, F.)–iv, 105.
,, hohenwarthiana, W. V. (Carpocapsa lanceolana, Hb.)–iv, 121.
Trycheris mediana, W. V. (Carpocapsa cana, Hw.)–iv, 123.
Xylopoda pariana, L. (Simæthis pariana, L.)–iv, 29.
Xanthosetia zœgana, L.–iv, 191.
Chrosis tesserana, W. V. (Argyrolepia tesserana, W. V.)–iv, 177.
Conchylis smeathmanniana, F. (Loxopera smeathmanniana, F.)–iv, 189.
Tortricodes hyemana, Hb. (Oporinia tortricella, Hb.)–iv, 234.
Exapate gelatella, L. (Oxypate gelatella, L.)–iv, 235. "Abundant in All Saints' Churchyard, Hertford, 27th Dec. 1822."
Epigraphia steinkellneriana, W. V. (Semioscopis steinkellnerana, F.)–iv, 239.
Talæporia pseudo-bombycella, Ochs. (Cochleophasia tessella, Hw.)–iv, 233.
Psyche pullella, Br. (Fumea muscella, F.)–ii, 82.
Phygas birdella, Curt. (Lepidocera birdella, Curt.)–iv, 350.
,, vaculella, F. R. (Lepidocera chenopodiella, Hb.)–iv, 351.
Micropteryx allionella, F. (Lampronia ammanella, Hb.)–iv, 362.
Nemophora schwartziella, Z. (Adela panzerella, F.)–iv, 232.
,, metaxella, Hb. (Adela robertella, L.)–iv, 232.
Swammerdamia pyrella, Vill. (Telea cæsiella, Hb.)–iv, 247.
Hyponomeuta plumbella, W. V. (Yponomeuta plumbella, F.)–iv, 244.
,, evonymella, L. (Yponomeuta evonymella, L.)–iv, 242.
Pepilla curtisella, Don. (Telea curtisella, Don.)–iv, 245.
Hypolepia radiatella, Don. (Chætochilus fissellus, Hb.)–iv, 238.
Depressaria arenella, W. V. (Depressaria gilvella, Hb.)–iv, 200.
,, vaccinella, Hb. (Depressaria purpurea, Hw.)–iv, 204.
,, yeatiana, F. (Depressaria yeatsana, F.)–iv, 200.
,, badiella, Hb.–iv, 199.
Gelechia cinerella, L. (Anacampsis cinerella, L.)–iv, 207.
,, scriptella, Hb. (Anacampsis tremella, W. V.)–iv, 215.
,, leucatella, L. (Telea leucatella, L.)–iv, 246.
Chelaria conscriptella, Hb. (Chelaria rhomboidella, L.)–iv, 220.
Dasycera oliviella, F. (Œcophora oliviella, F.)–iv, 228.
Œcophora lunaris, Hw. (Batia lunaris, Hw.)–iv, 291.
Röslerstammia erxlebenella, F. (Callisto fusco-cuprella, Hw.)–iv, 278.
Glyphipteryx fischeriella, Z.? (Herbëia forsterella, Z.)–iv, 263; (Herbëia simpliciella, St.)–iv, 263.
Argyresthia mendica, Hw. (Ismene mendicella, Hb.)–iv, 248.
,, pygmæella, Hb. (Argyrosetia semifasciella, Hw.)–iv, 252.
,, brockeella, Hb. (Argyrosetia brockeella, Hb.)–iv, 253.
Gracilaria swederella, Thnb. (Gracillaria thunbergella, F.)–iv, 367.
Coleophora deauritella, L. (Metallosetia trifolii, St.)–iv, 284.
,, anatipennella, Hb. (Porrectaria anatipennella, Hb.)–iv, 285.
,, discordella, L. (Porrectaria gallipennella, Hb.)–iv, 286.
,, murinipennella, F. R. (Porrectaria leucapennella, Hb.)–iv, 287.
,, fuscedinella, Z. (Astygates obscurella, F.)–iv, 281.

Elachista rufocinerea, Hw. (Aphelosetia lucidella, St.)–iv, 289.
Pterophorus ochrodactylus, Hb. (Pterophorus pallidactylus, Hw.)–iv, 375.

Bengeo and Brickendon (near *Hertford*).

Syricthus alveolus, Hb. (Thymele alveolus, Hb.)–i, 98.

Royston.

Heliophobus popularis, F.–ii, 190.

Rye House.

Mania maura, L. (Mormo maura, L.)–iii, 326.

II.

Lepidoptera recorded as occurring in Hertfordshire in 'An Illustrated Natural History of British Butterflies,' by E. Newman, 1874.

Berkhamsted Common.

Nemeobius lucina, L.—G. H. Raynor.–105.
Hesperia comma, L.—G. H. Raynor.–173.

Elstree (*Woodcock Hill*).

Arge galathea, L. (Melanargia galathea)—F. Bond.–79.

Hertfordshire.

(No locality given.)

Colias edusa, F.–146.
Vanessa polychloros, L.—F. Bond.–58. "Many localities."
Satyrus tithonus, L. (Epinephile tithonus).–94.

III.

Lepidoptera recorded as occurring in Hertfordshire by various writers in the 'Entomologist,' vol. i, 1841-42; vol. ii, 1864-65, to vol. xix, 1887.

Ashridge Common (near *Tring*).

Vanessa antiopa, L.—Rev. H. Harpur Crewe.–vi, 216. (1872.)

Baldock.

Sphinx convolvuli, L.—J. H. Durrant.–xvi, 235.

Berkhamsted.

Scoria dealbata, L.—C. L. Raynor.–v, 264.

Brickendon (near *Hertford*).

Vanessa antiopa, L.—W. Summers.–vi, 216. (One 12th Sept. 1872; another 16th Sept. 1872.)

Cheshunt.

Nepticula centifoliella, L.—W. C. Boyd.–iii, 187.

Farnham (near *Bishop's Stortford*).

Anticlea sinuata, W. V.—A. J. Spiller.–x, 48. (27th July, 1876.)

Haileybury (near *Hertford*).

Odonestis potatoria, L. (var.)—R. W. Bowyer.–xiii, 310.
Catocala fraxini, L.—R. W. Bowyer.–xx, 306.

Hertford.

Smerinthus populi, L.—W. Simmons.–vi, 316.

Hitchin.

Colias edusa, F.—J. Grubb.–viii, 270.
,, hyale, L.—J. Grubb.–viii, 270.
Vanessa cardui, L. (var.)—J. H. Barclay.–xviii, 24. (Erroneously recorded as *huntera*, xvii, 141; corrected, to *Pyrameis cardui*, l.c.)
Sphinx convolvuli, L.—J. H. Durrant.–xvi, 235.

Hoddesdon.

Lycæna argiolus, L.—W. L. Horley.–v, 113.
Vanessa antiopa, L.—W. L. Horley.–vi, 216. (1872.)

Knebworth.

Colias edusa, F.—B. Brown.–x, 189.
Mamestra persicariæ, L.—B. Brown.–ix, 279. (Erroneously recorded as *Valeria oleagina*, viii, 164; corrected, l.c.)

Lilley.

Acherontia atropos, L.—Rev. P. H. Jennings.–ii, 325.

Stanstead.

Vanessa antiopa, L.—W. L. Horley.–vi, 216. (1872.)

Totteridge.

Dicranura vinula, L.—S. C. Curtis.–xi, 252.

Watton-at-Stone.

Smerinthus ocellatus, L.—H. Hodges.–vii, 233.

Ware.

Colias edusa, F.—H. Tite.–xviii, 241.

IV.

Lepidoptera recorded as occurring in Hertfordshire by various writers in the 'Entomologists' Annual,' vol. i, 1855, to vol. xx, 1874.

Cheshunt.

Ebulea catalaunalis, Dp.—W. C. Boyd, 1868.–108–9, f. 4. (18th Sept. 1867. New to Britain.)
Nepticula minusculella, Hs.—H. T. Stainton, 1870.–159. (W. C. Boyd, Aug. 1868. New to Britain.)
,, centifoliella, Z.—H. T. Stainton, 1867.–163; 1870.–18. (W. C. Boyd, April, 1866. New to Britain.)

St. Albans.

Cerastis erythrocephala, W. V. (Glæa erythrocephala).—H. G. Knaggs, 1866.–139.

Tring.

*Notodonta cucullina, W. V. (Lophopteryx cucullina).—Rev. I. Greene, 1857.–114. (54 larvæ.)

*Eupithecia campanulata, H.S.—Rev. H. H. Crewe, 1866.–157.

V.

Lepidoptera recorded as occurring in Hertfordshire by various writers in the 'Entomologists' Weekly Intelligencer,' vol. i, 1856, to vol. x, 1861.

Cheshunt.

Sphinx convolvuli, L.—W. C. Boyd (communicated by A. Gaviller). –vii, 3.

Deilephila galii, L.—W. C. Boyd (communicated by A. Gaviller).– vii, 3.

Letchworth (near *Hitchin*).

Arge galathea, L.—Rev. F. H. Knapp.–ii, 155.

Lycæna corydon, F. (Polyommatus corydon).—Rev. F. H. Knapp.– ii, 155.

Lycæna alsus, F. (Polyommatus alsus).—Rev. F. H. Knapp.–ii, 155.

Chærocampa elpenor, L.—Rev. F. H. Knapp.–ii, 155.

VI.

Lepidoptera recorded as occurring in Hertfordshire by various writers in the 'Entomologists' Monthly Magazine,' vol. i, 1864, to vol. xxiv, 1887.

Cheshunt.

Deilephila lineata, F.—W. C. Boyd.–v, 147. (Captured 25th Aug. 1868.)

Nyssia hispidaria, W. V.—W. C. Boyd.–xvii, 48.

Ebulea catalaunalis, Dup.—W. C. Boyd.–iv, 152. (18th Sept. 1867. New to Britain.)

Stenopteryx hybridalis, Hb.—W. C. Boyd.–iv, 286.

Accentropus niveus, Oliv.—W. C. Boyd.–v, 147.

Meliphora alveariella, Gn. (Achrœa grisella)—W. C. Boyd.–v, 147.

Hyponomenta vigintipunctella, Retz.—W. C. Boyd.–v, 147.

Depressaria capreolella, Z.—W. C. Boyd.–v, 147.

,, pastinacella, Dup.—W. C. Boyd.–v, 147.

Gelechia rhombella, Hb.—W. C. Boyd.–v, 147.

,, lutulentella, Z.—W. C. Boyd.–xiii, 187.

Coleophora argentula, Z.—W. C. Boyd.–v, 147.

Laverna decorella, St.—W. C. Boyd.–v, 147.

,, langiella, Hb.—W. C. Boyd.–xxi, 111.

* The locality "Tring" is given for these species, but it is possible that they may not have been taken in Herts.—J.H.D.

Phyllocnistis suffusella, Z.—W. C. Boyd.–v, 147.
,, salignella, Z.—(Phyllocnistis saligna) W. C. Boyd.–v, 147.
Nepticula centifoliella, Z.—W. C. Boyd.–iii, 115 ; v, 147. (New to Britain.)
,, minusculella, H. S.—W. C. Boyd.–v, 280. (New to Britain.)

Hemel Hempstead.

Thecla w-album, Illig.—B. Piffard.–xviii, 68. "In thousands."
Chœrocampa nerii, L.—B. Piffard.–xiii, 138. "15th Oct. 1876, in a garden in the Alma Road; now in the collection of G. T. Porritt, Esq., of Leeds."

Hitchin.

Vanessa antiopa, L.—F. Latchmore.–ix, 107. (One seen 24th Aug. 1872, another 28th Aug. 1872—*neither captured.*)

Sandridge (near St. Albans).

Dichrorampha acuminatana, L.—A. F. Griffith.–xxii, 65.
Trifurcula pallidella, L.—A. F. Griffith.–xxii, 65. "Two specimens taken." H. T. Stainton.–xxii, 263.

Tring.

*Eupithecia campanulata, H. S.—Rev. H. H. Crewe.–ii, 93.

Watford.

Sphinx convolvuli, L.—A. Cottam.–xii, 139.

VII.

Lepidoptera recorded as occurring in Hertfordshire by various writers in the 'Transactions of the Watford Natural History Society and Hertfordshire Field Club,' vols. i–ii, 1875–80.

Berkhamsted Common.

Nemeobius lucina, L.—Rev. C. M. Perkins.–ii, 72.
Hesperia comma, L. (Pamphila comma).—Rev. C. M. Perkins.–ii, 75.

Bricket Wood.

Chortobius pamphilus, L. (Cœnonympha pamphilus).—Rev. C. M. Perkins.–ii, 68.
Thecla rubi, L.—Rev. C. M. Perkins.–ii, 73.
,, quercus, L.—Rev. C. M. Perkins.–ii, 72.
Polyommatus phlæas, L. (Cœnonympha phlæas).—Rev. C. M. Perkins.–ii, 73.
Lycæna agestis, W. V. (Polyommatus agestis).—Rev. C. M. Perkins.–ii, 74.
Syricthus alveolus, Hb. (Thymele alveolus).—Rev. C. M. Perkins.–ii, 74.

Bushey.

Colias edusa, F.—A. Cottam.–i, 239.

* See note on preceding page.—J.H.D.

Childwick (near *St. Albans*).

Satyrus semele, L. (Hipparchia semele).—Rev. C. M. Perkins.–ii, 68.

Harpenden.

Pieris rapæ, L.—J. Hopkinson.–ii, 233.

Hemel Hempstead.

Chærocampa nerii, L.—C. E. Fry.–i, 174. (Captured 13th Oct. 1876.)

Hertford.

Pieris rapæ, L.—J. Hopkinson.–ii, 233.

Hitchin.

Sphinx convolvuli, L.—A. Cottam.–i, 108.

Hoddesdon.

Vanessa antiopa, L.—A. Cottam.–ii, xix. (Several in 1875.)

St. Albans.

Colias edusa, F.—A. Cottam.–i, 240. Rev. C. M. Perkins.–ii, 66.
,, ,, var. ♀ helice, Hb.—Rev. C. M. Perkins.–ii, 66.
,, ,, hyale, L.—Rev. C. M. Perkins.–ii, 66.
Vanessa antiopa, L.—Rev. C. M. Perkins.–ii, 70. (12th Sept. 1855.)
Argynnis paphia, L.—Rev. C. M. Perkins.–ii, 71.

Ware.

Pieris rapæ, L.—J. Hopkinson.–ii, 39.

Watford.

Pieris brassicæ, L.—J. Hopkinson.–ii, 39, 233.
Pieris rapæ, L.—J. Hopkinson.–ii, 233.
Arge galathea, L.—Rev. C. M. Perkins.–ii, 67.
Acherontia atropos, L.—J. H. James.–i, 64.
Sphinx convolvuli, L.—A. Cottam.–i, 108.
Cossus ligniperda, F.—J. H. James.–i, 64, 135.

East Herts.

Vanessa antiopa, L.—S. Humbert.–ii, xix.

VIII.

Lepidoptera recorded as occurring in Hertfordshire by various writers in the 'Transactions of the Hertfordshire Natural History Society and Field Club' (a continuation of the 'Transactions of the Watford Natural History Society'), vol. i, 1880–82, to vol. iv, 1886–88.

Aldbury.

Depressaria arenella, W. V.—A. E. Gibbs.–iv, 1.
Dasycera sulphurella, F.—A. E. Gibbs.–iv, 1.
Elachista cygnipennella, Hb.—A. E. Gibbs.–iv, 1.

Bedmond.

Cossus ligniperda, F.—F. W. Silvester.–iv, 49.

Berkhamsted Common.

Vanessa io, L.—A. E. Gibbs.–iv, 1.
Stigmonota internana, Gn.—A. E. Gibbs.–iv, 1.
Catoptria ulicetana, Hw. (Grapholitha ulicetana)—A. E. Gibbs.–iv, 1.

Buntingford (Great Hormead).

Pieris brassicæ, L.—E. A. Ormerod.–ii, 80.
,, rapæ, L.—E. A. Ormerod.–ii, 80.

Bushey.

Pieris brassicæ, L.—E. A. Ormerod.–ii, 80.
,, rapæ, L.—E. A. Ormerod.–ii, 80.

Croxley.

Pieris brassicæ, L.—F. W. Silvester.–iv, 49.
,, rapæ, L.—F. W. Silvester.–iv, 49.

Harpenden.

Pieris brassicæ, L.—J. Hopkinson.–i, 137, 260. E. A. Ormerod.–ii, 80, 188. J. J. Willis.–ii, 242. F. W. Silvester.–iii, 91, 92, 233; iv, 49.
,, rapæ, L.—E. A. Ormerod.–ii, 80, 188. F. W. Silvester.–iii, 91, 233; iv, 49, 201.
Anthocharis cardamines, L.—F. W. Silvester.–iii, 233; iv, 49, 201.
Ephinephile janira, L.—J. Hopkinson.–i, 137. F. W. Silvester.–iii. 92, 233; iv, 49.
*Nudaria mundana, L.—J. Hopkinson.–i, 138. J. J. Willis.–i, xvii.
Abraxas grossulariata, L.—J. J. Willis.–ii, 241.
Mamestra brassicæ, L.—J. J. Willis.–ii, 242.
Agrotis segetum, W. V. (Agrotes segetum)—J. J. Willis.–ii, 242.
Plusia gamma, L.—J. J. Willis.–ii, 242.

Hertford.

Pieris brassicæ, L.—E. A. Ormerod.–ii, 80. F. W. Silvester.–iii, 91, 233; iv, 49, 201.
,, rapæ, L.—E. A. Ormerod.–ii, 80, 188. F. W. Silvester.–iii, 91, 233; iv, 49.
Anthocharis cardamines, L.—F. W. Silvester.–iv, 49.
Vanessa io, L.—E. A. Ormerod.–ii, 80.
Ephinephile janira, L.—J. Hopkinson.–i, 137, 260. E. A. Ormerod.–ii, 80, 188. F. W. Silvester.–iii, 91; iv, 49.

Hitchin.

Pieris brassicæ, L.—F. W. Silvester.–iii, 91, 233.
,, rapæ, L.—F. W. Silvester.–iii, 91, 233.
Anthocharis cardamines, L.—F. W. Silvester.–iii, 91, 233.
Ephinephile janira, L.—F. W. Silvester.–iii, 91, 233.
Hecatera dysodea, Hb.—J. H. Durrant.–iv, xxxii.
Sciaphila nubilana, Hb.—J. H. Durrant.–iv, xxxii.
Coccyx nanana, Tr.—J. H. Durrant.–iv, xxxii.

* I, 269.—*Nudaria mundana*?—I can find no reason why the "?" is inserted.

Dicrororampha politana, W.V. (Dichrorampha politana)—J. H. Durrant.–iv, xxxii.
Catoptria hohenwarthiana, W.V.—J. H. Durrant.–iv, xxxii.
Conchylis subbaumanniana, Wilk.—J. H. Durrant.–iv, xxxii.
Pepilla curtisella, Don. (Prays curtisellus)—J. H. Durrant.–iv, xxxii.
Gelechia terrella, W.V.—J. H. Durrant.–iv, xxxii.
,, domestica, Hw.—J. H. Durrant.-iv, xxxii.

See also "Lepidoptera observed in the neighbourhood of Hitchin." J. H. Durrant.–iii, 261–265. (405 species.)*

Knebworth.

Agrotis segetum, W.V.—E. A. Ormerod.–ii, 82.
Plusia gamma, L.—E. A. Ormerod.–ii, 81.

See also "Lepidoptera observed at Knebworth." J. H. Durrant.–iii, 265. (22 species.)

Odsey.

Pieris rapæ, L.—J. Hopkinson.–i, 137.

Redbourn Bury (near *St. Albans*).

Pieris brassicæ, L.—E. A. Ormerod.–ii, 80.

Royston.

Pieris brassicæ, L.—F. W. Silvester.–iii, 91, 233.
,, rapæ, L.—F. W. Silvester.–iii, 91, 233.

St. Albans.

Pieris brassicæ, L.—E. A. Ormerod.–ii, 80.
,, rapæ, L.—J. Hopkinson.–i, 260. E. A. Ormerod.–ii, 80, 188.
Epinephile janira, L.—J. Hopkinson.–i, 137.
Galleria cerella, Gn. (Galleria cereana)—F. W. Silvester.–iii, 94.
Carpocapsa pomonana, Q. (Tortrix pomonana)—F. W. Silvester.–iv, 50.

Sandridge.

See "List of Lepidoptera (exclusive of the Tineina) observed in

* Some notes by Mr. Griffith (iii, 266) call for remark on my part.

Sesia formiciformis, Esp.—On the 16th July, 1883, Mr. Wilfred Christian took a pair of this insect on the trunk of a willow tree at Norton Mill, Baldock. I saw them the next day, while still soft and unset, and have since re-examined them, and find my identification to be correct.

Toxocampa pastinum, Tr.—A single specimen was taken at Burleigh Heath, Knebworth, in 1881, by Mr. Benj. Brown, formerly of Deard's End Farm. Mr. Wm. Hill, of Hitchin, witnessed its capture and writes to me as follows:—"I was walking with Brown on Burleigh Heath, outside Knebworth Wood, working for Greasy Fritillaries, a moth got up from a small wet ditch which Brown captured after a chase—this was the Black-neck. The ground here was wet and marshy." Mr. Brown also writes to the same effect. I have not myself seen this specimen, but *Toxocampa pastinum* is so unlike any other species which occurs in this country that I fail to see why this species should not be admitted as a "distinguished member of our county list."

Mr. Griffith is right in considering *Melitæa artemis* and *Erastria fuscula* as new to our county fauna, but *Calligenia miniata* was recorded from Hertford by J. F. Stephens. (See *ante*, p. 64.)

the neighbourhood of Sandridge, Herts." A. F. Griffith and F. Ll. Griffith.–iii, 62–66. (514 species.)

Sawbridgeworth (High Wych).

Pieris brassicæ, L.—E. A. Ormerod.–ii, 188.

Throcking.

Pieris rapæ, L.—E. A. Ormerod.–ii, 80.
Gonepteryx rhamni, L.—E. A. Ormerod.–ii, 80.

Tring (Woods near Ashridge House).

Argynnis euphrosyne, L.—A. E. Gibbs.–iv, 1.
Panagra petraria, Hb.—A. E. Gibbs.–iv, 1.
Melanippe rivata, Hb.—A. E. Gibbs.–iv, 1.
,, fluctuata, L.—A. E. Gibbs.–iv, 1.
Platypteryx unguicula, Hb.—A. E. Gibbs.–iv, 1.

Tring (Moneybury Hill).

Lycæna alexis, Hb. (Polyommatus alexis)—A. E. Gibbs.–iv, 1.
Thanaos tages, L. (Hesperia tages)—A. E. Gibbs.–iv, 1.
Pygæra bucephala, L.—A. E. Gibbs.–iv, 1.
Crambus pratellus, Cl.—A. E. Gibbs.–iv, 1.

Ware.

Pieris rapæ, L.—J. Hopkinson.–i, 137. E. A. Ormerod.–ii, 80, 188. F. W. Silvester.–iv, 49.

Watford.

Pieris brassicæ, L.—J. Hopkinson.–i, 137, 260. E. A. Ormerod.–ii, 80. F. W. Silvester.–iii, 91, 233; iv, 49, 201.
,, rapæ, L.—J. Hopkinson.–i, 137, 260. E. A. Ormerod.–ii, 80, 188. F. W. Silvester.–iii, 91, 233; iv, 49, 201.
Epinephile janira, L.—E. A. Ormerod.–ii, 188. F. W. Silvester.–iv, 201.
Pygæra bucephala, L.—F. W. Silvester.–iii, 235; iv, 49.
Carpocapsa pomonana, L. (Tortrix pomonana)—F. W. Silvester.–iv, 50.

VII.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE IN 1887, AND ON THE BIRDS FREQUENTING THE TRING RESERVOIRS.

By the late John E. Littleboy.*

Read at Watford, 20*th March*, 1888.

It is with much pleasure that I present my ornithological report for the year 1887. Never before has it been my lot to lay before our Society a record of greater interest. Thanks to the assistance and information kindly afforded to me by the Hon. Walter Rothschild, I am able to add the names of 21 birds to our county list, and, by so doing, to increase our Hertfordshire avifauna to a total of 201 species. I am also enabled to present a special report on birds frequenting the Tring Reservoirs, which appears to me to be of considerable local value. With one exception, the whole of the birds new to our county are reported from the Tring district, and they are principally from the neighbourhood of the reservoirs. I think, therefore, that it will be desirable to preface my report by giving a few particulars respecting that locality.

Mr. A. M. Brown, of Tring, has been good enough to supply me with the following information:—"The Tring reservoirs are four in number, and, with the exception of about 10 acres, are all included in the parish of Tring. A group of three—Tring Ford, Marsworth, and Startop's End Reservoirs—comprising a water-area of 87 acres, are situated near the village of Marsworth; they are the property of the Grand Junction Canal Company, but all sporting rights are reserved to the owner of the Tring Park Estate. The fourth, Wilstone Reservoir, formerly divided into three, is now merged into one, and comprises about 120 acres. It is about a mile and a half distant from the others. They are all situated on the Chalk Marl, near to its junction with the Upper Greensand, and are overlooked by the low escarpment of Totternhoe Stone which runs at the base of the main Chalk escarpment stretching from Wendover to Dunstable. They occur at an average elevation of 350 feet above sea-level, being about 70 feet below the summit of the London and North-Western Railway at the Tring cutting." I think that the position of these reservoirs, placed, as they are, immediately at the foot of the Chilterns, their considerable extent, and the high level at which they occur, may be considered to account for the large number of birds which have been found to frequent them.

In accordance with my usual custom, I will now refer to our new species *seriatim*.

1. The Marsh-Warbler (*Acrocephalus palustris*).—A marsh-warbler was shot near the Marsworth Reservoir in August, 1883,

* This paper possesses a melancholy interest. It was read by its author when apparently in perfect health. The proof was sent to him in June; but, owing to his illness, which terminated fatally on the 3rd of August, he has not read it. The paper therefore appears without having had the benefit of his revision.—Ed.

and is now in the Tring Park collection. It is a rare summer visitor to the south of England; Mr. Harting has only recorded six occurrences, but it is probable that it may have frequently been mistaken for its congener, the reed-warbler. These two birds are very similar in general appearance, but are readily distinguished by their song and the different character of their nests and eggs. The marsh-warbler winters in Africa, and is a regular summer visitor to mid-Europe.

2. The Water-Pipit (*Anthus Spipoletta*).—Two specimens of the water-pipit were shot on the water-cress beds, near Berkhamsted, in 1886, and are preserved in the Tring Park collection. This species is believed to be an occasional spring or autumn visitor to Great Britain, but its occurrence has been so seldom recorded that it is hardly possible to speak of it with much certainty.

3. The Bearded Tit (*Panurus biarmicus*).—The late Rev. James Williams, of Tring Park, records the occurrence of the bearded tit in the following words*:—"On the 21st of December, 1848, a pair of these beautiful little birds were shot in the neighbourhood of the reservoirs. Owing to the unusual quantity of rain which fell during the latter part of last summer, the reeds, which have generally been cut every autumn, remained uncut, and this will no doubt account in some measure for the appearance of my little friends." I may add that Mr. William Lucas, of Hitchin, records a similar occurrence as having taken place near that town, in the same month, as follows†:—"I think there is a small flock of bearded tits in a bed of reeds on the banks of the Orton. A pair allowed me to approach almost close to them." The bearded tit is yearly becoming more and more scarce. It is emphatically a "bird of the reeds," and, like other species which it would be easy to mention, is constantly driven from its favourite haunts by the civilising influence of drainage and progressive agriculture. It still breeds on the Norfolk and Suffolk broads. It is resident in our island, and in winter small flocks frequently fly far away from their breeding-ground in search of food.

4. The Short-toed Lark (*Calandrella brachydactyla*).—On the 9th of March, 1886, a short-toed lark was shot in Tring Park, quite accidentally, by Mr. Rothschild. He was endeavouring to procure food for a tame owl, shot at a small bird, and was unconscious of the prize he had secured until he picked it up. It has been identified by Mr. Bowdler Sharp, of the British Museum, and has been kindly entrusted to me for exhibition here. The short-toed lark has only been recorded in England about half a dozen times, and generally in the autumn. It frequents the vast steppes of eastern Europe, and appears, like several other species, to migrate westwards across Europe and southwards towards the Mediterranean, occasionally detaching a few stragglers on the south-eastern shores of England.

5.—The Bar-tailed Godwit (*Limosa lapponica*).—A bar-tailed godwit was shot by the keeper on the reservoirs in December, 1880.

* 'Zoologist,' 1849, p. 2418. † *Ib.*, p. 2346.

It belongs to the large class of waders which visit our shores on migration. It is most abundant in spring and autumn, but is occasionally taken in the winter. It has never been known to breed in Great Britain.

6. The Black-tailed Godwit (*Limosa Ægocephala*).—A black-tailed godwit was taken on the reservoirs in September, 1886. This handsome bird is nearly allied to the species last mentioned, but is less abundant. Like its congener, it is a spring and autumn migrant, but differs from it in having occasionally nested in the eastern counties. Two hundred years ago Sir Thomas Browne wrote of it as follows :—"Godwits are taken chiefly on marsh land, they are accounted the daintiest dish in England."

7. The Wood-Sandpiper (*Totanus Glareola*).—A wood-sandpiper was shot in the same locality in August, 1886. This elegant little bird must also be recorded as a spring and autumn migrant, although, on one occasion, it has been known to nest in Northumberland. Its English name appears to be a misnomer; it does not frequent woodland districts, its favourite haunts being* wide open moors, where little ponds of water are to be found, half concealed in willow bushes.

8. The Marsh-Sandpiper (*Totanus stagnatilis*).—The occurrence of the marsh-sandpiper is an event not only of local but of national interest. Respecting it, Mr. Rothschild writes to me as follows :—"Last October [1887] I shot a bird which I took to be an immature or winter-plumaged greenshank, but I since find that it is a specimen of the marsh-sandpiper. It is not only the first killed in this county, but the first killed in Great Britain." The marsh-sandpiper, writes Dr. Bree,† inhabits the north of Europe, migrating along the rivers which flow eastward and south, more especially those that empty themselves into the Black and Caspian Seas. It comes irregularly and rarely into France and Italy, but more frequently into Greece. Lord Lilford states‡ that it is abundant in March, April, and the early part of May, on the racecourse at Corfu. Its habits closely resemble those of the green sandpiper, but it is less shy and not so clamorous. [The bird was shot near the reservoirs.—Ed.]

9. The Sanderling (*Calidris arenaria*).—The sanderling is reported to be fairly common on the reservoirs, during the period of its spring and autumn migrations. It is to be met with during the winter on most of our coasts; it is a shore-bird; it loves a sandy beach, and at low water greedily devours the minute shellfish and crustacea generally to be found in such localities. Its eggs have only been obtained very occasionally, but it is believed to breed on the shores of the Arctic Ocean and in Iceland.

10. Temminck's Stint (*Tringa Temmincki*).—A Temminck's stint was shot on the reservoirs in September, 1887. It is preserved in Mr. Rothschild's collection. This somewhat rare bird is the smallest of our British sandpipers. It visits our shores in spring and autumn, on its migration to and from its breeding-grounds in the far north.

* Seebohm, 'British Birds,' vol. iii, p. 133.

† 'Birds of Europe,' vol. iv, p. 62. ‡ *Ib.*, vol. ii, p. 344.

"It is essentially* an arctic bird, breeding in the old-world portion of the circumpolar region, on tundras above the limit of forest growth."

11. THE LITTLE STINT (*Tringa minuta*).—Two "little" stints were shot on the reservoirs in August, 1885, and are preserved at Tring Park. Like the species last described, the little stint visits us only on migration, but it is more frequently met with than its congener. I am pleased to record the occurrence of this interesting little sandpiper, not only as an important addition to the birds of our county, but as intimately associated with the name of a gentleman who has acceptably addressed our members on two occasions. To my friend, Mr. Henry Seebohm, and his companion, Mr. Harvie Brown, belongs the honour of having first discovered the breeding-grounds of the little stint. Having followed the course of the River Petchora to its mouth, they landed at Dvornik and invaded the vast prairies which border the Arctic Ocean. At a spot almost due south of the island of Nova Zembla their exertions were rewarded. "On a comparatively dry extent of tundra, sloping towards the north-east," both nests and eggs were discovered. Young birds in down were also obtained, and are at present exhibited at South Kensington.

12. THE GREAT SNIPE (*Gallinago major*).—In August, 1880, a purely white specimen of the great snipe was shot near the reservoirs. The great snipe is an occasional autumnal visitor to Britain. It has frequently been taken on the eastern coast, but is extremely rare in the Midland Counties. I cannot find any record of a white specimen having been previously obtained, and I think that it must be regarded as a sport of nature.

13. THE GREY PLOVER (*Squatarola helvetica*).—A grey plover was shot near the reservoirs in March, 1885. The grey plover occurs more or less frequently, chiefly during its autumnal migration, on the coasts of the British Isles, and is occasionally taken in the inland counties. It breeds in Northern Siberia, and its eggs were secured by Mr. Seebohm in the same district as those of the little stint.

14. THE LITTLE CRAKE (*Porzana parva*).—A "little" crake was shot near the Marsworth Reservoir on the 5th of January, 1887. The little crake, like so many of the waders, is a spring and autumn visitant to Britain, but, writes Mr. Seebohm,† "it is not impossible that some may remain to breed and others occasionally to winter."

15. THE ARCTIC TERN (*Sterna macrura*).—In the spring of 1886 an Arctic tern was shot on the reservoirs by the keeper, James Street. The Arctic tern is by no means uncommon. It is a summer migrant, and breeds abundantly in the Shetlands, the Orkneys, the Farne Islands, and on many parts of our coast. It was formerly confounded with the common tern, but it is, in fact, more abundant and more widely distributed than that species. It is distinguished from it by its red bill, and by the fact that its wings do not reach beyond its tail.

* Seebohm, 'British Birds,' vol. iii, p. 217. † *Ib.*, vol. iv, p. 549.

16. The Sandwich Tern (*Sterna cantiaca*).—Two Sandwich terns were shot near the reservoirs in October, 1886. The Sandwich tern, like the last species, is a summer migrant, but is not nearly so abundant inland. It breeds in countless thousands on the Farne Islands, and its eggs so closely resemble the pebbly beach on which they are deposited, that it is almost impossible to take a single step, on certain portions of the coast, without treading on them.

17. The Great Black-backed Gull (*Larus marinus*). — Mr. Rothschild has kept a few of these gulls pinioned on the reservoirs, and they have occasionally been visited by others of the same species. These visits have generally occurred towards the end of May, only two or three strangers having been observed at one time. The great black-backed gull is resident on our coasts, but in the breeding-season it is principally confined to the vicinity of rocky coasts and mountain lakes. It is the largest of our gulls. It is almost omnivorous in its habits; fish, flesh, or garbage of any description, appearing to be equally welcome. It runs riot among the eggs of terns, guillemots, and other coast birds, does not object to attack a weak lamb, and will swallow whole any young duck or wounded water-fowl that may come within its reach.

18. The Grey Lag Goose (*Anser cinereus*).—A grey lag goose was shot near the reservoirs in September, 1886. Although formerly common in the Fens, like other large wild fowl, it is constantly becoming scarcer. At present it has ceased to breed in any part of England, but it still nests in some of the wilder districts of Scotland. It is reported* that on a lake at Castle Coole in Ireland, Lord Belmore has more than a hundred of these geese, and that they never stray far from the lake.

19. The Polish Swan (*Cygnus immutabilis*).—A Polish swan was shot on the reservoirs, in August, 1885, two others in October, 1886, and on one occasion a flight of nine settled on the Marsworth and Wilstone waters and remained there for several days. Some difference of opinion exists among ornithologists as to the distinct character of this species. Mr. Dresser and Professor Newton admit it to specific distinction, but Mr. Seebohm hesitates to do so, and thinks that it "can only be regarded as a *quasi-albino*, produced by domestication." †

20. The Red-crested Pochard (*Fuligula rufina*). —A female specimen of this species was shot by Mr. Rothschild on the reservoirs, in September, 1887. The red-crested pochard or whistling duck is an important addition to our register. It is only an occasional visitor to England.

21. The Goosander (*Mergus Merganser*).—[Two of these birds were killed on the reservoirs in February, 1885.‡] The goosander is a tolerably common winter visitor to the British Isles, being fairly plentiful along the coasts of Norfolk, Suffolk, and Essex. It is a

* Yarrell, 'British Birds,' ed. 4, vol. iv, p. 257.

† 'British Birds,' vol. iii, p. 179.

‡ Information supplied from the author's register.—Ed.

circumpolar bird, breeding in Iceland and throughout Scandinavia. It is a wonderfully expert diver, and it is said that it can remain for two minutes under water.

The goosander completes my catalogue of birds new to our county. I will now direct attention to other occurrences of interest connected with the Tring district. Mr. Rothschild informs me that the following birds have been found to nest at or near the reservoirs:—

Reed-Warbler (*Acrocephalus streperus*).

Grey Wagtail (*Motacilla sulphurea*).—The nesting of the grey wagtail is worthy of special notice. It has always been regarded as a winter visitor, arriving in Herts about the beginning of October and leaving in February or March. The fact of its nesting at the reservoirs involves the conclusion that it occasionally becomes a resident in our county. The nest was discovered under an overhanging ledge; it was built upon the clay and well concealed behind grass, etc. The eggs are preserved.

Yellow Wagtail (*Motacilla Raii*).

Reed-Bunting (*Emberiza Schœniclus*).

Kingfisher (*Alcedo Ispida*).

Heron (*Ardea cinerea*).—Herons have occasionally nested in the fir-trees within Tring Park.

Bittern (*Botauris stellaris*).— Miss Williams, of Tring, has kindly written informing me that a bittern's nest, with four eggs, was taken on the reservoirs by her father, in July, 1849.

Woodcock (*Scolopax rusticola*).—In my last report I recorded three instances of the nesting of the woodcock, near Hoddesdon. I am glad to add that woodcocks have once or twice nested in Tring Park.

Ringed Plover (*Ægialitis Hiaticula*).—James Street, the keeper, appears to be quite certain that the ringed plover nests at the reservoirs. He has never been able to find the eggs, but he has frequently seen very young birds near the water.

Water-Rail (*Rallus aquaticus*).

Coot (*Fulica atra*).—About 200 pairs breed every year.

Black Tern (*Hydrochelidon nigra*).—It is confidently believed that the black tern nests somewhere in the district. The eggs have never been found, but about 20 pairs of birds remained throughout the summer, and a very young one was shot by Mr. Rothschild early in last August.

Crested Grebe (*Podiceps cristatus*).—This beautiful bird breeds abundantly. In 1884 there were 75 nests; in 1885, 45; in 1886, 43; and last April, when the keeper furnished me with this information, he stated that there were 115 birds then on the reservoirs.

Dabchick (*Podiceps minor*).

Teal (*Nettium crecca*).—A teal's nest, with five eggs, was found by James Street under a willow stump close to the reservoirs on the 25th of April, 1887. It is at present exhibited, together with the old birds, in a case at the South Kensington Museum.

Wild Duck (*Anas Boschas*).—From 100 to 150 nests every year.

Shoveller (*Spatula clypeata*).—Three to five nests every year. Eggs have been taken and are preserved.

Pochard (*Fuligula ferina*).—Fifty to eighty nests every year. In 1886 a female pochard paired with a tufted duck (*Fuligula cristata*), and reared a brood of nine young ducks, which in appearance were very like scaup. A female hybrid remained on the water till last May. The same birds again paired in 1887 and reared a second brood.

I will complete my notice of the birds of the reservoirs by selecting a few of the rarer species for record in our 'Transactions':—

Wheatear (*Saxicola Œnanthe*).—Fairly plentiful.

Ring-Ousel (*Turdus torquatus*).—Two shot in July, 1886, and one in October, 1886.

A hybrid between thrush and blackbird was shot 25th January, 1886.

Fire-Crest (*Regulus ignicapillus*).—One shot in January, 1887.

Wood-Warbler (*Phylloscopus sibilatrix*).

Garden-Warbler (*Sylvia hortensis*).

Red-backed Shrike (*Lanius collurio*).

Tree Pipit (*Anthus trivialis*).—Two killed 22nd May, 1886.

Meadow Pipit (*Anthus pratensis*).

Goldfinch (*Carduelis elegans*).—Fairly common.

Brambling (*Fringilla montifringilla*).—Generally common in winter.

Hawfinch (*Coccothraustes vulgaris*).

Lesser Redpoll (*Linota rufescens*).

Tree-Sparrow (*Passer montanus*).—One shot in August, 1886.

Common Bunting (*Emberiza miliaria*).

Cirl Bunting (*Emberiza cirlus*).—Two caught in November, 1885.

Waxwing (*Ampelis garrulus*).—One of these rare birds was obtained in March, 1883.

Great Spotted Woodpecker (*Dendrocopus major*).

Green Woodpecker (*Gecinus viridis*).—Frequent.

Night-jar (*Caprimulgus europæus*).—Occasionally.

Long-eared Owl (*Asio Otus*).—One taken in August, 1885; another in December, 1886.

Hen Harrier (*Circus cyaneus*).—Very rare; a female taken in December, 1884.

Merlin (*Falco Æsalon*).—Only once before have I had the pleasure of recording this beautiful little hawk. Two in immature plumage were taken in February, 1886, and two in mature plumage in January, 1887. All four were secured near the canal.

Osprey (*Pandion Haliaëtus*).—Two ospreys visited the reservoirs in the early part of September, 1886.

Bittern (*Botaurus stellaris*).—Two bitterns were shot on the reservoirs on 9th November, 1884.

Glossy Ibis (*Plegadis falcinellus*).—One of these rare waders was shot in October, 1886, just beyond the border of Hertfordshire in the direction of Wendover. I had the pleasure of recording it for the first time in 1881.

Curlew (*Numenius Arquata*).—One shot in August, 1884.

Greenshank (*Totanus canescens*).—Two shot in March, 1885.

Redshank (*Totanus Calidris*).—Two shot in March, 1885.

Green Sandpiper (*Helodromas ochropus*).—One shot in August, 1884, and two in March, 1885.

Dunlin (*Tringa alpina*).—Tolerably abundant in winter, and has also been taken, in full breeding plumage, in May and June.

Ruff (*Machetes pugnax*).—One shot in August, 1884. Two males killed at one shot in August, 1886.

Jack Snipe (*Limnocryptes gallinula*).—Fairly common.

Grey Phalarope (*Phalaropus fulicarius*).—One shot in October, 1885.

Golden Plover (*Charadrius pluvialis*).—Two shot in March, 1886.

Spotted Crake (*Porzana maruetta*).—One shot in September, 1883, and another in October, 1885.

Common Tern (*Sterna fluviatilis*).—One shot in February, 1885, and another in June, 1886.

Little Tern (*Sterna minuta*).—One shot in August, 1885, and two, at one shot, in April, 1886.

Kittiwake (*Rissa tridactyla*).—Two shot in January, 1885.

Black-headed Gull (*Larus ridibundus*).—One shot in August, 1884.

Lesser Black-backed Gull (*Larus fuscus*).—One shot in March, 1885.

Great Northern Diver (*Colymbus glacialis*).—One shot in November, 1885, and another in January, 1887.

Dusky Grebe (*Podiceps auritus*, var. *cornutus*).—Two shot in October, 1884.

Cormorant (*Phalacrocorax carbo*).—One shot in November, 1878.

Sheldrake (*Tadorna cornuta*).—One watched, for more than an hour, on 8th January, 1888.

Widgeon (*Mareca Penelope*).—Three shot in March, 1885, and one in January, 1887.

Garganey (*Querquedula Circia*).—Reported by Miss Williams as having been an occasional summer visitor.

Tufted Duck (*Fuligula cristata*).—Always common in winter.

Black Scoter (*Œdemia nigra*).—A female shot in October, 1884.

Golden Eye (*Clangula Glaucion*).—Fairly common in winter. Two males and eight females killed during 1885.

Smew (*Mergus albellus*).—A flight of nine visited the Marsworth reservoirs about the middle of February, 1885.

Scaup (*Fuligula marila*).—One shot on the reservoirs in October, 1884.

A hybrid between the wild duck and either widgeon or pintail was killed on 9th February, 1888.

I think that the particulars which I have now given cannot fail to be acceptable to all who are interested in the ornithology of the county. Some of the announcements will attract considerable attention, but Mr. Rothschild has taken great pains to carefully identify all the rarer species, and he assures me that their correctness can be entirely relied upon.

Perhaps it will be well for me to state that I have followed the nomenclature adopted by the Ornithologists' Union in their official catalogue published in 1883.

The following observations on the arrival, etc., of our migrants and other visitants have been reported.

Summer Migrants.

Species.	Locality.	Date.	Observer.
Nightingale	Redbourn Bury, St. Albans	Apl. 10	E. W. Arnold.
(*Daulias Luscinia*)	King's Langley	,, 17	Mrs. Betts.
	Hitchin	,, 18	Mrs. Lucas.
	Boxmoor	,, 19	H. Procter.
	Harpenden	,, 21	J. J. Willis.
	Odsey Grange, Royston	,, 21	H.G. Fordham.
	Hertford	,, 22	R. T. Andrews.
	Elstree	,, 24	E.P.Thompson.
	St. Albans	,, 25	Henry Lewis.
Redstart	Cassiobury, Watford	May 3	J.E.L.
(*Ruticilla Phœnicurus*)			
Wheatear	St. Albans	Apl. 6	Henry Lewis.
(*Saxicola Œnanthe*)	Hunton Bridge, Watford	Aug. 30	H. Procter.
Chiff-Chaff	Fanhams Hall, Ware	Mar. 26	R. B. Croft.
(*Phylloscopus collybita*)	St. Albans	Apl. 11	Henry Lewis.
	Hitchin	,, 18	Miss Barker.
	Leverstock Green	,, 28	J.E.L.
	Russell Farm, Watford	May 4	J.E.L.
Willow Wren	Bury Bushes, Watford	Apl. 18	H. Procter.
(*Phylloscopus Trochilus*)	St. Albans	,, 20	Henry Lewis.
	Hunton Bridge, Watford	,, 22	J.E.L.
Lesser Whitethroat	Elstree	,, 17	E.P.Thompson.
(*Sylvia Curruca*)	Hunton Bridge, Watford	May 7	J.E.L.
Blackcap	Hunton Bridge, Watford	Apl. 22	J.E.L.
(*Sylvia atricapilla*)			
Grasshopper Warbler	Harpenden	,, 28	Henry Lewis.
(*Locustella nævia*)			
Spotted Flycatcher	King's Langley	,, 28	J.E.L.
(*Muscicapa grisola*)	Odsey Grange, Royston	May 11	H. G. Fordham.
Yellow Wagtail	St. Albans	Apl. 19	Henry Lewis.
(*Motacilla Raii*)	Redbourn Bury, St. Albans	,, 22	E. W. Arnold.
Tree Pipit	St. Albans	,, 25	Henry Lewis.
(*Anthus trivialis*)			
Swallow	Redbourn Bury, St. Albans	,, 11	E. W. Arnold.
(*Hirundo rustica*)	Hunton Bridge, Watford	,, 15	H. Procter.
	Hertford	,, 18	R. T. Andrews.
	St. Albans	,, 19	Henry Lewis.
	Harpenden	,, 22	J. J. Willis.
	Fanhams Hall, Ware	,, 23	R. B. Croft.
	Watford	,, 23	J. W. Hill.
	Elstree	,, 25	E.P.Thompson.
	Hitchin	,, 28	Miss Barker.
House-Martin	Leavesden, Watford	,, 18	Mrs. W. Janes.
(*Chelidon urbica*)	Hunton Bridge, Watford	,, 26	H. Procter.
	Harpenden	May 2	J. J. Willis.
	St. Albans	,, 8	Henry Lewis.
	Redbourn Bury, St. Albans	,, 9	E. W. Arnold.

Species.	Locality.	Date.	Observer.
Sand-Martin	St. Albans	May 8	Henry Lewis.
(*Cotile riparia*)	Redbourn Bury, St. Albans	,, 9	E. W. Arnold.
Swift	Harpenden	,, 3	J. J. Willis.
(*Cypselus apus*)	St. Albans	,, 4	Henry Lewis.
	Redbourn Bury, St. Albans	,, 6	E. W. Arnold.
	Hunton Bridge, Watford	,, 10	J.E.L.
	Odsey Grange, Royston	,, 12	H.G. Fordham.
	Fanhams Hall, Ware	,, 13	R. B. Croft.
Wryneck	Hunton Bridge, Watford	Apl. 16	H. Procter.
(*Iÿnx torquilla*)	St. Albans	,, 18	Henry Lewis.
Cuckoo	The Grove, Watford	,, 13	F. Warren.
(*Cuculus canorus*)	Hunton Bridge, Watford	,, 16	J.E.L.
	Harpenden	,, 16	J. J. Willis.
	Redbourn Bury, St. Albans	,, 20	E. W. Arnold.
	Hertford	,, 22	R. T. Andrews.
	Fanhams Hall, Ware	,, 24	R. B. Croft.
	St. Albans	,, 24	Henry Lewis.
	Hitchin	,, 26	Miss Sewell.
	Bengeo, Hertford	,, 29	H. J. Tuck.
	Odsey, Royston	May 4	H.G. Fordham.
Night-jar	St. Albans	,, 8	Henry Lewis.
(*Caprimulgus europæus*)			
Turtle-Dove	Odsey, Royston	,, 7	H.G. Fordham.
(*Turtur communis*)	St. Albans	,, 8	Henry Lewis.
Landrail	Harpenden	Apl. 16	J. J. Willis.
(*Crex pratensis*)	Odsey, Royston	,, 30	H.G. Fordham.
	The Grove, Watford	May 11	H. Procter.
	St. Albans	,, 15	Henry Lewis.
	Fanhams Hall, Ware	,, 16	R. B. Croft.

Spring, Autumn, and Winter Visitants.

Redwing	Odsey Grange, Royston	Nov. 1	H.G. Fordham.
(*Turdus iliacus*)			
Fieldfare	Great Gaddesden	May 8	H. Procter.
(*Turdus pilaris*) (last seen)	Odsey Grange, Royston	Dec. 24	H.G. Fordham.
	Great Gaddesden	,, 25	H. Procter.
Hooded Crow	Royston	Oct. 15	E.O. Fordham.
(*Corvus cornix*)	Hoddesdon	Nov. 14	F.M. Campbell.
Woodcock	Odsey Grange, Royston	Oct. 11	H.G. Fordham.
(*Scolopax rusticola*)			

MISCELLANEOUS NOTES.

I must conclude my paper by recording a few miscellaneous notes kindly forwarded by correspondents from various parts of our county.

Wheatear (*Saxicola Œnanthe*).—Mr. Arthur Smith, of Smallford, near St. Albans, informs me that during the first week of last June, he found a wheatear's nest under a tuft of grass by the side of a gravel-pit, upon the Hill End Farm. I recorded the nesting of the wheatear for the first time in last year's report, at Barton, near Hitchin. I am glad to record a similar occurrence in this part of the county.

Willow-Wren (*Phylloscopus Trochilus*).—Mr. Norman Thrale, of Port Vale, Hertford, kindly forwarded to me, early in last January, a freshly-killed specimen of a willow-wren, which he secured on the 6th of that month. It has been mounted by Mr. Bowers, and I have pleasure in exhibiting it. The willow-wren is one of the most regular of our summer migrants, and I have never before recorded it during the winter months. It is probable that it was hatched late in the season, and did not arrive at maturity in time to accompany its fellows southward. It would certainly have died during the recent cold weather.

Dipper (*Cinclus aquaticus*).—I find that in the 'Zoologist' of 1849, p. 2346, Mr. William Lucas, of Hitchin, recorded the occurrence of the dipper on the stream near West Mill.

Waxwing (*Ampelis garrulus*).—Mr. Francis J. Butcher informs me that a waxwing was shot some years ago about a mile from Tring, on the Aylesbury road. It has been mounted and is preserved.

Pied Flycatcher (*Muscicapa atricapilla*).—Mr. William Hill, jun., of Hitchin, informs me that a pied flycatcher was shot near Stevenage during the second week of May. It is a very rare bird, and only once before has it found a place in our register.

Great Grey Shrike (*Lanius excubitor*).—Mr. Marlborough R. Pryor has been fortunate in observing a great grey shrike under somewhat unusual circumstances. This interesting bird is a regular winter visitor to our county, but on this occasion it made its appearance in the parish of Willian, near Stevenage, in the month of July. Respecting it Mr. Pryor writes as follows:—"I saw the bird within six yards, and I saw it at least a dozen times. I consulted Dresser's plates, and I have as little doubt as possible about it. Had I suspected it to be *Lanius minor*, I should have strained my conscience and shot it." It is quite possible that it may have been, as Mr. Pryor suggests, an early migrant on its journey southward. Mr. William Hill, jun., writes to me as follows:—"A great grey shrike was captured by a professional bird-catcher to the westward of Hitchin, quite at the end of November or early in December. It attacked the call-bird, which was pegged to the ground, and the man pulled his net over it. It was then put into a cage with a hedge-sparrow, which it immediately attacked and killed. After careful identification it was released in Mr. Tuke's garden, apparently none the worse for its experience. During its short captivity it was most pugnacious."

Kingfisher (*Alcedo Ispida*).—Mr. Robert Pryor, of High Elms, Watford, writes to me as follows, under date 7th July, 1887:—"In an old disused chalk-pit near my house, a pair of kingfishers have this year selected a hole between the chalk and the gravel for a nest. The pit must be more than a mile from the nearest water at Kytes and Garston, and nearly two miles from the River Colne. Two of the young birds were found dead below the nest."

Cuckoo (*Cuculus canorus*).—Dr. A. T. Brett has sent to me the following note:—"On the 14th of August I saw on the lawn at Cassiobury a young cuckoo, and now and then a pied wagtail would come and feed it, sometimes alighting on the back of the cuckoo, when it would turn its head to be fed, and at others feeding it from the ground. The same thing was observed last year, but the species of the small bird that did the feeding could not be ascertained." Mr. Horace J. Tuck, of St. Leonard's, Bengeo, Hertford, informs me that on the 29th of May a cuckoo was seen to flutter for a few seconds over a bush in his garden, closely followed by a cock blackbird. On visiting the bush two eggs were found in a whitethroat's nest, one of which was a cuckoo's. On the 15th of June another cuckoo's egg was found in the nest of a reed-warbler. In due time it was hatched, three eggs belonging to the foster-parents being turned out a day or two afterwards. The reed-warblers were most assiduous in their efforts to find sufficient food for the young cuckoo. It consisted chiefly of flies and caterpillars, especially of the gooseberry-caterpillar, and the birds completely cleared a few bushes which were covered with the latter. The cuckoo left the nest on 18th July, and was occasionally followed by its foster-mother, which still continued to feed it, frequently resting on the cuckoo's wing to reach its beak. This is the first time that I have recorded the fact of a cuckoo depositing her egg in the nest of a reed-warbler.

Hobby-Hawk (*Falco subbuteo*). — Our President, Mr. F. M. Campbell, has been good enough to inform me that a hobby-hawk was shot to the north of Cow-heath Wood, near Hoddesdon, on the 3rd of July, and is now in his possession.

Osprey (*Pandion Haliaëtus*).—On Saturday, 17th September, as a party of gentlemen were shooting over some land in the parish of Great Gaddesden, a large bird rose from the River Gade and flew just within gun-shot. It was slightly wounded in one of its wings, and at once brought to the ground. Six of the party formed a circle round it, but it exhibited its powerful hooked beak and villainous-looking talons with such decided effect that no one felt inclined to touch it. The offer of a gratuity to a farm-labourer quickly effected its capture, and when once seized it offered but little resistance. It was brought for identification to Hunton Bridge, where it remained for about a week. It proved to be a female osprey. It was confined in a covered fowl-run and fed entirely on fish. It refused to eat anything that was dead, but directly a live dace was placed in some water within its reach, it devoured it with avidity. It appeared to possess tastes superior to the attractions of minnows, and allowed them to swim about unmolested, but for chub, perch, and dace it evinced a decided predilection. Its method of feeding was peculiar; it commenced by tearing its victim open, and proceeded to devour the entrails before consuming the more fleshy portions. It measured 5 feet 2 inches from tip to tip of wing, and was in capital plumage. It lived in captivity for about six weeks. It is now mounted and is in the possession of Mr. W. M. Shirreff, Belsize Park, London. I am informed by Mr. Norman Thrale that, on the 18th of September, the day following the capture just described, an osprey was observed fishing in the River Lea, near Wheathampstead, where it was seen to take several trout. It was shot by Mr. William Thrale. It proved to be a male bird; has been mounted, and is preserved. There can be but little doubt that these birds were a pair, and that they visited our county in company. I may state that during the past seven years I have had the pleasure of registering seven ospreys, and that without an exception they have all been observed during the month of September. I feel fully justified in removing the name of the osprey from my list of rare and accidental visitors, and including it under the head of occasional autumnal migrants.

Red-Legged Partridge (*Caccabis rufa*).—Mr. E. Hubert Grundy, The Sycamores, Royston, has kindly forwarded an account of the nesting of a partridge, which well deserves record. The bird in question took possession of a forsaken nest of a wood-pigeon, which had been built in the fork of a spruce fir about six feet from the ground. It occurred in a small plantation on the slope of a baulk. Mr. Grundy visited it on Whit Monday last; there were then twelve eggs in the nest and one more was afterwards deposited. Fearing that the young birds might meet with some accident if hatched in a tree, the eggs were removed and placed under a hen, the result being that eleven birds were hatched.

Green Sandpiper (*Helodromas ochropus*).—Mr. Marlborough R. Pryor writes to me that a pair of green sandpipers remained at Weston Manor, Stevenage, during the month of August; and Mr. Norman Thrale informs me that he observed a pair of these birds near Hertford on the 12th of September last. I may add that Mr. Pryor is always most careful in protecting all his feathered visitors from molestation or injury of any kind.

The length of my paper forbids further comment. I will conclude by heartily thanking my numerous correspondents for their continued assistance.

VIII.

REPORT ON INSECTS OBSERVED IN HERTFORDSHIRE IN 1887.

By F. W. Silvester, F.R.Met.Soc.

Read at Watford, 8th May, 1888.

The prolonged warm weather and long droughts of last summer in all probability had much effect in causing the unusual amount of insect damage observable during the period embraced in this report. It may be interesting to note that the mean rainfall of the whole of the British Isles in 1887 was only 25·8 inches, whereas the mean for the 21 years, 1866 to 1887, was 35·3 inches, so that there is a deficiency of nearly 10 inches in 1887. Last year was in fact the driest we have experienced since 1866.

Foremost amongst the injurious insects of the year is the Hessian fly, which, it will be remembered, was brought under Miss E. A. Ormerod's notice in 1886, near Hertford. On 15th July, 1887, our President, Mr. F. M. Campbell, wrote to Miss Ormerod: "I am sorry to say that the Hessian fly is not only plentiful in Mr. Palmer's fields, but here also. Here I have found it in wheat close to the root." On the 19th Mr. Campbell forwarded samples of the attacked wheat, with the note: "Most of them are on the first joint, and one stalk has been visited both on the first and second joint. It is evident that most of the puparia about us in wheat will be left on the field after reaping. . . . *Cecidomyia destructor* may be said to infest our whole parish." And on the 26th Mr. Campbell added: "Hessian fly to my knowledge is over the whole of Hoddesdon, Ware, and Hertford districts." On July 23rd, Mr. Arthur Smith, of Smallford, St. Albans, forwarded specimens of Hessian-fly attack found by him in two wheat fields at Hill End Farm. Of three fields of wheat contiguous to each other, amounting to fifty acres, one field, clover in 1886, and sown at the end of October with Webb's challenge wheat, had no attack. Of the other two fields, part of one, fallow in 1886, sown with mustard ploughed in, and with Webb's "challenge" on Sept. 17th, also had no attack; but the other part, which had swedes carted off and was sown with April wheat on April 12th, was mildly attacked. The remaining one of the three contiguous fields, part fallow and mangolds, remainder peas in 1886, sown with Webb's "challenge" in the beginning of October, was more severely attacked. Both pieces of fallow attacked were partly manured with London stable-manure, but the portion of fallow not attacked, with artificial manure. Miss Ormerod adds: "From the above it appears that both the spring- and autumn-sown wheat on the fallow were attacked where London manure was used."

The destruction of the "flax-seeds" found after threshing in the siftings is the most sure way of guarding against a recurrence of this pest. Deep ploughing is good, and the Americans advise putting all infested straw in good square ricks, so that a large proportion of the flies which come out of the flax-seeds are destroyed, simply because they are not able to get to the outside of the stack. The scarcity of straw this season will ensure this remedy being taken advantage of. The time that we generally sow our autumn wheat is also another point in our favour, and probably will act as a preventive of future attack on wheat more than any other measure, because it is one which is usually carried out in the ordinary course of British husbandry.

The ribbon-footed corn-fly (*Chlorops tæniopus*), so often confounded with the Hessian fly, was reported by Mr. J. C. Mann, who wrote from The Grange, Bishop's Stortford, that "it swarms in my late barley and also in my neighbours'." Several people have told me that their crops have suffered from this pest. It did much more harm generally as a corn-pest last year than the Hessian fly.

Mr. John J. Willis has favoured me with the following interesting notes taken at Harpenden :—"In the early summer months kitchen-gardens did so indifferently that green vegetables were more than usually scarce and expensive to purchase. The 'fly' (*Phyllotreta undulata*), and the various grubs, especially *Agriotes lineatus*, played sad havoc among the newly-germinated seeds; many onion, carrot, and turnip beds being completely destroyed. The grub of the click beetle (*Elater lineatus*) was found very extensively among potato crops, and did much damage to mangel-wurzel plants. During the month of June root crops suffered as much from the effect of the 'fly' (*Phyllotreta undulata*) as from the drought. Thin crops were therefore the rule, and in many instances the plant was almost entirely destroyed, and the land had to be ploughed up. In some cases turnip-seed was sown both in gardens and in the open fields as many as three times, and each time the plants were destroyed as soon as they appeared above ground. The large cabbage-white butterfly has been enormously abundant throughout the whole of the summer months, consequently the cabbage tribe of plants were entirely spoiled for culinary purposes. The crane-fly (*Tipula oleracea*) was most plentiful during the months of July and August; in fact the meadows and pastures were teeming with it. Gardens, fields, and indeed almost every kind of soil, abounded with the grubs in September; and unless they had been carefully sought for and destroyed every day, around young cabbage plants that were set out, the crops would have been seriously damaged. The bean-aphis and the turnip-aphis did serious evil to these crops, cabbages and Brussels sprouts being also much pestered with the latter. The very little wheat-midge (*Cecidomyia tritici*) was observed this season. The apple-weevil was of frequent occurrence, and much fruit in consequence was entirely spoiled by its ravages. The gooseberry-sawfly (*Nematus ribesii*) was less abundant than usual. Wasps and house-flies were most prolific, and earwigs existed in such numbers that many of the houses in this neighbourhood literally swarmed with them. Conservatories and greenhouses were also much troubled with these insects; they devoured grapes and whatever fruit could be had, then they attacked the blossoms of flowers, and finally the foliage of the more tender plants. House-martins, swallows, and swifts were comparatively scarce, probably owing to the difficulty they experienced in obtaining mud for the erection of their nests. This might partly account for the over-abundance of insect-life."

Miss Ormerod, writing in her report of the white cabbage-butterfly, says: "At St. Albans I found them on cabbage or cauliflower plants in my garden at Torrington House, when I moved there in September, in such numbers as to attract the attention of every one who came near. The position is very warm and sunny, sheltered from the north by a high garden-wall, and with the ground sloping rapidly down to the valley with a S.S.W. exposure, and the caterpillars swarmed to such an extent that some of the plants were eaten to complete skeletons. This was a case in which hand-picking would have saved the crop, but being much occupied from change of residence, I could not attend fully. Many of the caterpillars, as is their custom, wandered away, and, after crawling along about the width of the garden down the hill and over the wall, went into chrysalides on the sunny side."

In my own garden at Hedges these caterpillars were excessively abundant. A vigorous hand-picking considerably lessened their numbers and partially saved the crop. It is highly important as a remedial measure against this destructive caterpillar to well search likely places for the chrysalides, during the autumn, and destroy them.

The turnip-grub (*Agrotis segetum*) was very prevalent during the past winter. It is one of the most voracious of our crop-pests, as it feeds on the plant in all stages of its growth.

The bean-beetle, formerly supposed to be *Bruchus granarius*, now distinguished as *rufinarius*, has been very abundant. A local corn-merchant informed me that he had never before seen so many samples infested by it. It is difficult to find, at least in the South-Eastern counties, samples of beans—ticks, mazagans, and broad beans—that are free from black specks and holes, showing that they have been attacked by these beetles. Some samples have from 40 to 50 per cent. affected; others from 15 to 20 per cent. In one case of small mazagans from East Kent there was a very small proportion free from spots and holes. In all probability the warmth and dryness of the late summer were favourable to the development of these insects.

Besides the possible failure of germination, and the certain weakness of plants from *Bruchus*-infested beans, the insects will be conveyed to the fields in the seed in largely-increased numbers to injure the next crop. Loss of weight, and of consequent feeding-value, is caused by the action of these beetles upon beans used for horses, sheep, and pigs. As a great means of prevention, beans infested by these beetles should not be used for seed. Kiln-drying, if judiciously performed, destroys the insects, and the soaking of beans in water has been found to be effectual. Steps should be taken to destroy beetles in the warehouses where they will swarm attracted by the first warm rays of spring sunshine.

The wireworm has been especially destructive to the young wheat in many places throughout the country; one of my own fields was so damaged as to render it necessary to plough up the crop. The new wheat-pest (*Zabrus gibbus*) has been reported to be present in the neighbourhood, and to have worked great ravages.

First appearances of insects have been noticed by Messrs. John Hopkinson, J. J. Willis, R. T. Andrews, H. G. Fordham, R. B. Croft, and the members of the Hitchin Natural History Club. The following is a detailed list of the observations :—

Melolontha vulgaris (cock-chafer).—Hitchin, May 28th ; *Nat. Hist. Club.* Hertford, June 4 ; *Andrews.* Harpenden, June 6 ; *Willis.*

Timarcha lævigata (bloody-nosed beetle).—Harpenden, April 13 ; *Willis.*

Lampyris noctiluca (glow-worm).—Harpenden, June 22 ; *Willis.* Hitchin, June 30 ; *Nat. Hist. Club.*

Apis mellifica (honey-bee).—Hertford, Jan. 19 ; *Andrews.* Ware, Jan. 20 ; *Croft.* Odsey, Jan. 26 ; *Fordham.* Harpenden, Feb. 5 ; *Willis.* Watford, Feb. 6 ; *Hopkinson.*

Vespa vulgaris (common wasp).—Harpenden, April 18 ; *Willis.*

Pieris brassicæ (large white butterfly).—Harpenden, April 11 ; *Willis.* Ware, April 28 ; *Croft.* Watford, May 7 ; *Hopkinson.*

Pieris rapæ (small white butterfly).—Hertford, April 4; *Andrews.* Watford, April 17 ; *Hopkinson.* Harpenden, April 17 ; *Willis.*

Anthocharis cardamines (orange-tip butterfly). — Harpenden, March 21 ; *Willis.*

Epinephile janira (meadow-brown butterfly).—Harpenden, May 8 ; *Willis.* Hertford, June 4 ; *Andrews.*

Bibio Marci (St. Mark's fly).—Harpenden, June 11 ; *Willis.*

Although this paper covers only a few observations, it will be seen what an immense amount of damage has been wrought in our own county alone by injurious insects, and one cannot help being reminded that the superabundance of the sparrow is answerable for the disappearance of many of our insectivorous birds, and the consequent increase of insect-life. This point was forcibly brought before the London Farmers' Club last week by Miss E. A. Ormerod, and may I suggest that the members of the Herts Natural History Society join in the crusade led by our eminent Honorary Member against these destructive birds, which annually cause such loss to our farmers and gardeners? The sparrow question demands serious attention, and it is to be hoped no false sentimentalism will induce any one present to take up the cudgels on behalf of *Passer domesticus.*

In conclusion I beg to thank all who have kindly contributed to this report; and my especial obligations are due to Miss E. A. Ormerod for kindly permitting me to take extracts from her eleventh Annual Report on Injurious Insects, and to Miss Georgiana Ormerod for the loan of the excellent diagrams I exhibit in illustration of the most important crop pests of the year.

IX.

ON FISH-FATALITY IN THE RIVER COLNE AT WATFORD.

By Alfred T. Brett, M.D.

Read at Watford, 8th May, 1888.

Abridged.

An enquiry as to the cause of fish-fatality in our rivers must be of some importance, as the water is used for culinary and even drinking purposes, and if the fish are poisoned, it is our duty to endeavour to discover what the poisons are. Lawsuits, also, are frequently taking place as to the pollution of rivers and the destruction of fish.

I will first show that the fatality exists. In a letter to me, Mr. A. P. Blathwayt, of Frogmore House, Watford, says:—"In July, 1887, dead fish were found floating in the water which passes through my grounds; amongst them were four trout of from 2 lbs. to $3\frac{1}{2}$ lbs. each. They had the appearance of having been dead for some time. On one morning in July I noticed a few small fish swimming on the surface of the water, and every now and then raising their heads above it as if to obtain air. In the afternoon I found that the fish were being poisoned by hundreds. As far as one could see there were fish of all sizes struggling for existence. I took three samples of the water, two by my own grounds and one from the stream running past Mrs. Sedgwick's brewery into the river, and submitted them to Prof. Attfield for analysis. I visit the river daily and have never seen a single dead fish from that day. I think that poison must have been thrown into the river."

Mr. J. G. Smith, of Hamper Mill, Watford, tells me that more than twenty years ago his foreman saw a shoal of fish swimming rapidly down the river as if in terror of their lives. Some fish jumped out of the water and others ran their heads into the sandy bank as if to avoid some enemy. The following day the bottom of the river was covered with dead fish. I have also been told by Mr. Martin, of Hamper Mill, that sometimes fish are found dead there in hundreds; and I have been shown a large basket full of fish, about two bushels, said to have been poisoned in the Colne. They were healthy-looking, plump, and bright, and some were of large size. Lately many fish have been found dead at the tumbling-bay.

I think, therefore, that it cannot be disputed that fish are occasionally found dead in our river in such quantities in a short time that the idea of poisoning is at once suggested rather than that the fish die of ordinary disease or by natural decay.

In investigating the cause of the fish-fatality it may be well first to enquire what manufactures or processes carried on on the banks of our river might act injuriously on the water. From above downwards we have (1) Messrs. Sedgwick's brewery; (2) Mrs. Urlwin's fellmongers' yard; (3) the Watford Flour Mill; (4) the Gas Works; (5) Tidcombe's (now Rogers') iron-foundry; (6) the Steam Laundry; and (7) the Sewage Farm.

Although the Colne receives a large accession of water from springs at Otterspool, above the Bushey Mill bridge, which is narrow, dead weeds may in the summer be seen, decaying for a long time, and by the meadows above the bathing-place the river is full of weeds.

Messrs. Sedgwick's brewery has for long drained into a ditch which runs into the river. The beer barrels are washed out by steam, and although the grosser matters are removed by filtration, poisonous substances might pass through the filter into the river and destroy fish. This might have occurred last July when the river was low and the water stagnant here, but as the washings will in future go into the sewers, it cannot occur again.

At the fellmongers' yard the skins are placed in pits with lime and are then washed in the river, and sometimes the water below here is quite white, I suppose with lime. The business has been established more than a century, and in my opinion the process carried on does not cause the destruction of fish in any quantity.

The flour-mill does not I think put any injurious substance into the water; it simply takes every drop of water from the old river and diverts it for water-power. This for six days in the week makes about a mile of the river a stagnant ditch in which dead creatures, animal and vegetable, float and decay to the annoyance and injury to health of those who pass by or live near the river. It is a wonder to me that fish can live at all in this stagnant water, and in my opinion the want of sufficient water to make a flowing stream is one cause of the unusual fatality amongst the fish.

I do not believe that anything is allowed to go into the river from the Gas Works. The ammoniacal liquor is a source of profit, and a concrete wall has been built to prevent any refuse from washing into the river. The river suffers from stagnation here, but the fish are usually found dead much above or much below.

I do not think that the iron-foundry injures the river. A nuisance which once existed here has been removed.

At the Steam Laundry soap-suds go into the river, but the refuse from the dyeing-works is collected in a tank and then thrown on to coals and burnt in the furnace. I cannot trace fish-fatality to it. On the last occasion the poisoned fish were found in the tumbling-bay, which is above it.

Lastly I must refer to the Sewage Farm. The effluent water which has drained through the earth is not injurious to fish, for, at the outlet of the purified sewage, fish are seen in greater numbers than in any other part of the water, and in experiments which Mr. Lovejoy has made for me he found that fish could live, first in diluted and then in undiluted effluent water.

The following is Professor Attfield's report on the samples of water submitted to him by Mr. Blathwayt:—"I have analysed the three samples of water taken from the Colne by Mr. Blathwayt. Neither sample contained any trace of either of the poisons which form the twelve or fourteen classes of the ordinary poisons. The sample labelled 'Water in which fish seemed to be poisoned' was simply dirty water with a slight smell of tar. The sample labelled 'Water with coating of tar' was saturated with tar, and had a very little tar, about two drops per pint, floating on the surface. I find by experiment that tar when added to water soon seriously reduces the quantity of dissolved oxygen in the water, and it is oxygen on which fish, like ourselves, depend for respiration. In my opinion fish would be liable to be suffocated in water thus super-saturated with tar. The water labelled 'Water from Sedgwick's ditch' possessed a strong smell of decaying vegetable matter and contained an unnaturally small portion of dissolved oxygen. I am distinctly of opinion that fish would be liable to die by suffocation in such water."

With regard to the effects of lime in the river Prof. Attfield says:—"The action of lime in killing fish may be direct or indirect. Direct by dissolving in the water and forming an irritant caustic alkali to the delicate structures of fishes, just as solutions of the stronger alkalies, potash or soda, are irritant caustics to stronger animals. Indirect, because the organic matter in all fish-frequented waters, whenever the water becomes charged with lime, very rapidly absorbs the life-supporting oxygen of that dissolved air which fishes breathe, and of course the fish then die of suffocation. Quick-lime and slaked lime are identical in action simply because the quicklime becomes slaked lime in contact with the water, $1\frac{1}{4}$ lb. of quicklime giving about $1\frac{1}{2}$ lb. of slaked lime, and the latter dissolving in about 1000 gallons of water. Water thus limed soon absorbs carbonic acid from the air, the lime thus being converted into chalk, which is harmless, and is either deposited as a sediment at the bottom of the water, or remains in solution when excess of carbonic acid is present, making the water harder than it was before."

As experience gained from other places may throw light upon our investigation, I have asked for information on fish-poisoning from others. Mr. George Rooper says:—"My knowledge of fish-poisoning is limited. In the south and west of Ireland the water in which flax is steeped is a deadly poison, and frequently the cause of much mischief, and I have heard that in the same localities other herbs are soaked and used by poachers for the destruction of fish. *Cocculus indicus* was formerly much used by poachers. Lime is a most destructive agent in the poachers' hands, and is much used in South Wales. Its effect is the choking of the delicate machinery of the gills, preventing breathing and acting as would removal of the fish from the water. Gas-tar, naphtha, or petroleum getting into a river by accident or design will poison every fish with which they come in contact. The drainings from a lead-mine will entirely deprive a stream of its trout. From Frank Buckland's experiments it would seem that this is owing to the silt when precipitated choking up and destroying the spawn. The gases generated in a shallow pond or lake in very hot weather are destructive to piscine life. I once saw a lake in Sussex the surface of which was covered with bubbles no doubt full of gas. I remember, too, when a boy, that the same occurred in Whittlesea Mere, then a lake twenty miles round. The fish were destroyed in millions."

Prof. Harker, of the Agricultural College at Cirencester, says that he thinks it possible that the fish in the Colne were asphyxiated or drowned by the water being deprived of the absorbed oxygen, and that filth, dirt, sewage, and dead weeds devour the oxygen, becoming themselves oxidised. Such fish, he says, as pike and carp, which live at the bottom of the water, have a greater power of living in polluted or stagnant rivers than trout or other fish which usually live in running streams.

I do not think that any one cause will account for all the fish-fatality in the Colne. That at Frogmore last July was probably due to poison or some noxious material getting into the river. The fish at Hamper Mill were, I think, destroyed by the overflow of sewage from the sewage-farm after a flood. In some parts of the water the fish die from want of air; they are suffocated, or, more correctly, asphyxiated. Such fish will mostly recover when placed in fresh water, which they would not do had they taken poison. I do not think that lime or tar is the cause of the mischief. Is it not possible that the Watford Piscators preserve the waters too strictly, allowing the fish to be overcrowded, having no room to breathe?

The practical point is, What is to be done? We must keep our river as pure as possible. We must not allow it to be made a sewer, or a receptacle for decomposing remains of animals and plants. And finally we must, if possible, allow the water to flow at least an hour a day. In fact we ought to pay more attention to the state of the river than we do to the state of our roads and footpaths.

X.

BIRDS: THEIR NESTS AND HABITS.

By George Rooper, F.Z.S.

A lecture delivered at Watford, 15th January, 1889.

On the last occasion, some years since, on which I had the pleasure of addressing the members of our Society, I brought under their notice, in a hasty and necessarily imperfect manner, some of the great writers on Natural History, more especially on Ornithology, ancient and modern, whose works are regarded as authorities on the subject. I referred to Pliny and Aristotle, Linnæus, Buffon, White, Waterton, and—last, not least—that pleasantest of writers, Frank Buckland. I may say in reference to him, that in his biography, published two or three years since, will be found a long extract, I venture to think not the least amusing portion of the book, from that address. I mention this to show that our Transactions find appreciative readers beyond the limited circle of our members.

I propose now to pass from the writers to the subjects of their writings, from the authors to the birds treated of by them, and to record such facts as, having come under my own observation, may seem of sufficient interest to claim your attention.

Birds differ from each other not more in size and colour of plumage than they do in their gait, their mode of flight, their nests, and their songs. Take their gait. The pigeon walks, pheasants run, the rook struts, herons stalk, ducks waddle, sparrows hop, as do most of the small birds, but larks and water-wagtails run. The swift, if he settle on the ground, which he very rarely does, can hardly be said to walk at all. From the shortness of his legs he is just able to scramble along, whilst the grebe and the whole tribe of auks move in an upright position, their legs being placed so far backwards, and walk like yokels running in sacks, as if they were always about to tumble on their noses.

Then consider the flight of birds, the different modes in which they use their wings. The kite glides through the air in graceful curves. He is called in Scotland the "glead," from this gliding motion. Scott has—

> "When the hound's in the greenwood,
> The deer keeps the hill:
> When the glead's in the blue cloud,
> The lavrock lies still."

The woodpecker and missel-thrush fly in a series of jerks and broken falls, rising and sinking as they go. Pigeons seem always in a hurry, and dash off their roost, striking the tips of their wings against each other as they fly straight to their point, as, at a lesser speed, do the rooks. The cuckoo flies in an aimless desultory manner, crying "Cuckoo!" as he flies, and not seeming to have made up his mind where he is going to. Swallows skim over the surface of the water, whilst the grebes use their wings to assist them in seeking its depth. The kestrel hovers over the devoted mouse or humble beetle he has marked for his prey; the buzzard *flops* along, and the harrier quarters the fields, hunting like a setter dog; the owl flits, still and graceful, dropping ever and anon upon the mouse all unconscious of its silent approach. Moorhens and coots fly along the surface of the water, with outstretched legs, by way of balance to the rest of their body, their wings being placed too far forward from the centre of gravity.

There is, however, nothing in which birds differ so much from each other as in the character of their nests, and the situation in which they are placed. The Irishman's cabin does not differ more from the Viceregal Lodge, than does the filthy heap of fish-bones on which the kingfisher lays her eggs, from the compact, well-constructed domed nest of the magpie. You perhaps know the fable, how the magpie was sent by Jupiter to teach the other birds how to build their nests. She began her lesson—"You must lay one stick thus." "Of course," said the jay, "every one knew that." "Then," proceeded the magpie, "you must lay another stick thus across it." "I knew that before," said the jackdaw. In short, there were so many interruptions by conceited birds, who thought they knew all about it, that the magpie flew away in disgust. In consequence the birds have since only built *half* a nest.

The outside of a bird's nest may sometimes in a trifling degree vary from that of its special kind; but the lining never. No bird that uses bents for lining ever resorts to feathers, nor do birds that use feathers ever utilise moss, wool, or hair. The lining of the thrush's nest is beautifully finished; it is formed of clay and cow-dung, kneaded together, and polished by the bird's body being turned round and round in it. The blackbird lines her nest with bents, the missel-thrush with wool, the swallow with feathers, the crow and all predatory birds with moss, hair, and wool. The dabchick, the little brown bird, a pair or two of which are still left near the St. Albans bridge, has a curious habit, entailing apparently a vast deal of unnecessary trouble. The bird lines its nest with water-weeds, and, though any quantity may be floating on the surface, prefers to dive down and bring up from the bottom every particle used.

The nests are generally proportionate in size to that of the birds themselves. The kite's nest is a nearly flat structure, three feet over at least, built with substantial sticks, and whether the hen-bird be sitting or the young birds hatched, furnished with an ample larder of headless rats, leverets, and rabbits. I have taken three or four kites' nests in my young days, and I think that no one else in this room has ever done so, I fear never will, for that beautiful bird is almost if not quite extinct. The water-ouzel makes, in proportion to its size, an enormous nest. It is frequently built under a bridge, where it has exactly the appearance of a mass of drift weed, or under a steep bank over which the water drops. Last year I found one on the bough of a tree; it was very large, more than three feet round, and contained four lovely eggs, white and transparent. By the way, all birds that lay white eggs, except the wood-pigeon, either build domed nests or breed in holes, a provision of nature to protect them from observation. I do not think that the fact of the water-ouzel building in a tree has ever been recorded. The nuthatch, who builds in the hole of a tree, has a curious habit of contracting the entrance by building up a wall of clay. It is said that after the hen bird has laid her eggs the cock builds her in, the hole being made too small for egress. Through this the cock bird feeds her until the young are hatched. I do not vouch for this, but certainly the hole of one I examined in Windsor Park last year seemed too small for the ingress or egress of the bird. The clay, properly tempered with saliva, was as hard as a brick; I could scarcely cut it with a knife. The toucan is said to build his mate in in like manner. The golden-crested wren hangs its nest under a bough, and is the only British bird that does so. The reed-warbler attaches hers to three reeds fastened together. The pee-wit, and birds of the plover and sandpiper tribe, make scarcely any nest, contenting themselves with any casual cavity in the ground. The pee-wit is the producer of the much-prized plovers' eggs, sold for 6*d.* a dozen in Wales and Scotland, and for 6*s.* in London. All the tribe lay four eggs, but, if taken, the number in subsequent layings is gradually reduced to one. The pee-wit, though called the green plover, is not a true plover, birds of that class having three toes only. The sandpipers have four, and the pee-wit, possessing a rudimentary back toe, is incapacitated for admission into the aristocratic family of the plovers.

Some birds build no nest at all, contenting themselves with the old or deserted ones of others. The kestrel and sparrow-hawk, for instance, lay their eggs in an old crow's or magpie's nest—occupy unfurnished lodgings as it were—for which, like the Irish peasant of the present day, they pay no rent. Crows never resort to their old nests, but rooks, who appear to hold on a repairing lease, commonly mend up their old habitations during the winter, and occupy them again in the spring. The cuckoo not only shirks the trouble of building a nest, but imposes on other birds, and those the smallest and weakest, the responsibility of maintaining her offspring. She drops her egg promiscuously into the nest of any soft-billed bird she comes across. The hedge-sparrow, the tit-lark, and the water-wagtail, are the most generally favoured, but the egg was found many years since by one of my sons in a swallow's nest, a fact not previously recorded; and I am assured by a gentleman in this neighbourhood that a young cuckoo was hatched last year in a wren's nest. This, if no mistake was made, and I have no reason to suppose it was, is unprecedented. Whether the diminutive birds could have brought their great foster-child to maturity is uncertain, as the clumsy bird tumbled out of or off the nest (for the upper portion must have been torn away), and some old hens pecked its eyes out. So the manner of its death was equally singular with that of its birth. Shakespeare tells us—

> "The hedge-sparrow fed the cuckoo so long,
> She had her head bit off by her young."

In Jenny Wren's case she might have been swallowed whole, and the cuckoo have felt neither remorse nor inconvenience from the meal. The mode in which the cuckoo deposits its eggs is as curious as any other of its proceedings. She lays the egg on the ground, then taking it into her mouth, drops it into the nest. Pliny, who was a good observer, but given to jump at conclusions, having witnessed the proceeding, recorded as a fact that the bird laid her egg from her mouth!

The jackdaw, when building her nest in the hole of a tree, suffers great inconvenience through her blind obedience to the laws of instinct, untempered by a glimpse of reasoning power. Like the rest of her tribe, although invariably building in holes of trees or towers, she thinks it necessary to provide a huge substructure of sticks, like that of the rook's or crow's. In carrying a stick to the hole, she generally holds it by the middle, at right angles to her body. Of course it will not pass through the hole, and the bird displays unwearied patience in repeated and vain endeavours to force it in. At last she gives up the puzzle in despair, drops the stick, and flies away to find another. I have seen enough sticks lying at the bottom of a tree, the result of these abortive attempts, to fill a large basket. The jackdaw is the only member of the crow tribe that never builds *on* a tree.

Eggs, as I have said, are generally protected from observation by the nature or position of the nests, but in some cases an especial safeguard is afforded. The guillemot, for instance, makes no nest, but deposits her single egg on the bare surface of a precipitous rock, from which it might be inferred that the first rough wind would dislodge it. But it is protected by its shape from this danger. One end of the egg is large and round, the other thin and narrowed almost to a point, the shape being something like that of a pegtop. The result is that, when struck by the wind, instead of being blown off the rock, it simply revolves on an axis, as you will find that anything of the same shape does if you put it in motion on a table.

I could say something of the songs and varied cries of different birds, but I will merely note the fact that the first to open the annual concert in the spring is the missel-thrush, who begins his song in January, and that the wren and the redbreast sing, weather permitting, all the year round. The nightingale, the reed warbler, and the corn-crake—if its monotonous "crake, crake" can be called a song—continue their notes through the whole of the night. To these, according to Shakespeare, may be added, under certain circumstances, the cock.

> "Some say that ever 'gainst that season comes
> Wherein our Saviour's birth is celebrated,
> The bird of dawning singeth all night long."

But the statement requires confirmation.

Such are some of the differences that occur to me in reference to the gait, the flight, and the nesting of birds, and I will now briefly turn to the domestic habits and mode of life of one or two of the commoner birds included in the British fauna. There are upwards of 600 individuals who claim to be included in the list, all differing from each other, and all offering materials for observation and comment, so it matters little where we may begin, and the more common the subject selected perhaps the better, as the accuracy of the recorded observations may be more easily tested. I will first take the swallows, the most harmless, useful, and inoffensive of birds, without whose aid the air we breathe would be filled with noxious insects to an insufferable degree. Of swallows four distinct kinds make these islands their summer residence,—the swallow, the martin, the sand-martin, and the swift. Of these the first to arrive (about the 12th of April) is the swallow or chimney-swallow, as they are called, from their habit, perhaps more common formerly, when wood was more used as fuel than coal, of building in chimneys. They now, I think, prefer empty shafts, the interior of hovels, or other open buildings. On their arrival, and before entering on the serious business of life, about a fortnight is occupied in recuperating after the fatigues of the journey, the whole time being spent in aerial excursions, revisiting the scenes of their youth, in flitting, wheeling, flirting, chasing one another, capturing insects, and generally enjoying themselves. Indeed, the swallow always strikes me as one of the happiest, as well as the most interesting, of birds. She has no cares, few enemies, and, unless she comes a little too early in the year, unlimited food. Even when building, she seems to make the process one more of pleasure than labour. The nest being formed of clay, moistened with saliva, it must necessarily be built up gradually, or it would fall by its own weight. So, like "the jolly wood cutter, who dwells below the hill, she takes her work at a light hand, and leaves it at her will." An hour or two of the day is spent in work, the rest in play. The swallow is distinguished from the martin by wearing a reddish-brown cravat under her chin, while the martin has a purely white waistcoat. She is longer in the wing, and of more rapid flight; her legs and feet are bare, whilst those of the martin are feathered down to the toes. She breeds twice in the year, and hatches four young ones each time.

The martin and the sand-martin arrive about the same time, a week or so after the swallow. The former is called the window-martin, from its habit of fixing its nest under the eaves and over the windows of a house. She, too, produces two broods of four each in the course of the summer. It is worthy of remark that so prolific a bird, and one so little persecuted, should not increase more rapidly in numbers, but so far as my own observation extends, the annual visitants are always the same in number, or nearly so. I have four or five pairs round my house every year, but never more. They must be gifted with strong memories, or are great observers of tradition. Forty years ago several pairs built round the eaves of my house, over my bedroom window. A tidy housemaid, irritated at the litter they made, poked the nest down, and they have never built there since. Almost their only enemy that I am aware of is that most impudent of birds, the sparrow, who sits quietly by, watching the progress of the nest, and, when completed, ejects the tenant, and takes possession of it for his own purposes.

Cats sometimes lay wait for them on the roofs, and catch them as they visit their nest. Cockney sportsmen, too, sometimes, with more or less success, practise shooting at their expense; but, as I said, the bird has few enemies and many friends—well she deserves to have these.

The sand- or bank-martin is a most amusing and interesting bird. It haunts rivers and large sheets of water, and is not, I think, often seen about here. A perpendicular bank of sand is absolutely necessary for the sand-martins' breeding requirements. In it they perforate holes three feet in depth wherein they lay their eggs and bring up their young. Like the swallow's, the eggs are four in number, and two broods are hatched during the summer. It is very amusing to watch these little birds flitting about the bank and taking "headers" into their holes. Unlike the swallows their number seems to increase year by year; in September, previously to their departure, any one rowing down the Thames will see them congregated in flocks which darken the air in the neighbourhood of the aits in which they roost. Now that the hawks are extirpated, they have really no natural enemies to dread; but, like ourselves, they have their little domestic troubles. Their holes swarm with fleas, sometimes to such an extent as to render them uninhabitable. I have seen these little pests, the real bed-fleas, clustering round the mouth of a hole as thick as bees about a hive. When this occurs the hole is deserted, and the little bird proceeds to dig out another. It is wonderful how, with its weak legs and claws, it can accomplish the task.

One only of this family remains to be mentioned—the swift; the last to come, the first to go (her stay with us is not more than four months, arriving in May and leaving in August). The swift appears to act on the principle on which Charles Lamb excused his late attendance at office. When called over the coals for coming so late, he admitted the fact, but pleaded as his excuse that he "went away so early." The swift generally affects the higher regions of the air, circling round church towers and other lofty buildings, wherein she usually makes her nest (though I have seen it under the thatch of a cottage). Excepting when sitting, the bird appears to spend her whole life in the air. She differs from the swallow in that she lays but two eggs, and only breeds once in the year; she has four toes, her congener but three.

The swift reminds me of an interesting little bird, not unlike her in appearance, though differing in every other respect. This is the stormy petrel; a true citizen of the world, her range extending from the most northerly latitudes ever reached by mariner or explorer, to the sands of Margate. Her home is on the deep, and the rougher the weather the more she seems to enjoy herself, now skimming over the white crests of the waves, and now dipping into the water-valleys made by their subsidence. These birds are most frequently seen in very rough weather. The sailors call them "Mother Carey's chickens," Mother Carey having been a witch, supposed to brew storms, and the birds being regarded as her emissaries. A poetical description of the petrel occurs to me, a few lines of which I may be allowed to quote.

> "O'er the deep, o'er the deep,
> Where the whale and the shark and the swordfish sleep,
> Outflying the blast and the driving rain,
> The petrel telleth her tale—in vain;
> For the mariner curseth the warning bird
> Who bringeth the news of the storm unheard.
>
> * * * * *
>
> "Ah! thus doth the prophet of good or ill
> Meet hate from the creatures he serveth still;
> Yet *he* never falters: so, petrel, spring
> Once more o'er the waves on thy stormy wing!"

The petrel is the smallest of the race of gulls, and I pass from her to the largest, the albatross, whose wings extend 12 feet from tip to tip. She is the inhabitant of the southern, as the petrel is of the northern, seas. Her powers of flight are unequalled; without apparently moving her wings, but sailing as it were like a boy's kite, she will accompany a ship day after day for thousands of miles. Little is known of her domestic economy, excepting that she is a deadly enemy to the flying fish, and preys indiscriminately upon any floating carcase she may find on the ocean. Unlike the petrel, she is considered a bird of good omen by that superstitious race, the sailors, who would consider any injury done to one as certain to bring misfortune. You will remember, in Coleridge's weird tale of the "Ancient Mariner":

> "At length did cross an albatross;
> Through the fog it came:
> As if it had been a Christian soul,
> We hailed it in God's name."

And immediately:

> "A good south wind sprung up behind;
> The albatross did follow,
> And every day for food or play
> Came to the mariners' hollo!"

Then the terrified listener:

> "'God save thee, ancient mariner!
> From the fiends that plague thee thus;
> Why look'st thou so?'—'With my crossbow
> I shot the albatross.'"

And you know what followed—how the crew dropped down dead one by one, and the ship in the end was worked by dead men.

> "The body of my brother's son
> Stood by me, knee to knee;
> The body and I pulled at one rope,
> But he said nought to me."

I have mentioned rooks. These birds are frequently confounded with crows; in Ireland and Scotland, indeed, they are only known by that name. Though not unlike in appearance, they differ in many material respects. The upper bill of the crow is furnished with coarse black hairs on its base, which, excepting in young birds, before their first moult, are never found in the rook. The habit of the crow is solitary, living in pairs all the year round, and never returning to the nest of the previous year. This is always built on the fork of a tree, or of a branch. It is beautifully finished internally by a lining of moss and hair as round and firm as a basin. The rook's nest is a slovenly affair, generally on the top of the tree, the lining of bents, moss, and twitch. It is never found singly; indeed, the rook is the most, if not the only, absolutely gregarious bird we have; others, like the sparrows, chaffinches, larks, pee-wits, and many more, collect in vast flocks in autumn and winter, but the spring invariably breaks up the community. The rook, a truly social bird, lives all the year round in a sort of commonwealth, the members going out and returning, feeding in the day and roosting at night in great flocks. They have many habits peculiar to themselves, and some are invented for them. They are said, when feeding, to place a sentinel on a tree to warn them of the approach of danger, but I don't believe a word of it. When many hundreds of birds are congregated in one field, some are sure to be perched on the trees, and will of course fly off first, the rest taking the hint and following their example, possibly not without cause. They are said to smell powder, and no doubt they have an acquired knowledge and dread of a gun. But if you approach them with a stick on your arm, the effect will be the same. The crow is an arrant poacher, far more mischievous to game than is the hawk. If he discover a nest or a covey of young birds, he will fly backwards and forwards, never resting till he has taken away the last of them. He is especially partial to young ducks. The hawk, excepting when he has a young family to provide for, is satisfied with one or two young birds, which having devoured he sits placidly on a tree or stone and digests. The crow is an earlier riser than the rook, and no doubt meets his reward in getting the earlier worm. The rook, as I have said, is devoid of hairs on his upper mandible. This is not caused by his digging in the ground, as is commonly supposed, but is natural to the bird; in fact he never dips his bill at all deeply into the ground, and, when he has occasion to turn over a big stone in search of the worm or beetle beneath, he applies his bill sideways, which in that position is in the shape of a wedge. Rooks have a habit of carrying acorns and chestnuts and other fruit and burying them in the earth, a provision of nature for the extension of forest trees. The young birds make a very good pie, as do young crows, though there is a prejudice against them, and the eggs, it is said, are sometimes sold as plovers' eggs, though during 50 years' observation of shops where plovers' eggs are sold, I have never known an instance, the only substitute I have seen for that toothsome dainty being the eggs of the black-headed gull. Although eminently gregarious, the rook can hardly be called a sociable bird, nor does his character stand high from a moral point of view. Like the rest of the tribe, from the raven to the jackdaw, he is a sad thief; the rookery at nesting time is the scene of constant bickering, arising from conflicting claims for building-sites and the distribution of building-materials. A pair never leave their nest together, one remains on guard, whilst the other brings sticks and materials for the nest, which in the absence of both would certainly be appropriated. They are narrow-minded, too, and object strongly to any extension of their colony beyond the prescribed limits of the rookery. If an enterprising young couple begin to build in a tree beyond the limits, a mob of their conservative companions will sometimes attack the nest and tear it down. Perseverance, however, meets its reward, and though the nest may be destroyed more than once, it is eventually completed, and the next year, and thenceforth, the tree will be fully occupied, and the area of the rookery extended. Their constitution is like that of our American cousins, a Republic "tempered with petty larceny."

Birds, although not gregarious, indeed, affecting isolation in their habits, are brought together in considerable numbers by community of interest and the calls of hunger. Fifty or sixty years ago, when a dead beast was not utilised as now for sausages or any other purpose, I have seen scores of kites, buzzards, ravens, crows, and magpies, feasting on the carcase of what once had been a horse or a cow, or sitting with drooping wings and distended crops on the neighbouring trees, pending the process of digestion.

Thanks to the persecution of many of our most beautiful, and, in some cases, useful birds, and the inhospitable reception accorded to strange visitants, numerous birds, formerly included in the British Fauna, have become practically extinct; the kite, the buzzard, the harrier, the bittern, all of which were in my young days common enough, and are indigenous birds, come under the above category; whilst the visits of our former occasional visitants the roller, the bee-eater, and the hoopoe are now never recorded. About the latter beautiful bird there is a legend current in the East. It is said that when Mahomet was wandering in the desert and fainting under the intolerable heat of the sun, a flock of these birds hovered over him, and, whilst fanning him with their wings, protected him from the glare. As a recompense Mahomet gave them golden crowns, a fatal gift, for the birds were hunted down for their sake and persecuted, until at their request the crowns of gold were changed into the beautiful tufts of feathers they now wear.

A favourite bird of mine, one not nearly so plentiful as formerly, is the kingfisher. This is a mythological bird. When my young friends take to classics, as I hope they will, they may read the history of the kingfisher in Ovid's "Metamorphoses." Alcyone was the wife of Ceyx; walking by the sea-shore she found his dead body cast up by the waves. Her grief was so immoderate that the gods, taking compassion on her, changed her and her defunct husband into kingfishers, or halcyons. It was fabled that they built their nest on the sea, and that whilst incubation was going on no storms vexed the deep; there was a period of perfect calm, hence called "halcyon days." The kingfisher, like the sand-martin, excavates a hole in the bank where she makes her nest, or rather lays her eggs, for the nest is nothing more than a heap of cast-up fish-bones. She lays, so far as my experience goes, seven eggs, and, as there is no shaft for ventilation, and her sanitary arrangements are incomplete, the smell from the hole when the young are hatched is by no means pleasant; it is, in fact, abominable. I used to wonder how the bird, which frequently breeds at a considerable distance from the water, got her young down to it, but I made it out this season. There was a nest in Mr. Pryor's park (High Elms, Watford), at least a mile from the River Colne, the bird's nearest haunt. When the young had left the nest, I found two of them dead under a high bank which lay in their way. I have no doubt but that the old birds fed them until they considered them fit to accomplish the journey, and then led them forth. The two I saw being too weak to top the bank, fell back and perished. The young birds have the beautiful colours of their parents, as is always the case with birds of which the cock and hen are alike.

I have, I fear, trespassed on your attention far too long, otherwise I would have given some account of the owls. The white owl, that "aerial wanderer of the night," is one of the most beautiful of our birds, and perhaps the most useful one we have—useful alike to the farmer and gardener, from whose hands, I fear, instead of protection, it frequently meets with persecution;—but time will not allow. I will, with your permission, quote a poetical description of the owl, which occurs to my memory:—

"In the hollow tree in the old grey tower,
The spectral owl doth dwell,
Dull, hated, despised in the noontide hour,
But at dusk he's abroad and well;
Not a bird of the forest e'er mates with him,
All mock him outright by day,
But at night, when the woods grow still and dim,
The boldest will shrink away.

And the owl hath a bride, who is fond and bold,
And loveth the wood's deep gloom,
And with eyes like the shine of the moonstone cold,
She awaiteth her ghastly groom;
Not a feather she moves, not a carol she sings,
As she waits on her tree, so still,
But, when her heart heareth his flapping wings,
She hoots out her welcome shrill.

* * * * *

Mourn not for the owl, nor his ghastly mate,
They are each unto each a pride,
Thrice happy perchance since a strange dark fate
Hath reft them from all beside."

XI.

ANNIVERSARY ADDRESS.

By the PRESIDENT, F. MAULE CAMPBELL, F.L.S., F.Z.S., etc.

Delivered at the Annual Meeting, 22nd February, 1889, at Watford.

LADIES AND GENTLEMEN,—

Will you allow me, as your President, on the completion of my term of office, to thank you for the unvarying kindness which I have at all times received at your hands, and to express my obligation to the officials of our Society, and more especially the Editor of our 'Transactions,' for their hearty co-operation in my endeavours to perform the duties which you did me the honour to entrust to my care.

The most natural course for me to take after my address of last year on "The Means of Protection possessed by Plants" would be to consider the analogous phenomena in animals. This would, however, involve a repetition of much which I had previously laid before the Society, and of many facts which are well known.

I have chosen for my subject this evening—STRUCTURAL VARIATIONS IN THE EYES OF ANIMALS IN REFERENCE TO THEIR FUNCTION. If succession of thought be advisable in the two addresses I have been called upon to make, it at least can be urged that the avoidance of danger by animals is greatly facilitated by the sense of sight. Further, the value of flight as a means of protection is much increased when sight enables the pursued to select from a distance a secure retreat. But quite apart from the consideration of the avoidance of enemies, locomotion is, under ordinary conditions, an essential requirement of any animal of fair size, for without such motion it could not obtain an adequate supply of food, and without sight it could not move in safety. Very minute animals do not require eyes any more than the plant *Volvox globator*, which is active in water. Animals without power of locomotion are eyeless, even when of some bulk, and an oyster, which is adherent to one spot during the whole of its imago existence, and which has its food brought to it by the medium in which it lives, could gain no more advantage from visual organs than a fixed plant, surrounded as it is by its pabulum of earth and atmosphere. Yet the plant is sensitive to light, and so are oysters, for they close their valves when the shadow of an approaching boat covers them. But we are referring to visual organs of some development, and the relations between them and locomotion are seen in the eyeless stationary mollusc which is the imago of a free-swimming larva with eyes.

The course I propose to adopt in my address is to draw your attention to the visual organs of the different groups of the Animal Kingdom as adapted to their function, and I shall conclude with a reference to the human eye.

It would be well now to briefly consider Light from a physical and physiological point of view. In the first place, do not let us think of light as we see it, but of the physical cause of the sensation, which is a movement propagated by successive waves in the ether distributed through the universe, in a manner analogous to circles caused by a stone thrown into water. These waves of light differ in size just as the waves and the ripples on the ocean. They all travel at the same rate, so that the number of waves which reach any spot in a given time is dependent on their length, and colour-sensations are due to the variations in the number falling on the eye in a certain time. The longest waves are invisible to us, and are called dark heat waves. The shortest waves are also invisible, and are called dark chemical waves, while the waves of moderate length produce the sensation we call light. But these latter waves are also not all of the same size. The longest of them cause the luminous sensation we call red, and as they become shorter, so the sensation is what we call yellow, green, or blue, while the shortest waves are violet. We see all these colours in a rainbow, and in the light after it has passed through a prism. The image so produced is named a spectrum. I have just stated that the waves which are longer than the red waves (called the ultra-red waves) and those which are shorter than the violet waves (called the ultra-violet waves) are invisible, but they can be brought within the range of human vision by altering their length. Yet we can form no opinion of the colour which the unadapted waves would produce if our eye were able to receive their stimulus, for the colour of a wave of light, like the note of a wave of sound, is dependent on its length. The rectilineal propagation of light, as seen in a sunbeam crossing a room, has led to the expression "rays of light," and thus we speak of (say) violet rays, as denoting the propagation of those waves which give to us the sensation of violet light.

We do not know that our fellow-man, and still less the lower animals, see colours as we see them. Experiments have shown, however, that these latter are also affected by different colours in different ways. The daphnias (water-fleas) prefer to rest under a green light rather than under violet, blue, yellow, or red. The question now arises, Can some animals see rays which are invisible to us? If so, they may perceive colours unknown to us. Let us briefly examine this. We know that light can be deprived of its ultra-violet rays if allowed to pass through a solution of sulphate of quinine, and that the luminosity of the beam is not sensibly weakened by its transmission. Now, Sir John Lubbock * has told us that out of 480 daphnias placed in a trough of water, 354 sought that portion illuminated with ordinary light, and only 126 remained where the incident rays had been deprived of those that were ultra-violet. The same naturalist has shown that ants remove their pupæ from the ultra-violet rays of the spectrum, and prefer to be under glasses of other colours than violet. Yet when sulphate of quinine was placed over violet glass, the ants accepted the shelter as well as that of the glasses of the other colours with which he experimented. Ants with their eyes blinded with varnish are not affected by ultra-violet rays. It would therefore seem that the ultra-violet rays are visible to the daphnias and ants, although they are not so to us. This leads us to think that while we are groping in darkness, other animals may in a greater or less degree see their way, just as, when quiet appears to us to reign in our study, to a spider the room may resound with the stridulations of its future mate. The expression that cats see in the dark, *i.e.* in places which are dark to us, is not so absurd as it may appear.

The sense of sight may be said to be possessed by an animal which is enabled to perceive, by means of a special organ, different values of light, but the exact anatomical representation for such a degree of vision is not known. Nor can we, without the most careful experiments, learn from the observations of the habits of the lower animals that they possess organs with such limited functions. The difficulty is realized in watching the eyeless hydra travelling towards the place where the direct rays of the sun are penetrating the water. The same phenomenon occurs with plants. Again, when we examine the so-called eyes of other members of the Cœlenterata and of the Vermes, we do not know whether the visual sensation exceeds that of mere light, as opposed to form and colour. It is, on the other hand, comparatively easy to form an opinion as to the possession of sight by the vertebrate whose habits are more related to our own, if only from observation we can ascertain, for instance, whether in its locomotion it avoids obstacles. But there is even a more trustworthy and extended source of information. We know the minute anatomy of our own visual organs, and when we find similar structures in other animals we know their function but not the extent of the function. We find differ-

* 'Journal Linnean Soc.,' Zoology, vol. xvi, p. 127. See also 'The Senses of Animals,' and 'Ants, Bees, and Wasps.'

ences in the eyes of the Vertebrata of which we can only guess the meaning, and under any circumstance we must admit that the anatomical basis of the perception of colour remains, like that of consciousness, hidden from our understanding.

The Nascent Eye.

We will now proceed to consider the nascent eye, by which I mean those structures which may be taken as the forerunner of the eye. Pigment-cells are more sensitive to light than unpigmented cells, and they may transmit the excitation caused by the chemical changes produced by the waves of light to the adjacent nervous substance. If this be the case, we may take the spots of colour of the Infusoria when affected by light to be capable of producing some response in these creatures. Ehrenberg describes these eye-like pigment-spots as veritable optic organs, but this view is untenable, for no nervous system exists in the Infusoria. A further advance towards vision is seen in the eye-spots of the Vermes. These consist of pigment-cells in connection with nerves, and they are sometimes provided with refractive bodies which may perform the function of lenses. Such organs are found in many animals, in a greater or less degree of development, and especially in the Cœlenterata, in which nerve-structure and sight are generally accepted as first occurring. It must, however, be borne in mind that the incidence of light on a nerve-ending surrounded by pigment, and even accompanied by refractive bodies, may only produce the sensation of heat. All nerves of special sense have special endings. The special endings of the optic nerve are either rod-like or conical bodies, called rods or cones, and they are essential to convert the external movement of the waves of ether into a stimulus, which, after travelling along the nerve to the central organ, is by it perceived as light.*

The Simple Eye.

The expression simple eyes is used in contradistinction to compound eyes, which are generally found in the Crustacea and Insecta, and simple eyes are widely distributed in the Invertebrata. The optical principle of these is the same as that of the eyes of Vertebrata. The latter, however, are more perfected, and we will consider them hereafter. The sensation of light may in many of the simple eyes be limited to mere opalescence without any perception of the form of external objects. Yet even such light would

* I have purposely limited my observations under this heading, and refer the general reader to Sir John Lubbock's recent publication 'The Senses of Animals.' See also 'Die Sehorgane der Thiere' by Carrière, Munich, 1885, and 'Comparative Biology,' by Balfour, vol. ii, p. 387.

be of service to animals seeking or avoiding places illuminated by the direct rays of the sun. Thus the snail or slug may be guided to shelter. It has, however, been suggested that the beautiful eyes of the pecten or common scallop, which are situated on the mantle, and number from 80 to 120, are organs for the emission of the phosphorescence* which it sometimes displays, but I have no reason to think this to be the case, and believe them to be eyes of high structural development.† Now, the sense of sight can be of no service to the pecten in obtaining food, which is brought to it by the water. Nor is vision really required for its protection against its enemies; for although it can move with some agility by closing its half-opened valves and forcibly expelling the water, yet like the oyster it can shut its hard encasement on the approach of danger. It is possible that its eyes serve to warn it of the ebbing tide, by being affected by the increasing intensity of light.

I propose for the moment to confine my remarks to simple eyes as possessed by insects and spiders. The general form may be described as a capsule, the internal portion of which is lined with pigment, while the outer surface is transparent and convex, and is called the cornea. It is generally of sufficient thickness to act as a lens; hence the term corneal lens. Behind the lens is a semi-liquid which fills the optic chamber, the hinder part of which is lined with the retina, and any image it receives is reversed as in the human eye. Such is the structure of the eyes of spiders, of many larvæ of insects, and of *fleas*, which, unlike most insects, have in their imago state two simple instead of compound eyes.

The sense of sight possessed by insects with such eyes is probably exceedingly limited, and it is quite likely that many of them are dependent more upon the senses of touch and smell for obtaining their food than upon the sense of sight. This seems confirmed when we consider that the larvæ of the dragon-fly, which can only obtain their food by employing specialised organs to capture other aquatic insects, have even in their earliest stages compound eyes, while the random leaps of the flea, which frequently only bring it back to the danger from which it had just escaped, tend to show the inferiority of the simple eye. A further advance in the structure of the simple eye is seen, for instance, in the caddis-flies, and in some of the Copepoda. The corneal lens is of reduced thickness, and immediately behind it is another of different refractive power. So far as the ocelli are concerned, many entomologists hold that their function is confined to the delicate perception of the various

* 'Proc. Acad. Nat. Science Philadelphia,' 1886, p. 61.

† See "The Eye of the Pecten," 'Quarterly Journal Micro. Science,' 1880.

degrees of light, and that they can produce nothing worthy the name of an image.

In the isapod crustaceans are found groups of single eyes, which might be considered as intermediate between a single eye and a compound eye. Landois,* however, in 1866, drew attention to eyes of caterpillars as a link between the two sets of visual organs. The subject appears to have been neglected until, in 1884, Lowne, in the 'Transactions of the Linnean Society,' † drew attention to these so-called "compound single eyes" in noctuid caterpillars. He describes beneath the lens of each eye a fusiform spindle, and attaches to it a function which we will explain hereafter. Several of these eyes are united by branches from the optic nerve.

The Compound Eye.

The outer surface of the cornea of the compound eye is divided into very many minute facets, behind each of which is a lens. Close behind this lens is a structure called the crystalline cone,‡ the apex of which is surrounded with pigment. This cone closes the top of a long narrow chamber, at the bottom of which is a spindle. Each corneal lens, crystalline cone, and spindle is enclosed in a common sheath, and the whole rests side by side with the other similar portions of the eye, on a membrane, at the back of which is the optic nerve. The long columns or rods are generally considered to be the endings of the optic nerve. The inner extremity of the long rods is usually surrounded with pigment, and they are penetrated by many small tracheal vessels. Now, if we look at the eyes of a moth which has been kept some time in darkness, we see a brilliant luminosity, which after a little time fades away. The luminosity is explained by the reflection from these tracheal vessels, and its gradual disappearance is due to the contraction of the pigment surrounding the tops of the crystalline cones. Pigment, as already stated, is exceedingly sensitive to light, and just as the granules are brought closer together in the skin of frogs and fishes,§ by the action of the sun, so are the pigment-granules on the top of the crystalline cone brought closer together and so shut off the rays of light.

The manner in which the compound eye subserves the function

* 'Zeitschrift f. Wissenschaftliche Zoologie,' Bd. xvi, p. 27; and 'Ann. Mag. Nat. Hist.,' 3rd Ser., vol. xix, p. 61 (1867).

† 2nd Ser., Zoology, vol. ii, p. 395.

‡ In some insects the crystalline cone is replaced by a capsule containing fluid.

§ The direct effect of light on pigment is perceptible, but it must not be confounded with the protective results of the chromatic function to which I refer in my conclusion.

of vision is still an unknown problem. Johann Müller,[*] in 1826, propounded the so-called mosaic theory. He supposed that each facet produced a single visual impression of objects in their natural position, and that the whole visual field consisted of a mosaic of such impressions. R. Wagner,[†] in 1835, suggested that the compound eye was an aggregate of simple eyes, and that the whole visual field was a mosaic of reversed and inverted images. Wagner, Ruete,[‡] and Dor[§] mistook for the retina the capsule of the crystalline cone; and various writers, *viz.* Max Schultze,[||] Claparède,[¶] Grenacher,[**] Hickson,[††] and quite recently Patten,[‡‡] ascribe to it a position between the cornea and the inner end of the great rods. It is, however, generally held that each facet takes in a small portion of the field, which is inverted and reversed as in a camera-obscura, and that the insect combines the separate images to form one picture. But how? Let us suppose that the rays of an external object which we will take to be an arrow fall upon three facets of a compound eye. The image of the arrow would be inverted and reversed as below.

A

B

A. External object. B. Three images of the same inverted.

It is not easy to understand how an insect by means of its nervous system could combine the inverted images so as to represent the arrow. The difficulty of correction would be so great that Müller was led to believe that the visual impressions originated by each facet were neither reversed nor inverted, but that the mosaic pattern on the retina must consist of objects in their natural position.

I have already stated that the generally-accepted opinion is that the long rods are terminations of the optic nerve. Gottsche[§§] suggested that they were highly refractive axial threads. Lowne,[||||] however, holds that the spindle which they contain and which corresponds to that found in the "compound single eyes" of noctuid

[*] 'Zur vergleichende Physiol. des Gesichtsinnes des Menschen und der Thiere,' Leipzig, 1826, and a translation by Baly, 'Physiology of the Senses.'

[†] Wiegmann's 'Archiv,' Bd. i, p. 372.

[‡] Gratulationsschrift der med. Fac. zu Leipzig zu C. G. Carus, 1881.

[§] 'Archiv d. Sciences Phys. et Natur.,' 1861.

[||] Schultze's 'Archiv,' Bd. ii, p. 404.

[¶] 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. x.

[**] 'Untersuchungen über das Sehorgan der Arthropoden,' Göttingen, 1879.

[††] "Eye and Optic Tract of Insects," 'Quarterly Journal of Microscopical Science,' vol. xxv (1885), p. 215.

[‡‡] "President's Address," 'Transactions Entomological Society,' 1888, p. xlviii.

[§§] Müller's 'Archiv,' 1852, p. 483.

[||||] *Loc. cit.*

caterpillars, should be regarded as "lenses of very short focal length." He contends that the optic nerve has never been satisfactorily traced into the great rods, that the nerve ends beneath the great rods in bodies identical in all essential characters with the rods of the vertebrate retina, and further that vision would be optically impossible if the nerve ended in the great rods themselves. He states that the great rods are lenses which magnify and reverse the sub-corneal images, and project them as a common image on the retina, an arrangement which he claims to have discovered. These views have met with opposition, chiefly as it appears to me on the ground that nerve-fibres are believed to penetrate the great rods, which would be fatal to the new theory. We may, however, look forward with interest to the further publications of Lowne's researches on this subject. The question, moreover, arises, whether there is any power of lens-adjustment in the compound eyes. An object at a distance of more than about half an inch from the cornea requires no accommodation owing to the minute size of the lens and its exceedingly short focal length. The accommodation for objects still nearer is, according to the unpublished statements of Lowne, provided for by a perfectly intelligible mechanism.

The swift and safe flight of many insects shows that they not only have their wings under complete control, but that they also possess excellent visual power, which, so far as locomotion is concerned, is not so much needed by slow fliers. Osten-Sacken* points out a relation between the large compound eyes of some of the Diptera, and their habit of poising as if to survey the field of vision. Such insects rarely walk, and do not require the protection of the bristles found on other members of the same group of flies which have smaller eyes and less power of flight, and walk constantly.

The Eyes of Vertebrata.

As already stated, the eyes of the Vertebrata are constructed upon the same general principles as the simple eyes of insects. The vertebrate eye is, however, surrounded by much harder tissue. The lens is elastic and is in most cases capable of being adjusted to near and distant objects by means of a muscle which surrounds its edge. In front of the lens is the iris, which is involuntarily dilated or contracted according to the degree of light and the distance of the object which is looked at. The iris is only found in eyes of Vertebrata. The mode of distribution of the optic nerve

* 'Transactions of Entomological Society,' 1884, p. 497.

is distinct from that of the eye usually found in Invertebrata.* In the latter case the nerve becomes differentiated into its terminals as it approaches the optic chamber, the hinder portion of which is lined with nothing but the nerve-terminals which point towards the light; on the other hand, in the Vertebrata the optic nerve becomes differentiated with terminals only after it has entered the optic chamber or eye-ball and after it has commenced its retinal expansion, and the nerve-terminals, namely, the rods and cones, point inwards, *i.e.* away from the light. Hence there is a spot on the retina of the vertebrate eye where there are no nerve-endings, or in other words where there is not the structure essential for the production of a visual sensation. Thus even in the human eye there is a blind spot to which I shall afterwards refer. The most acute vision of the eye is situated where a line would meet the retina if drawn through the centre of the cornea and the centre of the lens. This line is called the optic axis, and at the point where it meets the retina there is, in the human eye and in no other, a slight circular depression of a yellowish hue called the yellow spot. It is there that the nerve-endings are the most numerous, but instead of the rods and cones being uniformly distributed as in other parts of the retina, the cones are abundant, while the rods are found only towards the margin of the depression. When we look at anything, we place our eye in such a position that the image falls on the yellow spot; this is called "direct vision." The term "indirect vision" is applied when the image falls on the other parts of the retina, in which case it is much less distinct.

The various habits of the Vertebrata necessitate some adjustment in their visual organs. Thus the fish, living in a dense medium, has a different lens from that of a bird with a wide field of vision.

THE EYES OF FISHES.†—The eyes of *Myxine*, *Petromyzon*, and *Amblyopsis* are hidden. In *Amphioxus* they are represented by a mere pigment-spot lying directly on the nervous system. The function of such eyes must be most limited. In all other fishes the eye is well developed, but the muscles which serve for adjustment are feeble. The cornea is comparatively flat, and part of the lens projects through the pupil, which is exceptionally large, while the iris is capable of but very slight contraction and dilation. The outer covering of the eyeball, or the sclerotic, contains some cartila-

* The eyes of the pecten and the dorsal eyes of the Onchidia, to which I refer hereafter, resemble those of the Vertebrata in this respect. The "pineal eye" of reptiles mentioned in the conclusion of my address is of the Invertebrate type.

† See "Beiträge zur Anatomie des Sehorganes der Fische," by Berger, 'Morphologisches Jahrbuch,' Band. viii, in which there is a bibliography.

ginous plates which prevent the alteration of its shape, and we find here, in a nascent form, the bony sclerotic ring which is so useful to birds, and which I shall mention hereafter. In some large fishes the whole outer covering is converted into a cup of bone with two orifices, one for the cornea, and the other for the entrance of the optic nerve. The fish has no lachrymal glands to moisten the external surface of the eye, nor indeed does the medium in which it lives render this necessary. The lens is large in proportion to the size of the eye, and is almost spherical and of extreme density. All these adjustments are seen to be required when we consider the habitat of the fish, but they are not well suited to aerial vision. It is necessary that the lens should be of greater density than the surrounding medium, in order that the rays of light should be refracted towards a focus. The large size of the lens increases the luminosity of the image, and its spherical form is the most suitable owing to the high refractive index of the water, and for this reason divers wear strong convex glasses, which enable them to see distinctly. The protrusion of the lens through the iris enables the fish to see objects floating above it. Nor are these the only peculiarities in the eye of the fish. A delicate fold* (*processus falciformis*) from one of the coats of the capsule of the eye (*the choroid*) traverses the retina, and terminates in a vascular enlargement (*campanula Halleri*) attached to the centre and back part of the capsule of the lens. Another vascular body of the choroid (*the choroid gland*) causes the retina to project near the entrance of the optic nerve into the chamber of the eye-ball. This chamber is filled, as in all eyes of Vertebrata, with a semi-liquid (*the vitreous humour*) and is closed in front by the lens. Cuvier and Valenciennes† thought that the choroid gland might serve to adjust the eye to different distances. When charged with blood it certainly may push the retina nearer to the lens. The *campanula Halleri* may also act as an accommodation, not only by means of the muscular fibres it contains, but also when enlarged, for it may then cause the vitreous humour to alter the shape of the optic chamber, and thus affect the distance between the retina and lens. But the exact function of these bodies is not known.

Most kinds of fishes are without eyelids, but the sharks and dogfishes not only possess these organs, but some of them have also a movable nictitating membrane, such as is found in many birds, and to which I shall refer hereafter.

* See 'Die Sehorgane der Thiere,' by Carrière, Munich, 1885.
† 'Histoire naturelle des Poissons,' tome i, Paris, 1828.

In the monkfish the common skin of the body passes over the eye, and has the function of an eyelid. The eyes of the skates or rays are particularly worthy of notice. Hanging from the upper part of the iris is a fringed curtain which nearly covers the pupil. It is generally supposed that this organ is used for shutting off the light when too brilliant. This may certainly be of service to flat fishes like the skates whose eyes are more exposed to the direct rays of the sun. But another suggestion has been made, *viz.* that the fimbriated veil may serve to limit the retinal image to the object looked at, and thus prevent the attention of the fish from being unnecessarily diverted. Should this be the case, the curtain of the eye of skates is analogous to one of the means used by photographers to produce a vignette. In contradistinction to the rays, the flat fishes (*Pleuronectidæ*), such as the sole and plaice, are remarkable for their asymmetrical bodies and the position of their eyes. At an early stage their form is symmetrical, and their eyes are on opposite sides of the head, like those of an ordinary fish.* The depth of their bodies, the small size of their lateral fins, and the absence of a swimming-bladder, render difficult the maintenance of a vertical position. Falling on one side, they try to see above them with the lower eye, and their efforts are so constant that the bones of the head become contracted and their eyes acquire the well-known abnormal position.

The sense of sight has possibly been more elicited by man in the fresh-water fish than in any other group of animals. The nature of their habitat and the etiquette of sport require that they should be captured by wiles which may be detected by acute sight, and where angling is constant the fish soon learn to distinguish between their food and the bait. It is true, deep-sea fish are caught with clumsy tackle, but that may be partly due to the few individuals which have, out of an untold number, had the opportunity to gain experience of a hook. The visual judgments of fish and the art of the angler are, in a much-frequented stream, running a race. Wit sharpens wit. The dry fly has become a necessity where the trout are accustomed to the appearance of a sunken fly, and anglers

* See Traquair "On the Asymmetry of the Pleuronectidæ," 'Trans. Linnean Soc.,' vol. xxv, p. 263. Van Beneden in 1853 ("Note sur la Symétrie des Poissons Pleuronectes dans le jeune age," 'Ann. des Sciences Naturelle,' 3e série, vol. xx, p. 340) first recorded the change of position of the eyes of the Pleuronectidæ. A. W. Malm also elucidated the true mode in which the eye passes from the blind side ('Svensk. Vet. Akad. Handl,' vol. vii, 1868, p. 28). A translation of Schiödte's paper "On the Development of the position of the Eye in Pleuronectidæ" is in 'Annals and Magazine of Natural History,' ser. 4, vol. i, p. 378. Steenstrup in 1863 ('Ofvers. Dansk. Vidensk. Selsk. Forhandlung.' 1863, p. 145), stated in error that the eye of the blind side pierced the tissues of the head to reach the other side.

who would be triumphant in Scotch or Irish waters will return with an empty basket after a visit to a well-whipped stream. But however careful fish may be, they are always at a disadvantage when tempted by a dry fly, for their eyes as we have seen are specially adapted to their habitat, and though they may distinguish a stranger from one who regularly supplies them with food, yet they seem to detect with difficulty minute differences in an object out of water. A friend informs me that the trout in a neighbouring oft-frequented water will not take the welcome natural May-fly unless its wings are well raised, owing apparently to the fact that the wings of an artificial fly fall on the water after a little use. If these fish had a keen vision for floating objects, they would recognize the difference between their natural food and its imitation, irrespective of position.

Amongst the most interesting eyes are those of the Anableps. This fish inhabits fresh waters in Central America and the tropical parts of South America. It is constantly on the surface, and each eye is divided into an upper and lower portion, as if adapted to both aerial and aquatic vision.

The Eyes of Birds.—The rapid motion of birds and the extended horizon which results from their frequent elevated aerial position, would lead us to expect adjustments in the eyes of birds which are not found in other Vertebrata.

Sight is the initial means of livelihood to birds. It is essential for their safety, if not for the acquisition of their food, that they should rapidly focus on their retina the images of external objects, even when close to them. We are all familiar with the different appearance of striped from unstriped muscle, and we know that the duration of the contraction of the latter is the longer of the two, and that therefore it is less efficient when quick adjustments are required. In our own eyes the muscle which regulates the focus of our optic lens is unstriped, but that of birds is striped, and hence we may assume that they can change the focus of their eyes more rapidly than we can. Moreover, their power of accommodation is facilitated by the great mobility of their iris, and by muscles which affect the degree of convexity of the cornea and the shape of the eyeball. Yet even the adjustment of our lens is so quick, that unless our attention has been directed to the subject, we think we can focus near and distant objects clearly at one time, which is just as impossible with the eye as it is with a photographic camera. When travelling by express train we find it difficult to observe objects we pass unless they are at some distance, yet a bird in rapid flight appears to see its quarry with as much clearness when near as when remote. But there are other modifications in the eyes of birds. The eye as compared with the brain is of unusual size, and it is also of peculiar shape, for the antero-posterior axis is considerably lengthened. The cornea is prominent, and the retina is further removed from the lens than in the human eye, while the surface of the hinder portion of the eyeball is larger than that of the front portion. The peculiar form of the eyeball is most marked in the nocturnal birds of prey, and least in aquatic birds, in which also the cornea is less convex.

Under the cornea of all birds is a bony ring, which is highly developed in owls. In such birds bony plates are arranged side by side in the direction of the axis of the eye, and form a case around the optic chamber. These bones can be made to overlap each other, and, as the case contracts, the cornea and the lens are not only rendered more convex, but the distance between the lens and the retina is increased. This arrangement permits of acute vision of near objects. All these modifications of the vertebrate eye are such that the focus of the eye can be made to vary between long and short-sighted vision, and also that the animal can see in a weak light. All the structures necessary to effect these objects are found in a greater degree in birds, such as owls, which are of nocturnal habits.

All birds, with the exception of the wingless Apteryx, have a vascular organ, called the *pecten*,* which projects boldly into the optic chamber close to the entrance of the nerve. It corresponds to the *processus falciformis* of fish, to which I have already referred, and its function is believed by some to be confined to the nourishment of the inner portions of the eye. Others hold that, when distended, it may by means of the vitreous humour alter the shape of the optic chamber and assist in adjusting the vision to external objects as suggested to be the case with the *processus falciformis*.

Birds have three eyelids, two of which correspond to our own, but are unlike ours in this respect, viz. that our upper eyelid is much more movable than our lower, whereas the reverse is the case with birds. Their eyelids rarely have lashes, and, when these occur, they may be regarded as feathers rather than hairs. The third eyelid of birds is the nictitating membrane, to which I have referred as being possessed by sharks. This is situated in the inner corner of the eye, and consists of a thin membrane to some extent transparent, which can be drawn across the eye as a curtain. It

* See 'Die Sehorgane der Thiere,' by Carrière, Munich, 1885, and 'Untersuchungen über den Kamm des Vogel's, by Mikalkovics, Schultze's 'Archiv,' Band ix. The development of this organ is treated of by Balfour in 'Comparative Embryology,' vol. ii, p. 411.

exists also in some of the Mammalia, as for instance in the walrus, and is useful in protecting the eye against intense light, while it does not prevent vision. In the human eye it is represented in a very rudimentary form by the red fold called the "caruncle," which varies in size not only in races, but also in individuals. The nictitating membrane is always associated with a special gland for lubrication.

The Eyes of Reptiles present no very special feature. The muscles which serve as adjustments are strong and striped. In the tortoise and some of the lizards the external covering of the eyeball contains a circle of bony plates such as just described as existing in birds, but it is of much less development. Snakes, geckos, and amphisbænas have no eyelids, but their cornea is protected by a transparent capsule. The chamæleons have a single eyelid consisting of a muscular ring with a circular opening, and they can move their eyes very freely. Other reptiles have an upper and lower eyelid, and the land-lizards can raise their lower eyelid like a transparent curtain. The turtles have a nictitating membrane. The *processus falciformis* of fishes and the pecten of birds are represented in the lizards by certain folds of the choroid.

The Eyes of Amphibians are sometimes without eyelids. The salamanders have two. The batrachians, or frogs and toads, can withdraw the eyeball into a socket. They have an upper eyelid, and, with the exception of the Surinam toad, also a nictitating membrane. Toads have a rudimentary lower eyelid. The lens of amphibians has not such a high refracting power as that of fish.

The Imperfections of the Human Eye.

I have thus far briefly sketched some of the modifications of the eye in the different groups of the Animal Kingdom, and we find in them all a practical adaptation to the wants of the organism. We must, however, bear in mind that the faculty of vision is dependent not only on the eye but also on the percipient centre, *i.e.* the brain. Thus when we come to consider the imperfections of even the human eye as an optical instrument, we shall find that they are all corrected either by the retina itself or by our interpretation of the sensations conveyed to us. Brass and glass instruments with similar defects require brass and glass adjustments, but the brain counteracts the errors of its own instrument.

I have already referred to the blind spot on the retina of the vertebrate eye. It is situated in the human eye about one-tenth of an inch nearer the inner (nasal) side than the yellow spot, and is about one-sixteenth of an inch in diameter. We can recognize its existence by the old experiment of looking at two spots of ink on a piece of paper on the same level and about three or four inches apart. We hold the paper in front of us at arm's length and draw it towards us, and as we fix say the right eye on the spot to the left, we find the spot to the right disappears and then becomes again visible when the paper is closer to us. So large is the blind spot that the experiment can be varied by slowly walking backwards from two plates about three feet apart fixed on a wall. Mariotte discovered this phenomenon and amused Charles the Second by showing him how he could see men with their heads cut off, for while the image of the head of a man could be made to fall on the blind spot, that of the figure fell on the surrounding retina and was visible. There are other blind spots, or rather blind streaks caused by the distribution of the blood-vessels over the surface of the retina. The larger vessels shut off the light altogether, and the smaller ones reduce its quantity. If we make a hole with a needle in a card, and look through it at a bright sky, moving it a little from side to side, the bright spot will disappear as its image falls on one of the blood-vessels. We perceive the shadows of these blood-vessels, which are called Purkinje's figures, by facing a dark wall and holding a candle close to the outer side of the eye, so that the light falls obliquely into it. It is only with some little difficulty that we can discover these gaps in the field of vision by means of the above experiments, and the reason is not because we have two eyes, and that what we do not see with one eye we see with the other. Persons blind with one eye do not notice these defects, which are rectified by the constant movement of the eye, and by the attention being generally directed to the image thrown on the yellow spot where the vision is most acute, and where there are no such imperfections.

The question, however, naturally arises, How is it that we are not conscious of a blank in the field of vision? But what character could this blank assume? It could not be that of a black patch, because on the blind spot there are no structures to enable us to see anything, any more than there are on the soles of our feet. We find on carefully noting our experiences in the above experiments that the field of vision closes in, just as if there were no blind spot at all.

Further, when we buy a microscope or telescope, we expect it to be achromatic, in other words that it should give an image with a sharp outline free from any fringe of colour. We require an instrument which will bring to the same focus the different rays of colour seen in the spectrum, and which constitute white light.

This is effected in optical instruments by using lenses of various kinds of glass. Now, on looking at a spectrum at some distance, we find we cannot focus at the same time the red and violet rays. Again, if we make a narrow slit in a card and place it in a glass coloured violet with cobalt oxide, which shuts off the yellow and green rays, and then look at a point of light through the covered aperture, we shall see either a blue centre with a red fringe, or a red centre with a blue fringe, according as the image falls in or out of the true focus. Yet with ordinary light we do not notice these chromatic defects, which, like the shadows of the blood-vessels in the retina, are observable under special illumination.

Another defect in our eye is that the various media through which light passes are not of uniform transparency. The lens itself is composed of fibres arranged around six diverging axes, and the rays we see around stars and street lamps are due to its construction. Yet these appearances only arise when viewing illuminations which either from their size or distance appear small. The same cause leads some people to see two or three new moons instead of one. Further, the vitreous humour contains floating bodies, called *muscæ volitantes*, which are seen as irregular rows of beads, and are occasionally inconvenient in microscopic examination. They are "the will-of-the-wisps" of the eye, for they float away as soon as an attempt is made to fix the vision upon them.

The nicety of structure requisite for the eye to perfectly discharge its function is even traceable in the abnormal results occurring in such eyes as are of a somewhat defective formation. If, for instance, the curvatures of the cornea or of the lens are not symmetrical, a difficulty arises in seeing horizontal or vertical lines. Some people cannot see steps and yet can see the banisters; others can see the banisters and cannot see the steps. But how rarely do we meet with such a defective condition of the organ of sight? Again, the human cornea is supposed to be the most perfect projection-lens in existence, owing to its ellipsoidal surface. To produce this form is the thing striven for by opticians,* but hitherto it has baffled all their resources. The eye also has an advantage over all other optical instruments in its large field of vision.

Colour Sensations.

I have already stated that the region of acute vision is limited to the yellow spot. The yellow pigment, however, absorbs the greenish-blue rays, so that yellowish light falling on that portion

* See "The Construction of Photographic Lenses," by C. Beck, 'Journal Soc. of Arts,' vol. xxxvii, p. 180.

of the retina appears to us as white, and blue light appears darker. Hence it follows that the inequalities of the retina affect the colour as well as the distinctness of the image. We find also that the susceptibility of the retina to red rays diminishes towards its circumference, so that red colours seem much darker when viewed indirectly. We recognise this when, after looking at a red geranium, we raise our eyes so that the image of the plant falls outside the yellow spot, for we find that we then see the leaves and their colour, but not the blossoms.

The inequalities of the retina as to red rays are also illustrated in one of the toys of the nursery. Four figures of mice are stitched with red wool on a blue or green ground, and as the child moves the piece of work up and down in front of her eyes, the mice disappear and reappear as their image falls on or outside the yellow spot.

But to return to our subject. All the contradictory sensations of colour are reconciled not only by the constant movement of the eye, but also by our learning to judge from the colour-sensation of indirect vision that colour which we would see if the same object were viewed by direct vision. Under most circumstances we form an opinion of the colour of an object by direct vision, *i.e.* by placing our eye in such a position that the image falls on the yellow spot. Now we have already seen that the pigment of this yellow spot absorbs some of the rays, and that it thus affects the colour of an object we *look* at. We see then that there can be no exact correspondence between the rays of light and the colours they produce, and in truth colours are only subjective. This is of subordinate importance. The primary use of colour is the facility with which it enables us to discern objects, and the eye duly performs this function inasmuch as similar light produces under like conditions a like sensation of colour.

It is curious to observe that the yellow spot is less sensitive to weak light than the other parts of the retina. Thus stars of inferior magnitude become visible or more brilliant when viewed *indirectly*. This may be due to the yellow pigment weakening the blue rays. There is also an analogy between the retina and the skin. Those parts which are most discriminating in the sense of touch are the least tender because more constantly used. So the yellow spot is less sensitive to weak light than the other parts of the retina.

I have already referred to the red-colour blindness of a great portion of the retina, and this condition is seen in an extreme form in the inability of many persons to distinguish green from red. The fact that colour blindness is nearly twice as prevalent among the Quakers as among the rest of the community has led Francis Galton to suggest that it may have been a physiological basis for the opinions of the founders of the sect "that the fine arts were worldly snares," and also for their conspicuous practice of dressing in drabs. Nothing can be done for the colour-blind by either oculist or optician, for the anatomical basis of colour-sensation is unknown. The absence of cones in the retinas of nocturnal animals has led to the suggestion that these nerve-endings are concerned in colour-vision, but we do not know that these animals are colour-blind. The theory appears, indeed, to be confirmed by the absence of the other special nerve-terminals (the rods) of the retina in the yellow spot, which is full of close-set cones, and is most sensitive to colour rays, yet, as Foster observes: "the fact may equally tend to prove that the rods are of no use in vision at all." There are no rods in the retina of snakes.

The interesting discovery that the colour of the outer limbs of the rods of the retina is due to a pigment called "the visual purple," which is bleached by exposure to light and restored to its natural colour by darkness, appears to open the way to further knowledge of colour-sensation. Images can be fixed like a photograph on the visual purple, but the question of its function remains to be solved. This must also be said of the red and yellow globules of oil which are found in some of the cones of the retina of birds, reptiles, and amphibians. It has been suggested that these globules would shut off almost completely from their cones, blue light, which would only reach the cones without globules. The red globules would admit red light, and yellow and green light would enter through the yellow globules. The theory is attractive, but it is not proved.

The Perception of Sight.

The images of external objects are all inverted and reversed on our retina, or in other words topsy-turvy. The top becomes the bottom, and the right of the object becomes the left of the image. It is generally supposed that in our infancy our sense of touch enabled us to see things in their proper position, and so complete was the lesson and so constant has been the practice, that we now can with difficulty imagine we ever saw them otherwise. This is an unsatisfactory explanation, for there are many physiological facts which contradict it. For instance, when we view objects with our head between our legs, our position is that of a man standing on his head, and yet the objects we see are not inverted. Cases are recorded in which persons have obtained sight for the first time in after life through an operation, and they have seen things in their proper position. Chickens which have been blindfolded immediately after leaving the egg have, on removal of the hood, pecked at grain with the unerring aim of an old bird.* The most probable theory appears to be, that there is a complex relation between the position of the eye and that of the image on the retina, and that both are factors leading to a correct judgment which depends upon complex relations between different parts of the brain.

We have also obtained a very different idea of the size of external objects as compared with their image on our small retina. The perceptions of distance and size which we derive solely from our field of vision are limited to the relative size and position of the different objects in the field, and this alone would be of little service to us. We learn from the sense of sight the topographical relations of objects, but it is the sense of touch and muscular movement which has enabled us to judge of size, and it is the association of the two senses which has formed our interpretation of the size and distance of objects in the image thrown on our retina. If we hold, say, an envelope in one hand, and pass the other round its form, we have an idea how in infancy we first obtained a judgment of the size of an object which we saw.

The relative size of known objects in the field of vision to unknown ones enables us to form judgments of the latter. But the perception of the size of an object varies with concurrent conditions. Thus the moon appears smaller at the zenith than on the horizon, for we are then influenced by its relative size to terrestrial objects. Again, just as we are deceived as to distance by the muffled voice of the ventriloquist, so are we by the size of a man whom we see in a fog. The indistinctness of the image gives us an idea of distance, for which we make an allowance, and thus think the man larger than he is. Nor does an object appear to be of the same size to every individual. The image of the full moon on the retina of all human beings is about $\frac{1}{230}$th part of an inch in diameter, yet few will agree as to its apparent size. Our perception of magnitude is widely different from what it was in our childhood, and there is every reason to believe that the apparent size of any object varies throughout the animal kingdom according to the structure of the organism. In truth all our notions of size and position and solidity are visual judgments and depend as much on the brain as on the eye. The further consideration of these matters would carry us far beyond the limits of my address.

* See Spalding's experiments in 'Macmillan's Magazine,' Feb. 1873.

Conclusion.

I have already referred to the difference which exists between Vertebrata and Invertebrata as to the arrangement of the optic nerve upon the retina. The eyes of the tentacles of the *Onchidia* (slug-like Molluscs) are not exceptional in this respect, but the greater number of the species of this genus have on their shell-less backs other eyes, the optic nerve of which enters in the same way as with the Vertebrata. In some individuals there are as many as one hundred eyes. Such *Onchidia* live in tropical regions on the sea-shore, or in brackish marshes, and obtain their nourishment from the organic particles mixed with the sand as they creep along close to the edge of the water. They thus fall an easy prey to certain fishes (of the genera *Periophthalmus* and *Boliophthalmus*) which skip along the water-line and even on the land where they can live for some time. Now the back of the *Onchidium* is studded with glands with minute orifices capable of expelling a thick secretion. It is supposed that the Mollusc is warned of danger by the shadow of the leaping fish falling on its dorsal eyes. It then contracts its body and emits with considerable force its secretion, which if not offensive or injurious may at least disturb the fish and divert its course. Semper* has observed the habits of the *Onchidia*, and he points out that, so far as his experience goes, those species with dorsal eyes have precisely the same distribution as the two fishes already named, whereas where the fishes are not, there the *Onchidia* have no dorsal eyes. In our English species (*O. celticum*), as indeed in many others, these highly-developed glands and dorsal eyes are both absent. This is as we should expect, for the two sets of organs seem so closely related for defensive purposes that one is next to useless without the other. Time prevents the consideration of the interesting question as to the development of these dorsal eyes, or as to how far in such species as our own, these organs, together with the associated weapons of defence, may at one time have existed, and have become abortive through disuse. It is sufficient for our present purpose to point out the apparently remarkable adaptation of the dorsal eyes to the wants of the organism possessing them.

The degeneration of the eye from disuse, followed as it is frequently by blindness, is familiar to most of us. Thus people who squint and who saw at first all objects double, may lose in time the sight of one eye, by constantly suppressing its image in order

* See "Ueber Schnecken-Augen v. Wirbelthiertypus," by Semper, 'Archiv f. Mikroskopische Anatomie,' Band xiv, p. 118; also by the same author, 'Animal Life,' pp. 281 and 378, and 'Reisen im Archipel der Philippinen,' Wiesbaden, 1877, 2nd part, vol. iii.

to obtain single vision. In other words the eye may learn not to see, and ends in not being able to see. The absence of light, or what is called cavern darkness, which is associated with the conditions of existence of the adult stage of many animals, has caused in them the same visual degeneration. The function of the organ has become useless. Thus for instance the crabs* which live in the branchial cavities of many Mollusca gradually become blind, and, when old, lose all trace of eyes, which were well developed before they entered their dark habitat. Thus, too, the eyes of the mole are in course of retrogression and sometimes vary in structure in the same individual. Thus, too, the blind Amphibian—*Proteus*—living in the subterranean waters of Carniola and Dalmatia, has eyes in a rudimentary stage, deeply seated in the head and covered with skin. There are many such illustrations, and to this incomplete list may be added the reptiles with a retrograded "pineal eye" † situated on the median line on the top of the head, and which appears to have been possessed in full development by some of the animals of the Pre-tertiary periods. The exact function of this organ is not known, and we can only guess at the conditions which have led to its disuse and degeneration, but it may have been limited to the acute discernment of the direction whence came rays of heat or light, and have guided animals to clear atmosphere out of dense mists. In fact, just as the ocelli of moths may enable these insects to avoid that excess of light which renders them temporarily blind as to form by the contraction of the pigment of their compound eyes,‡ so the "pineal eye" may have enabled extinct animals to reach places where their true organs of vision could perform their function. As the atmosphere of our earth assumed its present condition, so the "pineal eye" would have become of little use, and would have degenerated until it reached the various stages of retrogression seen in some of the reptiles of our time.

It is clear that there is a relation between the absence of light and the degeneration of visual organs, but it is equally true that many animals inhabiting dark caves, and the Pacific Ocean at a depth of nearly three thousand fathoms, have well-developed eyes, while others have not. It has been suggested that the bottom of the ocean is illuminated with phosphorescent light diffused by deep-sea creatures, but of this there is no direct evidence, any more than

* These crabs belong to the family Pinnotheridæ.

† The pineal eye is of the Invertebrate type. See "Pineal Eye in Lacertilia," by W. Baldwin Spencer, 'Quarterly Journ. of Microscopical Science,' vol. xxvii, new series.

‡ See supra p. 112, and my paper on "Instinct" in the 'Transactions' of this Society, Vol. III, p. 133.

there is to show that the animals with eyes in the dark caves have not been there long enough to lose them. We know, however, that the deep-sea fishes have, like nocturnal feeders, large eyes, which are adapted to a habitat where there is but little light, and that many of the abyssal fauna—including fishes—are luminous on account of their mucus being phosphorescent, while others have under their control special phosphorescent organs* which may enable the sexes to find each other. The brilliant colours of many of these deep-sea creatures would at one time have been regarded as a proof that the rays of the sun reached their habitat. Experiments have, however, shown that pigments in animals as well as in flowers are developed in darkness as well as in daylight.

I cannot close this address without very briefly referring to the so-called "Chromatic function," with which the eye is closely connected. The term is applied to the protective changes of colour observed in fishes, reptiles, frogs,† etc., which are due to the altered distribution of differently-coloured pigment cells. The action of light upon their skin does not produce these phenomena, which have been shown to be dependent upon the light reflected from external objects reaching the eye. Thus pipe-fish when amongst living sea-weeds resemble them even to a mixed colouring of green, yellow, and white, and after having rested half an hour amidst dead sea-weeds become so dirty-brown that they can hardly be distinguished from their immediate surroundings.‡

The adaptation of the eye to light is the most delicate response of nerve to Nature's touch. We can investigate the minute anatomy of the retina, but, having done so, we find ourselves as far off as ever from comprehending how it is that contact with waves of ether can produce in us the sensations that we receive from sight. This remains always a mystery as obscure as life itself. The eye cannot be satisfied with seeing, because the mind recognizes that seeing is but the effect of a cause which cannot be seen.

* See Günther on "Deep Sea Fishes," 'Report 'Challenger Expedition,' Zool., vol. xxii (1887).

† See Lister's paper, "On the Cutaneous Pigmentary System of the Frog," 'Philosophical Transactions,' 1858, p. 627; and Pouchet's "Note sur la mutabilité de la coloration des Rainettes, etc.," 'Académie des Sciences, comptes rendus,' tome xxvi, p. 574.

‡ See "Bemerkungen über den Farbenwechsel einiger Fische," by Heinke, 'Schriften des Natür Wissenschaftlichen Vereins für Schleswig-Holstein,' Kiel, 1873, p. 225.

XII.

A NATURALIST'S CALENDAR FOR THE SOUTH-WEST OF HERTFORDSHIRE.

By John Hopkinson, F.L.S., F.G.S., etc.

Read at Watford, 22nd March, 1889.

The meeting of our Society held in May, 1875, was devoted to the consideration of periodical natural phenomena, four papers upon this subject being read. The first of these was an introductory paper, in which I gave a list of the species and a calendar of the phenomena recommended for observation by the Meteorological Society, the dates in the calendar being compiled from the Rev. T. A. Preston's record at Marlborough, and that of the Rev. L. Jenyns (now Bloomfield) at Swaffham Bulbeck, near Cambridge. The Cambridge records were from observations extending over the 12 years 1820–31, and the Marlborough over the 10 years 1865–74. The three papers which followed, by other members of the Society, were on the plants, the insects, and the birds to be observed.

The object of these communications was to induce members of our Society to observe and record such phenomena, to which the name of phenological has been given, and for the following year I was able to compile the first of a series of annual reports, continued to the present time.

My own record at Watford extends over the 12 years 1875–86, but for the first year very few observations were made. For these years I now give a naturalist's calendar for the south-west of Hertfordshire, somewhat similar to the calendar for the northern border of the county for the 10 years 1877–86 communicated to the Society by Mr. Fordham two years ago. The calendar gives the earliest, latest, and mean dates of flowering of sixty species of plants observed within a radius of about three miles from the town of Watford, nearly all the observations, however, having been made in the northern half of the area comprised within this radius, and therefore on plants growing on a dry subsoil, gravel on chalk. For the four species of insects and the eight species of birds in the calendar I have not relied entirely on my own observations. As they have not been sufficiently numerous, I have included a few by other members of the Society made in the district which includes Watford, St. Albans, and King's Langley, extending, therefore, about seven miles to the north of Watford.

In the first column in the calendar are the phenomena observed, the rotation numbers in the Royal Meteorological Society's list being inserted in parentheses. The second column gives the number of years of observation. Then the earliest, latest, and mean dates are given, the day of the year following in each case the day of the month. For comparison I have added the mean dates of the longest series of observations of which we have any published account,—that of the Rev. T. A. Preston and his coadjutors at Marlborough, extending over the 20 years 1865–84.

NATURALIST'S CALENDAR FOR SOUTH-WEST HERTS (WATFORD).

Abbreviations:—

fl.—flowers open; ap.—first appears; arr.—arrives; sg.—song commences.

Phenomena.	Watford, 1875–86. No.	Earliest.		Latest.		Mean.		Marlbro', 1865–84. No.	Mean.	
January and February.										
Song-thrush—*Turdus musicus* (93)—sg.	10	Jan. 1	1	Feb. 16	47	Jan. 17	17			
Snowdrop—*Galanthus nivalis* (78)—fl.	7	,, 13	13	,, 15	46	,, 29	29	20	Jan. 28	28
Skylark—*Alauda arvensis* (99)—sg.	9	,, 21	21	,, 18	49	,, 30	30			
Hazel—*Corylus Avellana* (74)—fl.	9	,, 15	15	,, 22	53	Feb. 3	34	20	,, 31	31
Honey-bee—*Apis mellifica* (84)—ap.	8	,, 22	22	Mar. 17	76	,, 15	46			
Dogs' mercury—*Mercurialis perennis* (70)—fl.	10	,, 23	23	,, 30	89	,, 23	54	20	Feb. 14	45
Lesser celandine—*Ficaria verna* (2)—fl.	10	,, 12	12	,, 21	80	,, 24	55	20	,, 7	38
Rook—*Corvus frugilegus* (101)—builds	10	Feb. 8	39	,, 6	65	,, 25	56	10	,, 28	59
March.										
Coltsfoot—*Tussilago Farfara* (45)—fl.	10	,, 17	48	,, 23	82	Mar. 4	63	19	,, 21	52
Sweet violet—*Viola odorata* (10)—fl.	6	,, 20	51	Apl. 3	93	,, 9	68	20	Mar. 5	64
Great sallow—*Salix Caprea* (72)—fl.	9	,, 25	56	,, 1	91	,, 11	70	20	,, 7	66
Daffodil—*Narcissus Pseudo-narcissus* (77)—fl.	8	,, 25	56	Mar. 31	90	,, 13	72	20	,, 2	61
Butter-burr—*Petasites vulgaris* (44)—fl.	4	Mar. 9	68	Apl. 3	93	,, 23	82	19	Feb. 18	49
Chiff-chaff—*Phylloscopus collybita* (98)—sg.	9	,, 8	67	,, 9	99	,, 26	85	.6	Mar. 28	87
Wood anemone—*Anemone nemorosa* (1)—fl.	8	,, 10	69	,, 3	93	,, 31	90	20	,, 7	66
Ground ivy—*Glechoma hederacea* (64)—fl.	10	,, 17	76	,, 26	116	,, 31	90	20	,, 24	83

April.										
Cowslip—*Primula officinalis* (68)—fl.	9	Mar. 5	64	May 13	133	Apl. 1	91	20	Apl. 4	94
Marsh marigold—*Caltha palustris* (4)—fl.	8	,, 12	71	Apl. 24	114	,, 3	93	20	Mar. 7	66
Cuckoo-flower—*Cardamine pratensis* (7)—fl.	9	,, 30	89	May 4	124	,, 5	95	20	Apl. 6	96
Blackthorn—*Prunus spinosa* (27)—fl.	9	,, 17	76	,, 3	123	,, 5	95	20	,, 1	91
Small white butterfly—*Pieris rapæ* (87)—ap.	10	,, 15	74	,, 3	123	,, 8	98	18	,, 10	100
Greater stitchwort—*Stellaria Holostea* (13)—fl.	11	,, 8	67	,, 4	124	,, 9	99	20	,, 9	99
Swallow—*Hirundo rustica* (103)—arr.	12	Apl. 4	94	Apl. 25	115	,, 13	103	19	,, 5	95
Garlic-mustard—*Alliaria officinalis* (8)—fl.	4	,, 3	93	,, 24	114	,, 15	105	20	,, 21	111
Nightingale—*Daulias Luscinia* (95)—sg.	11	,, 7	97	,, 22	112	,, 16	106	7	May 3	123
Large white butterfly—*Pieris brassicæ* (86)—ap.	10	Mar. 28	87	May 5	125	,, 18	108	18	Apl. 26	116
Cuckoo—*Cuculus canorus* (102)—calls.....	12	Apl. 12	102	Apl. 28	118	,, 19	109	18	,, 17	107
Blue bell—*Scilla nutans* (79)—fl.	11	Mar. 30	89	May 18	138	,, 20	110	20	,, 12	102
Ribwort-plantain—*Plantago lanceolata* (69)—fl	8	,, 18	77	,, 18	138	,, 21	111	20	,, 20	110
Speedwell—*Veronica Chamædrys* (60)—fl.	11	,, 12	71	,, 18	138	,, 25	115	20	,, 17	107
Herb Robert—*Geranium Robertianum* (17)—fl.....	11	,, 17	76	,, 20	140	,, 29	119	20	May 4	124
Bush vetch—*Vicia sepium* (25)—fl.	8	Apl. 10	100	,, 23	143	,, 30	120	20	Apl. 26	116
May.										
Upright crowfoot—*Ranunculus acris* (3)—fl.	6	,, 18	108	,, 11	131	May 1	121	20	,, 15	105
Comfrey—*Symphytum officinale* (58)—fl.	6	,, 1	91	,, 19	139	,, 6	126	20	,, 26	116
Creeping bugle—*Ajuga reptans* (67)—fl.	10	,, 16	106	,, 23	143	,, 7	127	20	,, 28	118
Swift—*Cypselus Apus* (106)—arr.	11	,, 28	118	,, 16	136	,, 7	127	20	May 2	122
Laburnum—*Cytisus Laburnum* (21)—fl.	4	May 7	127	,, 19	139	,, 12	132	20	,, 14	134
Hawthorn—*Cratægus Oxyacantha* (32)—fl.	4	,, 10	130	,, 20	140	,, 15	135	20	,, 13	133
Mouse-ear hawkweed—*Hieracium Pilosella* (54)—fl.	6	,, 1	121	June 3	154	,, 17	137	20	,, 18	138
Red rattle—*Pedicularis silvatica* (59)—fl.	4	,, 3	123	,, 4	155	,, 18	138	20	,, 7	127
Cleavers—*Galium Aparine* (40)—fl.	11	,, 12	132	May 27	147	,, 19	139	20	,, 9	129
Milkwort—*Polygala vulgaris* (11)—fl.	7	Apl. 14	104	June 14	165	,, 20	140	20	,, 8	128
Dutch clover—*Trifolium repens* (22)—fl.	11	May 9	129	,, 2	153	,, 23	143	20	,, 21	141
Ox-eye—*Leucanthemum vulgare* (47)—fl.	12	,, 7	127	,, 5	156	,, 23	143	20	,, 21	141
Silver-weed—*Potentilla Anserina* (29)—fl.	10	,, 15	135	,, 5	156	,, 24	144	20	,, 15	135
Bird's-foot trefoil—*Lotus corniculatus* (23)—fl......	11	,, 15	135	,, 11	162	,, 29	149	20	,, 18	138
Ragged Robin—*Lychnis Flos-cuculi* (12)—fl.	9	,, 24	144	,, 11	162	,, 30	150	20	,, 27	147
Meadow butterfly—*Epinephile Janira* (89)—ap.	8	,, 2	122	,, 17	168	,, 31	151	17	June 13	164

Phenomena.	Watford, 1875-86.							Marlbro', 1865-84.		
	No.	Earliest.		Latest.		Mean.		No.	Mean.	
June.										
Red poppy—*Papaver Rhœas* (5)—fl.	12	May 21	141	June 14	165	June 1	152	20	June 4	155
Yellow iris—*Iris Pseudacorus* (76)—fl.	8	,, 25	145	,, 19	170	,, 6	157	20	,, 2	153
Dog rose—*Rosa canina* (30)—fl.	11	June 1	152	,, 13	164	,, 7	158	20	,, 4	155
Spotted orchis—*Orchis maculata* (75)—fl.	7	,, 2	153	,, 16	167	,, 7	158	20	,, 4	155
Meadow vetchling—*Lathyrus pratensis* (26)—fl.	7	May 30	150	July 1	182	,, 9	160	20	,, 2	153
Common mallow—*Malva silvestris* (14)—fl.	11	,, 25	145	,, 1	182	,, 12	163	20	,, 8	159
Hedge woundwort—*Stachys silvatica* (66)—fl.	10	June 2	153	June 22	173	,, 12	163	20	,, 10	161
Broad willow-herb—*Epilobium montanum* (34)—fl.	8	,, 10	161	,, 29	180	,, 17	168	20	,, 13	164
Field thistle—*Cirsium arvense* (52)—fl.	5	,, 2	153	,, 30	181	,, 18	169	15	July 3	184
Black knapweed—*Centaurea nigra* (50)—fl.	7	,, 12	163	,, 28	179	,, 19	170	18	June 23	174
Meadow-sweet—*Spiræa Ulmaria* (28)—fl.	6	,, 4	155	July 12	193	,, 20	171	20	,, 19	170
Selfheal—*Prunella vulgaris* (63)—fl.	4	,, 15	166	,, 1	182	,, 20	171	18	,, 19	170
Milfoil—*Achillea Millefolium* (46)—fl.	10	,, 14	165	,, 12	193	,, 26	177	20	,, 7	158
Upright St. J. w.—*Hypericum pulchrum* (16)—fl.	5	,, 25	176	,, 2	183	,, 28	179	14	July 3	184
Tufted vetch—*Vicia Cracca* (24)—fl.	4	,, 17	168	,, 12	193	,, 28	179	18	June 22	173
Ragwort—*Senecio Jacobæa* (49)—fl.	5	,, 24	175	,, 3	184	,, 30	181	19	,, 22	173
July to September.										
Yellow bedstraw—*Galium verum* (41)—fl.	5	,, 29	180	,, 28	209	July 6	187	18	,, 27	178
Hair-bell—*Campanula rotundifolia* (55)—fl.	7	,, 25	176	,, 14	195	,, 8	189	14	July 7	188
Hairy willow-herb—*Epilobium hirsutum* (33)—fl.	4	,, 24	175	,, 17	198	,, 9	190	14	,, 18	199
Greater bindweed—*Calystegia sepium* (57)—fl.	6	,, 12	163	,, 15	196	,, 12	193	14	,, 13	194
Corn sow-thistle—*Sonchus arvensis* (53)—fl.	4	July 5	186	Aug. 2	214	,, 15	196	13	,, 13	194
Devils'-bit scabious—*Succisa pratensis* (43)—fl.	4	June 29	180	,, 16	228	,, 23	204			
Mugwort—*Artemisia vulgaris* (48)—fl.	4	July 20	201	,, 8	220	Aug. 1	213			
Ivy—*Hedera Helix* (37)—fl.	7	Sept. 7	250	Sept. 23	266	Sept. 16	259	16	Sept. 27	270

It is scarcely necessary to mention that this calendar does not include the results of all the observations made at Watford. I have excluded all of less than four years. With a larger minimum number of years than this I could not have included any of the phenomena added in the revised list of the Royal Meteorological Society, which came into operation in 1883. I have also excluded a few abnormally early dates, and a few exceptionally late ones, the former, for instance, not showing the true date of general first-flowering, but probably only of a single precocious plant, and the latter being due to omission of notice of first-flowering at the actual time of its occurrence. The phenomena have also been selected with a view to facilitate the taking of means of groups of observations of equal numbers, the seventy-two being divisible into nine groups of eight each.

If the mean dates of all the phenomena which have been observed both at Watford and Odsey* are compared, it will be found that they are on the average about half a day later at Odsey than at Watford. A rather greater difference than this might have been expected. The number of observations from which these means are deduced being small—relating only to twenty-seven phenomena—the comparison cannot be considered thoroughly satisfactory.

The phenomena observed both at Watford and Marlborough, and at Watford and Cambridge, are much more numerous. A comparison of the mean of all observations taken both at Watford and Marlborough shows the phenology of Watford to be three days later than that of Marlborough. A similar comparison of the observations at Watford with those at Swaffham Bulbeck near Cambridge, during the years 1820 to 1831, shows the phenomena to be on the average four days later near Cambridge than in the neighbourhood of Watford. Both those results are what might be expected from the situation of Watford, about midway between Marlborough to the south-west and Cambridge to the north-east; but too much reliance should not be placed on the results of observations taken in different series of years, or even in the same series if the phenomena are not all observed in every year of the series. The greater the number of observations, the less is the liability to error, and that the result is as stated is doubtless due rather to the large number from which the mean is deduced tending to mask errors, than to the exactitude of the individual observations.

* See Mr. Fordham's Calendar in 'Trans. Herts Nat. Hist. Soc.,' Vol. IV, pp. 194, 195.

XIII.

REPORT ON INSECTS OBSERVED IN HERTFORDSHIRE IN 1888.

By F. W. Silvester, F.R.Met.Soc.

Read at Watford, 22nd March, 1889.

The abnormal heat and drought of the summer of 1887 was unusually favourable for insect propagation, and consequently laid a foundation for the attacks which were made by insects in the advance of the next year's spring, but, so far as evidence appears, after the heavy midsummer rainfall of 1888 serious injury ceased to be generally felt. This had its natural effect upon the numbers of insects in this county to be noticed in the annual report which, through the kind co-operation of old contributors and a few new aids in the work, I have now to introduce to your notice. Miss E. A. Ormerod has, with her usual kindness, allowed me to draw copiously from her extensive resources, and I gratefully acknowledge her help.

Dr. Brett has sent to me the following extract from the 'Daily News,' which will have interest to members of our Society, as it alludes principally to the Hessian fly, which Miss Ormerod first noticed as appearing in our county in 1886:—"The cold, wet summer of last year does not seem to be altogether an unmixed evil. It will he remembered that some time ago there was a great deal said and written about the Hessian fly and its appearance in Hertfordshire. Another enemy was added to the long list of farmers' foes, and there were no means of knowing how near we were to a plague such as this little creature causes every now and then in America and on the continent of Europe. In 1887 specimens were sent in to the Agricultural Department from various parts of the country, but, according to Mr. Whitehead, Agricultural Adviser to the Committee of Council, no similar reports have been made since last harvest. 'There is every reason to hope,' he says, 'that the wet season, in other respects lamentable, has freed this country, at all events for a time, from this dreadful scourge.' Dr. Packard, in his account of the Hessian fly in America, calls attention to the fact that its ravages are greatest where the wheat is early, and that late crops are not sufficiently developed to receive the eggs at the time of their deposition. Professor Riley maintains that the insect is only dangerous when two annual generations are uniformly produced, which means that there must be two years in succession in which the wheat is early and the spring and summer mild. A cold spring or a wet summer is an effectual check on its multiplication. Hence it seems that there is but little danger in this variable climate, and if farmers keep a sharp look-out for its first appearance even this limited risk may be discounted."

The bean-beetle (*Bruchus rufimanus*) has again been troublesome, though Messrs. E. Dixon and Sons inform me that new samples are much more free from this pest than those of the previous year.

Mr. Willis of Harpenden thus writes, in 1888, with regard to it: "Attention was frequently called in the spring of this year to samples of beans and peas badly infested by the beetle *Bruchus rufimanus*. A sample of Aquadolce broad beans, which was examined by myself, contained 45 per cent. of beetle-infested seeds, and a sample of Seville long pods contained 20·5 per cent. of injured seeds. As an experiment these were put into common paraffin oil and allowed to remain for a few hours; when taken out every beetle was dead, and could be shaken from the beans. The seeds were afterwards planted, and in nearly every instance grew and produced a satisfactory crop. Thus while the paraffin kills the beetles it does not injure the germinating powers of the seed." Mr. George Street tried the following remedial measures. He dressed his beans before sowing with one pound of vitriol, one pint of MacDougall's sewage carbolic, and six quarts of water to six bushels of beans, and found the result successful. In Canada, where greater attention is paid to the destruction of crop pests than with us, Miss Ormerod reports: "It is a common custom, where they have infested beans, to get very large vats and put the seed in them, then to place in them tubes containing bi-sulphide of carbon, the scent of which passes out through perforations in the tubes and kills the insects."

Mr. R. T. Andrews, writing from Hertford last June, sends to me the following note:—"I send to you by this post a small tin box containing about three pairs of beetles and some eggs upon asparagus. They are devastating our asparagus beds about here this year. I shall have to cut all my asparagus off, and either burn it or scald it, and even then I fear I shall find the beetles again next year." The specimens were the asparagus-beetle (*Crioceris asparagi*). Sprinkling the plants with a mixture of soft soap, flowers of sulphur, and soot is a good remedy. So also is the application of dry soot, or strewing the plants with unslacked lime in the early morning.

Mr. Beckett sends this interesting note from the gardens, Aldenham House:—"*Selandria Æthiops*, commonly called 'pear saw-fly' or 'slimy grub,' during the past two seasons has been very numerous and troublesome on the pear trees in the gardens here. It first makes its appearance early in July, and, if allowed to go unchecked, the grub continues to feed on the upper surface of the leaves till the end of September, and quickly destroys all the foliage. In this stage it is very much like a small black slug, and during the daytime appears to be lifeless. I tried many advised remedies such as powered quick-lime, soot, and hellebore powder, but found none so effectual as a strong solution of tobacco-water and soft soap, applied in a warm state with a syringe and washed off half an hour afterwards with clean soft water. If thoroughly done, none of the grubs will survive."

A feature of the season was the unusual abundance of white aborted ears in wheat, but the cause of this malady cannot yet be regarded as satisfactorily settled.

Orchard fruit-trees suffered severely from insect pests, and the experience of the year has added materially to our knowledge of the insect foes of the apple crop. Though our county cannot rank as a fruit-growing one, still enough fruit is grown to render economical measures of preservation desirable, so the adoption of Miss Ormerod's advice in some of the Gloucestershire orchards, near Cheltenham, where about 100,000 trees have been banded with cart-grease to check the attack of the wingless winter-moth, is worth recording, and it is still more satisfactory to note that millions of these pests have thus been caught and destroyed.

The past year has seen a new weapon of defence put into the hands of cultivators in the form of Strawson's air-power distributor, and the degree of perfection which this ingenious machine has now attained can leave no doubt that it may become the means of saving many hundreds of thousands of pounds annually which were formerly lost through the ravages of injurious insects.

A great advance has taken place in the application of methods of prevention against the attack of the ox-warble-fly. The intense pain and the loss of condition occasioned to the animal, and the depreciation in value of the warbled hide, render this pest a legitimate object of attack on both humane and commercial grounds, and the tormented animals would be truly grateful if they could know the pains that are being taken for their comfort by the circulation of the pamphlet on 'The Ox-Warble-Fly,' which has done so much to call the attention of farmers and stock-owners to the easy remedy by which this attack may be avoided.

Many members of our Society must have noticed last spring the desolate appearance of the oak trees just as they were coming into leaf. This was due to the caterpillars of *Tortrix viridana*, which feed in such numbers on the young leaves as to strip the trees of their foliage, and retard the growth of the first shoots, entirely ruining the acorn crop of the season. Miss Ormerod describes them thus: "The caterpillars are at first greenish grey, or lead-coloured; when full grown they are dull green with dusky spots, and about half an inch long. They have the power of rolling the tip of the leaf and spinning it together into a cylinder, within which when full-fed they turn to chrysalids, but meanwhile on alarm, or as a matter of choice, they let themselves down by scores or hundreds, by means of silken threads, for about seven or eight feet, and sway about as the wind may waft them beneath the infested boughs, catching on any passing object, and also being a prey to many kinds of birds; but if nothing else happens they crawl presently back again, each up its own line to the bough. The chrysalis is brown, and is formed in a silken cocoon on a leaf. The moth, which appears towards the end of June, is about an inch in the expanse of the fore-wings, with the head, the body between the wings, and the fore-wings, of a light green; the hind-wings are brownish, and the fringes of the wings, as well as a line on the front edge of the foremost pair, are whitish." Mr. Willis reports these caterpillars at Harpenden, and Mr. James in the neigbourhood of Watford, and I can add that nearly all the oaks near my house were greatly damaged, and a total failure of the acorn crop was the result. Where practicable shaking the branches has a good effect in ridding oak trees of these destructive insects. In the case of young trees, drenching by means of a large garden-engine with washes of soft soap, sulphur, and gas-water might be tried with advantage.

It may be interesting to mention in passing the enormous loss caused to owners of vineyards by another species of leaf-rollers, the *Pyralis rostralis*, which is also very destructive to the hops. In the department of Saône et Loire, in France, in ten years alone, the ravages of the *pyralis* caused a total loss of 34,000,000 francs, or £1,360,000. The only safe course is to pluck off the leaves laden with eggs, and burn them, or bury them in deep holes.

Mr. J. J. Willis reports the following first appearances, and the subsequent interesting notes :—

"Harpenden, 1888.—*Timarcha lævigata* (bloody-nosed beetle), April 17th; *Lampyris noctiluca* (glow-worm), July 8th; *Apis mellifica* (honey-bee), at work, March 15th; *Vespa vulgaris* (common wasp), May 8th; *Pieris Brassicæ* (large white butterfly), April 13th; *Pieris Rapæ* (small white butterfly), April 30th; *Anthocharis Cardamines* (orange-tip butterfly), June 1st; *Bibio Marci* (St. Mark's fly), April 16th.

"*Chlorops tæniopus*.—An observer from Cirencester told me (Mr. Willis says) that many fields of barley in that neighbourhood had been seriously attacked by the gout-grub; and in August it was thought that some of these would scarcely be worth the cutting. Together, we examined some fields of barley at Rothamsted, and found that the gout-grub was present there also, but not to any serious extent. When one is made acquainted with the disease, the affected plants are easily distinguished by the sickly and imperfectly-formed seed-spike and the swollen stem where the small grub is located."

"Mangold-wurzel crops.—In an experimental field at Rothamsted, where mangolds have been grown year after year for thirteen years in succession, both without manure and with various descriptions of manure, a somewhat curious fact was this year brought into prominence. During recent years it has always been most difficult to secure a good plant of mangolds wherever ammonia salts formed part of the manurial supply. This was thought to be due to the exhaustion of the organic matter of the soil caused by the constant removal of the root-crops. In the present season, however, while the remaining part of the field failed to produce a plant, even under the most favourable conditions as to manure, the plots receiving ammonia salts or nitrate of soda gave an almost full crop. The previous failure of plants on this portion of the field is now thought to be due to insect injury."

Mr. Willis also sends notice of what he considers a new potato disease, affecting potatoes left out on the ground. I am inclined, however, to think that the worm-like creatures noticed as present may be rather a consequence than a cause of the putrescent state of the tubers, *i.e.* they may be some of the worms or whitish millipedes often infesting roots.

Mr. Willis yesterday sent to me the following letter:—" Clover injury.—Having called your attention in my recent notes on insect injury to a worm infesting diseased potatoes, I now beg to state that at the present time we have at Rothamsted, in a field of red clover, a strip of land three or four yards wide all across the field where the plants are now dying entirely off, and, on digging up some of the plants to-day, I find on the roots of every diseased plant a small white worm similar to those found in the potatoes. On enquiry I find that upon this portion of the field a dressing of fish-manure was applied to the barley-crop of last year, but whether that has anything to do with the development of these worms is a question. Up to January of the present year the clover plant was strong and healthy."

Though not strictly in my department, I have quoted Mr. Willis' letter in full, for doubtless many will be interested in the subject. Although we cannot ascertain the cause of the attack till specimens have been submitted to a competent authority, this may serve as a basis of inquiry for a series of investigations on plant injury, which Dr. Brett informs me he intends to urge our Society to take up.

XIV.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1888.

By JOHN HOPKINSON, F.L.S., F.G.S., etc.

Read at Watford, 22nd March, 1889.

FOR ten years in succession the Society has had most interesting reports on the birds observed in the county, by an accurate and keen-sighted observer, an accomplished ornithologist, a pleasant writer, an eloquent speaker—the late Mr. John E. Littleboy. By his death in August last we have lost one of our most valued members, one whom it was always a pleasure to have with us at our field meetings, and whose "Notes on Birds," read at our evening meetings, invariably attracted a large audience.

Perhaps the most valuable of Mr. Littleboy's reports was his last (that for 1887), in which, from information supplied to him by the Honourable Walter Rothschild, of Tring Park, he was enabled to add 21 species to the county list, all but one being birds which frequent or have visited the Tring Reservoirs, and that one being recorded from specimens preserved in the Tring Park collection. In the previous report only two species were added to our list of Hertfordshire birds, and it cannot be expected that the number (201) recorded by Mr. Littleboy up to the end of the year 1887 as frequenting or as having at any time been seen in the county will be much increased.

I have now, in the present interim report which I have drawn up pending the appointment of a successor to Mr. Littleboy's office of ornithological recorder to the Society, only one species to add to his list—one, however, of great interest.

PALLAS' SAND-GROUSE (*Syrrhaptes paradoxus*).—On the 21st of May, our ex-President, Mr. F. M. Campbell, F.L.S., wrote from his residence, Rose Hill, Hoddesdon, to Mr. Littleboy, as follows:—"Yesterday, 20th May, at 6 p.m., were shot at Jepps Farm (about two miles from this place) two sand-grouse which rose off a ploughed field with a flight of 40. The birds are in my possession and will be stuffed." To this Mr. Littleboy replied on the following day:—"Thank you very much for the very interesting information respecting the sand-grouse. I had heard of two dead ones being picked up near Royston; but a flight of 40! The news is most welcome." A week later Mr. Henry Lewis, of St. Albans, wrote to Mr. Littleboy informing him that Mr. Arthur W. Dickenson, of New Farm, St. Albans, saw, on 22nd May, seven sand-grouse "flying over or near Batch Wood, St. Albans. They did not settle and their flight resembled the golden plover's." Some time after this Mr. Chapman, of Bennington, wrote to Mr. Lewis stating that he shot a very fine sand-grouse at Bennington on 4th June. He thought when he first saw it that it was a golden plover, but when he heard its call of "cruck, cruck," he knew that it was a strange bird to him. He has had it stuffed, and offers to show it to any one interested in ornithology. The arrival of the sand-grouse in Hertfordshire was announced by Mr. Campbell in a letter which appeared in the 'Times' of 23rd May, and the two birds which were killed near Hoddesdon were exhibited at a conversazione of the Linnean Society on 25th May, exciting considerable attention and interest. The circumstance is mentioned by Mr. J. E. Harting, in the 'Zoologist' for June, 1888 (ser. 3, vol. xii, p. 234).

These are all the records I am aware of relating to this visitation of Pallas' sand-grouse to our county.

The sand-grouse form the order *Pterocletes*, an order allied to the Columbæ and Gallinæ, and comprising two genera—*Pterocles* and *Syrrhaptes*. No species of *Pterocles* has ever been known to visit Britain, and of the two species of *Syrrhaptes* only *paradoxus*. Both the generic and specific name of *Syrrhaptes paradoxus* relate to the form of its feet,—*Syrrhaptes*, derived from a Greek word signifying to sew or stitch together, indicating that the last phalanges only of the toes are free, and *paradoxus* from another Greek word meaning strange, this structure of the feet being so peculiar. The species agrees with other sand-grouse in its general form, in its lengthened wings, and in the shortness of its feet, but may be at once distinguished from all other species by the peculiarity from which it derives its name.

Syrrhaptes paradoxus inhabits Central and Eastern Asia. It has often been mistaken at a distance for the golden plover, from the similarity of its flight, which is swift, direct, and elevated. Its food in this country has been found to consist almost entirely of the small seeds of several of our most troublesome weeds, the seeds of *Polygonum aviculare* (knot-grass) being particularly abundant in the crops of birds killed here. In China the food is chiefly millet. The nest is made of the down of grasses, and is placed on sand or amongst stones under a bush. The eggs are usually three in number (rarely four). The time required for incubation and for the growth of the young is comparatively short. The female quits her nest only at the last extremity.

The first record of the occurrence of Pallas's three-toed sand-grouse in Europe is in 1853, when it was stated to be very rare at Sarepta, on the Lower Wolga. It made its first appearance in Britain (and in Western Europe) in the summer of 1859. Early in July one was killed in Norfolk, and another, a few days later, in North Wales, three being seen; and a fortnight afterwards (23rd) a third was killed in Jutland. Early in October a fourth was shot, being one of a pair which had haunted sand-hills in Holland since July, and the last seen in that year was killed in Kent in November.

Four years after this, in 1863, there was an immense irruption of these birds into Western Europe, the number seen being estimated at about 700, of which at least 500 are believed to have been killed. There are records of their massacre from nearly every country in Europe, and from nearly every county in England, and also from Wales, Scotland, and Ireland. In France they were mostly eaten, in Germany presented to public museums, and in Britain retained in the collections of private individuals. In the counties of Norfolk and Suffolk alone 86 are recorded to have been shot. Although not registered by Mr. Littleboy, Hertfordshire is one of the counties these birds visited, and in which consequently they were killed. In June two were shot at Dugdale Hill,* South Mimms, and nine on Therfield Heath, Royston, and its vicinity.† They first appeared in Europe on the 6th of May, and first in England on the 21st, and the records of their destruction continue through every subsequent month in the year and even into 1864, the last bird having been seen, and shot, early in February. Several flocks attempted to locate themselves on sandy tracts similar to those they frequent in their native country, they seemed to find suitable food, and some birds even deposited their eggs. Had they been unmolested and allowed to nest it seems possible that they might have permanently established themselves with us, and might have become a valuable addition to our game-birds; but every bird that came within the reach of a gun appears to have been mercilessly shot. From 150 to 200, however, are believed to have escaped destruction, having been seen in the island of Rügen on the 3rd of October, flying from N.W. to S.E., apparently returning to their native haunts, where they are free from molestation.

Is it possible that the warm reception these birds met with in our hospitable country, and others in Western Europe, could account for the long time that elapsed before any considerable number of their species again ventured to pay us a visit? We know that the lower animals can communicate certain information to each other, and that birds do so by voice and gesture, but we do not know to what extent, and whether or not it is possible for a bird to warn others against pursuing a certain track we cannot say. From the great irruption of 1863 to that of 1888, an interval of a quarter of a century, only a few stragglers have been seen in Western Europe. From February, 1864, to May, 1888, the only records I can find are the following:—One shot near Tamworth in 1866; two killed on the Faroe Islands in June, 1868; a flock seen in Northumberland early in June, 1872; two killed in Scotland late in the same month; a flock of from fifteen to twenty seen at Winterton in Norfolk on or about 21st May, 1876; one killed near Modena in Italy in June; and two (a pair, *i.e.* male and female together) shot in Ireland in October of the same year. It seems probable that some of the earlier of these may have been birds which escaped being slaughtered in 1863–64.

We now come to the second great invasion of the British Islands and other countries of Western Europe by *Syrrhaptes*. At least twice as many birds must have visited us in 1888 as in 1863, probably more than three times as many, but it is very difficult to eliminate duplicate observations of a bird of such rapid flight as

* This locality is in Middlesex, but it is surrounded, except for a short distance on the south-east, by Hertfordshire.

† 'Zoologist,' vol. xxi, pp. 8685 and 8723.

this. They were first seen passing over the island of Heligoland on the 8th of May, and were observed by the veteran naturalist, Herr Gätke, almost daily throughout the month in flocks of a few up to two hundred. "What flyers they are," he says, in a letter to Mr. John Cordeaux, "they beat all we have ever seen here." *

They reached our coast on or before the 13th of May, on which day they were first seen in Norfolk. Mr. T. Southwell estimates that, up to the 31st October, from eleven to twelve hundred birds were seen in this county alone, and that nearly two hundred were killed.† They have been recorded, as in 1863, from most of the counties of England, and from Wales, Scotland, and Ireland; but the number shot is happily much less in proportion to the number seen than it was then. Unfortunately, however, as Mr. Southwell says, when they first arrived, every man's hand was against them, and although they came prepared to nest here, they were not allowed to settle until too late—until the breeding season was over. So far I believe only two undoubted instances of nesting have been recorded. In June a sand-grouse was shot in Norfolk as it rose from its nest, and three eggs were taken from it, and a nest was seen near Durham with three young birds in it.

Scarcely a week after their first appearance in Norfolk they were, as we have seen, first observed in Hertfordshire. Athough Mr. Littleboy has not given the date on which the two dead birds were picked up near Royston, it must, from his expression "I had heard," have been before the 20th of May, when about 40 were seen by Mr. Campbell near Hoddesdon. In the pages of the 'Zoologist' and of the 'Naturalist' will be found records of their appearance in different parts of the kingdom in every month from May to February, and many birds must still be with us.‡

It might be interesting to discuss the various hypotheses which have been suggested to account for the irruption of Pallas' sand-grouse into Europe, but I think there are only two sufficiently probable to be worth mentioning. It was thought by Alfred Newton to be due to "the natural overflow of the population of *Syrrhaptes*, resulting from its ordinary increase;" § while Henry Seebohm suggests that "They had visited, or attempted to visit, their usual breeding-grounds, and, finding their progress eastwards barred by cold or snow, had changed their course." || It may be

* 'Zoologist,' ser. 3, vol. xii, p. 267.

† *Ib.* p. 448.

‡ "An Act for the better protection of the Sand-grouse in the United Kingdom" (51 and 52 Vict. ch. 55) was passed in December. It consists of a preamble: "Whereas it is expedient to provide for the protection of the Sand-grouse, in order that it may, if possible, become acclimatised in the United Kingdom"; and two clauses, the first prohibiting, between 1st February, 1889, and 1st January, 1892, the killing, wounding, taking, or selling of any Sand-grouse, under a penalty of £1; and the second stating that the Act "may be cited as the Sand-grouse Protection Act, 1888." The postponement of the time of the Act coming into operation probably defeated its object, leading to the killing of many birds *before* the 1st of February.

§ 'Ibis,' vol. vi, p. 219 (1864).

|| 'British Birds,' vol. ii, p. 420 (1884).

that both these suggested causes have influenced the action of the bird in seeking "pastures new" in its breeding season—increase of population necessitating migration to a greater distance, so as to cover a wider area than usual, and severe climatic conditions limiting, in an unusual degree, the area sought to be occupied. It is difficult to imagine that increase of population alone would cause migration on such a vast scale, at such long intervals of time as a quarter of a century; and we have no grounds for inferring that in the regions usually visited by *Syrrhaptes* in the breeding season there has been excessive cold or snow in the spring time, only in the years 1863 and 1888. The probability of 1863 being the first year in which there was a great irruption of *Syrrhaptes paradoxus* into Europe becomes very great when we consider that such an occurrence could not have happened for at least a century before that time without being recorded.

MISCELLANEOUS NOTES.

The following notes are chiefly compiled from the register of the late Mr. Littleboy, and from the letters of his correspondents.

Reed-warbler (*Acrocephalus streperus*).—Mr. Henry Lewis states that a bird frequents the water at Sopwell Park, St. Albans, which is most probably the reed-warbler, although he has not been able to secure a specimen for identification. The reed-warbler has only hitherto been recorded in our county from the low meadows near King's Langley, and as frequenting the Tring Reservoirs.

Golden Oriole (*Oriolus Galbula*).—Mr. Henry Warner, of Wormley, writes on 20th July that a pair of golden orioles had that week paid a visit to the garden of Mr. Thorne of Broxbourne, one of them having nearly paid the penalty of being caught in a strawberry-net. The golden oriole is an irregular straggler to England on migration, occasionally breeding in the south. It has only twice before been recorded in Hertfordshire. In 1881 a nest with three eggs was found near Ware, and in 1886 a bird was shot near Welwyn.

Great Grey Shrike (*Lanius Excubitor*).—The Hon. Walter Rothschild informs me that a great grey shrike appeared at Tring in October. Although a rare autumnal visitant to the British Islands, this bird has frequently been seen, and shot, in our county.

Hawfinch (*Coccothraustes vulgaris*).—Mr. Littleboy saw a pair of hawfinches in his garden at Hunton Bridge on 27th April.

Brambling (*Fringilla montifringilla*).—Mr. Lewis observed a flock of bramblings at St. Albans about 23rd February.

Crossbill (*Loxia curvirostra*).—In a letter to Mr. Henry Lewis, Mr. Chapman of Bennington states that on the 29th of July he observed there a flock of crossbills (14 in number). He saw them on some fir trees and was quite close to them.

Hoopoe (*Upupa Epops*).—A hoopoe was observed by Mr. Joseph Procter, near The Hoo, Great Gaddesden, in April. It did not remain long, and the fact of a hoopoe being shot near Wendover a few days after one had been seen near Great Gaddesden would seem, Mr. Littleboy says, to indicate that it was the same bird and had wandered in that direction. The hoopoe is an irregular visitor to the south of England, and has only been seen in Hertfordshire at considerable intervals of time, the last record being of one shot at Brocket Hall in 1882.

Cuckoo (*Cuculus canorus*).—A few years ago Mr. Arthur Dickenson, of New Farm, St. Albans, took a very young cuckoo out of a robin's nest and had her for several weeks, after which time she made her escape. Her foster-parents, the robins, found her, or she them, and they fed her for some weeks. That it was the same cuckoo Mr. Dickenson infers from her tameness and also from seeing her near the place of her birth. Last year (1888) he found in one of his meadows a robin's nest and two hedge-sparrows' nests within about a hundred yards of each other, each nest containing a young cuckoo.

Sparrow-hawk (*Accipiter Nisus*).—Mr. C. Dickenson, of New Farm, once placed several sparrow-hawks' eggs under a dove-house pigeon. She hatched them out, and he then took them away and brought them up by hand. As they grew up they became perfectly tame, coming at his call and taking food from his hand.

Cormorant (*Phalacrocorax Carbo*).—I am informed by the Hon. Walter Rothschild that a cormorant visited Tring in October. It is ten years since one has been seen there, the only previous record being of one shot on the reservoirs in November, 1878.

Sheldrake (*Tadorna cornuta*).—On the 8th of January a common sheldrake was observed on the Tring Reservoirs by the Hon. Walter Rothschild for more than an hour. The only previous record of the sheldrake in our county is of one which was shot on the Elstree Reservoir in December, 1883.

Tufted Duck (*Fuligula cristata*).—Mr. Henry Manser writes on 25th February that two male tufted ducks have remained for about a month on the Lynch, Hoddesdon.

Wood-pigeon (*Columba Palumbus*).—In the 'Herts Advertiser' of 15th December, Mr. Henry Lewis records that "During the last few days large flights of wood-pigeons have passed over St. Albans and its neighbourhood. It is several years," he adds, "since such large numbers of these birds have visited us."

Water-rail (*Rallus aquaticus*).—Mr. E. W. Arnold reports on 15th January that water-rails are plentiful at Redbourne Bury, St. Albans.

Golden Plover (*Charadrius pluvialis*). — Mr. Norman Thrale reports that large flocks of golden plovers were observable throughout the month of March near Hertford and at Hatfield Hyde; and Mr. Henry Lewis states that they were plentiful at St. Albans in December.

Guillemot (*Lomvia Troile*).—A common guillemot is reported by Mr. Norman Thrale to have been shot on the Hertford Meads on 5th April. Our only previous county record of this bird is of one having been shot on the Elstree Reservoir in November, 1882.

NESTING.—The rook (*Corvus frugilegus*) is recorded to have commenced to build at Odsey on 3rd March (*Fordham*), at St. Albans on 5th (*Hopkinson*), and at Harpenden on 6th (*Willis*); young are reported to have been seen at Odsey on 11th April (*Fordham*) and at Hitchin on 15th (*Hurst*). A nest of the blackcap (*Sylvia Atricapilla*) with four eggs was seen by Mr. Lewis at Sparrow's Wick, near Harpenden, on 29th May; and a nest of the redbreast (*Erithacus Rubecola*) with one egg was seen by Miss Laura Dickenson at Leasy Bridge on 17th *October*.

The following observations on the commencement of song of our residents, and the arrival, etc., of our summer migrants and winter visitants, have been reported.

RESIDENTS.

SPECIES.	LOCALITY.	DATE.	OBSERVER.
SONG THRUSH	Hertford	Jan. 7	R. T. Andrews.
(*Turdus musicus*)	Harpenden	,, 8	J. J. Willis.
	Odsey, Royston	,, 25	H. G. Fordham.
SKYLARK	Hertford	Jan. 7	R. T. Andrews.
(*Alauda arvensis*)	Odsey, Royston	,, 7	H. G. Fordham.
	Harpenden	,, 8	J. J. Willis.
	St. Albans	,, 9	J. Hopkinson.
TAWNY OWL	Harpenden	Mar. 14	J. J. Willis.
(*Syrnium Aluco*)			

SUMMER MIGRANTS.

SPECIES.	LOCALITY.	DATE.	OBSERVER.
WHEATEAR	St. Albans	Apl. 10	A.W.Dickneson.
(*Saxicola Œnanthe*)			
NIGHTINGALE	Hitchin	Apl. 18	Alfred Ransom.
(*Daulias Luscinia*)	St. Albans	,, 21	Arthur Lewis.
	Great Gaddesden	,, 23	H. Procter.
	Harpenden	,, 25	J. J. Willis.
	Hoddesdon	,, 27	F. M. Campbell.
	Hunton Bridge, Watford	,, 29	J. E. Littleboy.
WHITETHROAT	Hunton Bridge, Watford	Apl. 17	J. E. Littleboy.
(*Sylvia cinerea*)	St. Albans	,, 29	H. Lewis.
BLACKCAP	Hunton Bridge, Watford	Apl. 30	J. E. Littleboy.
(*S. Atricapilla*)			
CHIFF-CHAFF	Hunton Bridge, Watford	Apl. 2	J. E. Littleboy.
(*Phylloscopus rufus*)	St. Albans	,, 15	H. Lewis.
	Hitchin	,, 15	— Hurst.
WILLOW WARBLER	Hertford	Apl. 14	Norman Thrale.
(*P. trochilus*)	St. Albans	,, 20	H. Lewis.
SEDGE WARBLER	St. Albans	Apl. 8	H. Lewis.
(*Acrocephalus phragmitis*)	Hunton Bridge, Watford	,, 24	J. E. Littleboy.
TREE PIPIT	St. Albans	Apl. 28	H. Lewis.
(*Anthus trivialis*)			
RED-BACKED SHRIKE	St. Albans	May 29	H. Lewis.
(*Lanius Collurio*)			
SPOTTED FLYCATCHER	Odsey, Royston	May 16	H. G. Fordham.
(*Muscicapa Grisola*)	Great Gaddesden	,, 18	H. Procter.
	Hunton Bridge, Watford	,, 19	J. E. Littleboy.
SWALLOW	Harpenden	Apl. 15	J. J. Willis.
(*Hirundo rustica*)	Great Gaddesden	,, 15	H. Procter.
	Hitchin	,, 15	— Hurst.
	St. Albans	,, 16	H. Lewis.
	Watford	,, 17	J. E. Littleboy.
	Fanhams Hall, Ware	,, 17	R. B. Croft.
	Odsey, Royston	,, 20	H. G. Fordham.

SPECIES.	LOCALITY.	DATE.	OBSERVER.
HOUSE MARTIN	Harpenden	Apl. 24	J. J. Willis.
(*Chelidon urbica*)	Boxmoor	,, 27	J. E. Littleboy.
	St. Albans	,, 30	H. Lewis.
	Fanhams Hall, Ware	May 8	R. B. Croft.
SAND MARTIN	Hertford	Apl. 15	Norman Thrale.
(*Cotile riparia*)	Hunton Bridge, Watford	,, 28	H. Procter.
SWIFT	St. Albans	May 10	H. Lewis.
(*Cypselus Apus*)	Fanhams Hall, Ware	,, 10	R. B. Croft.
	Harpenden	,, 12	J. J. Willis.
	Odsey, Royston	,, 13	H. G. Fordham.
Last seen	St. Albans	Aug. 17	H. Lewis.
NIGHTJAR	Harpenden	May	A.M.Dickenson.
(*Caprimulgus europæus*)			
WRYNECK	St. Albans	Apl. 20	H. Lewis.
(*Iÿnx Torquilla*)			
CUCKOO	Fanhams Hall, Ware	Apl. 20	R. B. Croft.
(*Cuculus canorus*)	St. Albans	,, 21	J. Hopkinson.
	Harpenden	,, 21	J. J. Willis.
	Hitchin	,, 26	— Hurst.
TURTLE DOVE	Leavesden, Watford	May 4	H. Procter.
(*Turtur communis*)	St. Albans	,, 6	H. Lewis.
	Odsey, Royston	,, 10	H. G. Fordham.
CORNCRAKE	Fanhams Hall, Ware	May 12	R. B. Croft.
(*Crex pratensis*)	Harpenden	,, 14	J. J. Willis.

WINTER VISITANTS.

REDWING	St. Albans	Oct. 8	H. Lewis.
(*Turdus iliacus*)			
FIELDFARE	St. Albans	Dec. 2	H. Lewis.
(*T. Pilaris*)			

I am pleased to be able to conclude this report by announcing that the ornithological recordership to the Society is no longer vacant, having since it was written been accepted by one of our past presidents, Mr. George Rooper, F.Z.S., of Nascott House, Watford; and I would ask our members to communicate to him any observations they may make or information they may obtain on the visits of birds to the county and on their habits as observed in the county. If his correspondents are as numerous and energetic as were those of the late Mr. Littleboy, I feel sure that we shall annually have from him very interesting and valuable "Notes on Birds."

XV.

PRE-HISTORIC MAN IN BRITAIN.

By Henry Hicks, M.D., F.R.S., F.G.S.

A Lecture delivered at St. Albans, 25th March, 1889.

The term "Pre-historic" is used to indicate the whole period relating to man disclosed by geological and archæological evidence as distinguished from what is known to us by written records. Time, however, will not allow me this evening to refer to more than a limited portion of that period; I shall therefore confine my remarks chiefly to the earliest stages as unfolded by comparatively recent researches.

The evidence that man occupied this country at a very remote period in the world's history, as compared with the time indicated by any written record, has been derived mainly from the finding of the implements which he used, in association with the remains of extinct animals, in limestone caverns and in valley-gravels which are known geologically to be of great antiquity. From the finding of the implements we learn that he lived in this country in association with the lion, hyæna, mammoth, woolly rhinoceros, etc., and that the geographical and the climatic conditions were at that time very unlike those which have since prevailed. Much evidence bearing on this question has of late years been accumulated. Not long ago, however, geologists were very loth to believe in this great antiquity for the human race, and every conceivable objection was raised against such views. It was not until the researches carried on in the valley of the Somme in France by M. Boucher de Perthes and Dr. Rigollot, described by Prof. Prestwich, Dr. John Evans, and others, and in the Brixham Cave in Devonshire by Mr. Pengelly, about thirty years ago, that the evidence was considered decisive, though facts tending strongly to such a conclusion had been obtained in Kent's Cavern and elsewhere at an earlier period. In addition to the evidence as to man's antiquity derived from the associated animal remains, we find, in the implements used by him at the various stages, an indication that his development towards a state of civilisation was very gradual, and that it must have extended over a vast period. The most important stages in this advance have received, from the character of the implements used, the names of the Stone age, the Bronze age, and the Iron age. Of these the earliest was the Stone age, when implements and ornaments were formed exclusively of stone, wood, horn, or bone. The use of metal for such purposes was then quite unknown. This was succeeded by the age of Bronze, when the implements were either made of that metal or of copper. In time iron superseded bronze for arms, axes, knives, etc., and the term Iron age is given to this period, although bronze was still in common use for ornaments, and frequently also for handles to swords and other arms. Some stone weapons also continued in use during the ages of Bronze and Iron.

In this lecture I shall refer mainly to the earliest or Stone age, which has been divided into two periods under the names Old Stone age (Palæolithic) and New Stone age (Neolithic). The implements belonging to the earlier or Palæolithic period were usually pieces of flint, chert, or quartz, very rudely fashioned, being merely roughly chipped into shape and never ground or polished. Those of the later or Neolithic period are much more varied in form, and often beautifully finished, being frequently ground to a sharp point or edge and polished all over.

Through the kindness of Mr. Allen Brown, of Ealing, I am enabled this evening to exhibit a few of the Palæolithic implements discovered by him in that neighbourhood. They were obtained mainly from the high-level gravels of the Thames Valley, *i.e.* above the 50-feet contour-line. Between Ealing and Acton Mr. Brown was fortunate enough to come upon what he considers to be the site of a Palæolithic workshop floor, under the brick-earth, and about six feet below the surface of the ground. From it Mr. Brown obtained no less than about 500 implements. It was near the 100-feet contour-line, and he supposes this spot to have been at the time an island in comparatively shallow water, whence the occupants must have been compelled to retreat suddenly, probably by flood-water, which carried mud and sand so as to cover the site rapidly over. The implements obtained here retain their sharp edges, and therefore could not have been rolled. The prevailing forms found by Mr. Allen Brown are "javelin and spear-heads, ranging in length from 3 to 6 inches; they are roughly but symmetrically chipped by secondary working to a point, and flanged at the butts, producing a rudimentary tang, and the edges are sharply bevelled. They show, like the implements of a similar kind obtained from other parts of the district, that a regular method was in use by which these objects were made. Thus it seems evident that, after striking single-ridged flakes from the cores, so as to leave a hollow where the one-ridged flake had been taken off, care was taken to strike the second or double-ridged flakes about the centre, and just behind the previous point of impact; in this way a double-ridged flake was formed, having a thin end or butt which could be easily inserted into the spear-shaft . . . . . Besides these objects, there were many rounded semilunar scrapers, knives with worked edges, flints with neatly-worked semicircular depressions, three or four awls or perforators made on the same pattern, and other worked flints. Some of the implements are rudely chipped like celts, while one fine specimen formed from a long flake is worked all round to a cutting-edge, both ends being carefully rounded."

A most interesting discovery of a similar floor has been made by Mr. F. C. J. Spurrell in the valley of the Thames near Crayford. It is two miles distant from the present river, and about 35 feet above its level. Among the specimens found here were some flakes which when placed together showed the original form of the mass of flint from which they had been struck, the mode of their manufacture being thus clearly explained. These flakes occurred beneath sand and brick-earth along with bones of rhinoceros, etc. In addition to the unabraded implements, very many have been discovered scattered about in the gravels of the Thames Valley, with indications of having been rolled by water-action. Many of these have been obtained from the lowest deposits which rest on the irregular floor formed by the London Clay. It is therefore evident that man must have occupied this area before the gravels were deposited; hence it is important to know to what period they should be assigned, and by what agencies they were accumulated.

By most authorities these gravels have hitherto been classed as of Post-glacial age, but some, notably the late Mr. Belt,* have tried to prove that they are in reality continuous with, and of the same age as, the acknowledged glacial deposits which spread over the hills to the north of the valley. Mr. Belt has demonstrated by numerous sections the similarity in the character of the gravels and brick-earth in the Thames Valley with the glacial drift found at Hendon, Finchley, Whetstone, etc., in Middlesex, and has given many reasons why he considers that they should not be classed with ordinary river-deposits. We examined many of the sections in these districts together, and found the glacial deposits mantling the hills and descending the slopes into the valleys in many places to the level of the higher Thames-Valley implement-bearing gravels. Since that time I have had opportunities of examining many fresh sections on the plateaux and along the slopes at Kingsbury, Hendon, Finchley, Whetstone, etc., with similar results, proving that the main features are due to the underlying irregular floor of London Clay. Evidence is therefore constantly accumulating, tending to show that the high-level gravels and the overlying brick-earth, from having so much in common with the glacial drifts, must be considered as belonging to the Glacial period. They are found, on comparison, to have little or nothing in common with the recent deposits in the Thames Valley, and are altogether unlike any ordinary river-accumulations. Moreover, it must not be forgotten that very little change has taken place in the level or position of the Thames during the historic period, and that, except under such very great changes as took place during and at the close of the Glacial period, accumulations of this kind could hardly have been spread out over such extensive areas.

The occurrence of an unstratified deposit, containing large stones, at the base of the gravels in the Thames Valley, agrees so exactly with the conditions witnessed everywhere in the glacial drift at Hendon and Finchley, that one is inclined to refer this deposit to a very early phase in the Glacial period. It is, in reality, all that remains of the lowest boulder-clay, and, as it consists mainly of local materials, it may be considered the local till. In the Thames Valley, as on the plateaux in Middlesex, these lowest deposits are covered by more or less stratified sands and gravels (the so-called middle sands and gravels), and upon the latter in the Thames

* 'Quarterly Journal of Science,' July, 1878.

Valley the brick-earth is found occupying apparently the position of the highest boulder-clay in the other areas. Similar conditions are to be witnessed in the valleys and plateaux of the adjoining counties. In Hertfordshire, glacial deposits are spread out over extensive areas, and in the main they resemble those which occur in Middlesex. Some, however, have supposed that the pebble-gravels of the higher plains should be classed as of Pre-glacial age, whilst others consider them as of Middle-glacial age, and think that they should be correlated with the subangular gravel and sand of the lower plain. From an examination which I have made of some of these higher gravels, I am inclined to think that they must have been deposited at an early time in the Glacial period, and that their somewhat peculiar character may be accounted for by their having been mainly derived, like the lower deposits in Middlesex, from certain Tertiary beds, such as the Bagshot Sands.

If it can be proved that the high-level gravels in the Thames Valley are to be correlated with the glacial deposits at Hendon and Finchley, it is clear that the gravels near Hertford mentioned by Prof. Hughes* as containing bones of some Pleistocene Mammalia, viz. horse, ox, reindeer, mammoth, and rhinoceros, must also be considered as of Glacial age.

Several implements were obtained by some friends and myself in caverns in the Vale of Clwyd, North Wales, during explorations carried on there in the years 1884–87. Much interest is attached to one of the flakes, as it was obtained under deposits of undoubted Glacial age outside a covered entrance to the cavern in association with bones of the mammoth, hyæna, rhinoceros, and reindeer. It seems to have been used as a scraper, and resembles some which have been found in Kent's Cavern and elsewhere in association with the oldest Pleistocene fauna. Its position under a great thickness of undisturbed glacial deposits shows that man undoubtedly occupied that area before the latter were accumulated, and there is ample evidence to show that these beds are to be correlated with the recognised glacial deposits in many other areas in England and Wales. We found several flint implements, in association with a similar fauna, in the deposits within the caverns, and the conclusions which we arrived at were that they belonged also to the same period. The caverns appear to have been occupied by the animals named and by man either before or during the earlier stages of the Glacial period, and to have been subsequently covered over by marine deposits and boulder-clay. The implements found in the caverns, as also those of the Thames-Valley gravel, closely resemble those made use of by some of the uncivilised races of the present day. So nearly identical are some of the implements used by the Esquimaux at the present time with those of the Palæolithic period that it has been suggested by Prof. Boyd Dawkins that the Esquimaux may be the direct descendants of Palæolithic man. The two periods of the Stone age are also distinguished by the animals which were associated with man.

* 'Quart. Journ. Geol. Soc.,' vol. xxiv, p. 283 (1868).

The men of the Early Stone age do not appear to have had any domestic animals. They were evidently a race of fishers and hunters, and doubtless lived mainly in caves, though possibly they were able to construct some rude shelter when these were not accessible. They had a certain amount of artistic skill, as may be seen by the drawings which they made on some of their bone weapons. Of the people themselves very little is known, since but few skeletons have been preserved. Those which have been found seem to show that the race must have been what is called the long-headed (dolichocephalic). According to MM. de Quatrefages and Hamy, two long-headed races occupied Europe in the Palæolithic period. The one was characterised by the more or less extraordinary prominence of the superciliary ridges, and by a low, narrow, and receding forehead, the orbits very large and almost circular, the nasal bones prominent and the nasal orifices wide, while the upper jaw projected and the chin retreated. In short the face and cranium must as a rule have presented a strangely savage aspect. The body appears to have harmonized with the head, and the few bones of the limbs, preserved more or less intact, indicate a low stature. The other race had more finely-developed skulls, were also taller, and it is to these latter that the artistic hunters are supposed to have belonged.

The Newer Stone age man was probably, at least in this country, separated from the man of the Older Stone age by a considerable lapse of time, hence not only are his implements much more highly finished, and more varied in character, but the animals which were associated with him were (with one or two exceptions) essentially the same as those which are now found in Europe. Thus the Palæolithic period is marked off as it were from the Neolithic, not only by the very distinct character of its human relics, but also by the strong dissimilarity of its Mammalian remains. A gradual passage from the Newer Stone age to the succeeding Bronze age may be traced, but no such transition has as yet been detected in this country between the relics of the New and the Old Stone periods. This is probably due to the great physical changes which took place about this time, the cause of which constitutes one of the most interesting and absorbing subjects which geologists have to deal with.

The oldest implements have been found mainly in those limestone caverns and river-gravels which have been classed geologically as belonging to the Post-pliocene or Pleistocene period. By most authorities they are assigned to a time subsequent to the Glacial period, though some of us maintain that there is the clearest evidence to show that Palæolithic man occupied this country before it was overwhelmed by glacial conditions. If this can be satisfactorily proved, it, of necessity, adds greatly to man's antiquity, and he must be considered as of Glacial, if not of Pre-glacial age.

To understand what is meant by the Pre-glacial age, we must carry the mind back to that era in geological chronology which is designated by the name *Tertiary*, for the present geographical features in the northern hemisphere mainly date from that time. The great change which took place at the close of the *Secondary* era, known as the age of Great Reptiles, brought with it animals (Mammalia) far more closely allied to those of the present day than any which had preceded them, consequently the Tertiary is known as the age of Mammals. During the latter period, however, there were very considerable geographical and climatic changes, beginning with a tropical and subtropical, and ending with a cold climate. Towards the close of the Tertiary era much of the floor of the sea, which then extended at some points from the Atlantic to the Indian Ocean, was upheaved, so that its consolidated strata were bent into those mighty earth-wrinkles which now constitute our grandest mountain-chains. The limestone of the Middle Tertiary was lifted up in the Alps to 10,000 feet above sea-level, and in the mountains of Thibet to heights of at least 13,500 feet. A great fringe of volcanoes stretched in an almost continuous band from Central France through the Rhine provinces to Bohemia and the Eastern Carpathians. The Rocky-Mountain ranges in America, like those of the Alps, underwent their last upheaval also at this time. England was joined to the continent, and to Ireland, and a belt of land probably stretched northward from Scotland to Iceland and Greenland, and the latter was also connected with America. Britain stood at this time between 2000 and 3000 feet higher out of the sea than it does now, while some of the mountains of Wales and Scotland lifted their crests 8000 or 9000 feet above the sea-level of the period. Gradually the country became covered by ice and snow, until at last it assumed the condition now witnessed in the Arctic and Antarctic regions.

It may be of interest to note that, in addition to the animals already referred to, large apes occupied, at an early part of the period, the forests of France, Switzerland, Germany, and Italy, but there is no satisfactory evidence to show that man lived there at an equally early date. So far as the evidence goes, it seems to indicate that apes disappeared from Europe towards the close of the Tertiary era ; their gradual southern retreat and final extermination in Europe being, in the opinion of Prof. Boyd Dawkins, probably due to the lowering of the temperature by the gradual change in climate. If man appeared in Europe in company with the early Tertiary Mammalia, as did the apes, from some eastern or southern source, he would doubtless have remained until the close of that era, deer and other animals suitable as food for him still being present in great abundance. Hitherto, however, no decided relics of man have been found in the recognized deposits of this period.

When we first meet with evidences of man in the succeeding deposits, we find clear proof that, though in what must be considered a savage condition, he was far from being in his rudest state. He was evidently a hunter and a fisher, and probably clothed himself in the skins of animals which he slew, for we find that he used bone needles, as well as ornaments with which he decorated himself. Unlike the tropical savage, who requires to think little of his necessities, he had to defend himself against the rigour of the climate, and to be constantly on the alert to supply his wants. The indolent tropical savage would not migrate towards such an inhospitable region by any sudden impulse, and it is probable that the man of the reindeer period whom we first meet with in this country, though possibly the descendant of a more tropical race, had attained to his condition through a very gradual process.

The close of the Tertiary era in the north-west of Europe, it should be said, was marked by such an increase in the severity of the climate that the southern forms gradually migrated from this country, and animals of northern types appeared on the scene. It is in the deposits which accumulated at this date that relics of man are first found, in association with the remains of animals of northern origin, and of a few southern forms such as the lion and hyæna, which still remained. Researches which have been carried on in recent years in the Victoria Cave in Yorkshire (described by Mr. Tiddeman*) and in the Ffynnon Beuno and Cae Gwyn Caves in North Wales,† have proved conclusively that the northern animals and man reached this country at the beginning of the Glacial period, and not, as has hitherto been generally supposed, immediately after that period. The settlement of this question is of great importance, as it not only carries the advent of man back to a far remoter period than was before supposed, but it also shows that the cave-man is at least of equal antiquity with the man of the older valley-gravels. Prof. Prestwich, our greatest authority on these questions, has recently stated that, in consequence of the newly-accumulated evidence showing the occurrence of human relics in Glacial times, he has been led to change his views as to the age of the high-level gravels in the Somme, Seine, Thames, and Avon valleys, and that he is now disposed to assign these beds to the earlier part of the Glacial period, when the ice-sheet was advancing. Until these explorations the caverns in this country had furnished evidence only to show that man must have been contemporary with the extinct Mammalia already referred to. But these more recent researches have proved, not only that these animals and man lived together, but that they must have been here before the country was covered with ice and snow, hence long before the submergence which took place at the climax of the Ice age, when the mountains in Wales, which, as already shown, had previously stood at a great elevation, were submerged to such a depth that marine sands containing shells were deposited upon them, and are now found at heights of about 1500 feet above the present sea-level. At this time our islands, which in the early period were joined to the Continent and extended much farther out into the Atlantic, at least as far as the 100-fathom line, are supposed to have been almost completely submerged, leaving only a group of islands consisting of the higher parts of our mountain-lands.

* 'Brit. Assoc. Report,' 1874, p. 133; 1875, p. 166.

† Hicks, 'Brit. Assoc. Report,' 1886, pp. 219 and 839; 1887, pp. 301 and 912; 'Quart. Journ. Geol. Soc.,' vol. xlii, p. 3 (1886); vol. xliv, p. 561 (1888).

As none of the characteristic extinct Mammalia occur in deposits subsequent to that period, it is natural to suppose that they did not return to this country after it was re-elevated, and the break between Palæolithic and Neolithic man is found to correspond with the time indicated by these great changes. Palæolithic man, like the lower animals, was driven out of this country by these great physical influences, and though he afterwards occupied for a time some parts of the south-east of Europe, when the climate gradually changed and the glaciers retreated, it seems clear that he must have returned northwards with the reindeer and other northern animals. As the work of forming and spreading over the world the races of mankind was done in the Pre-historic period, we are justified in assigning to that period a long stretch of time, and also in believing that though the Palæolithic hunters were then a northern race, their ancestors may at some very remote period have migrated from an original home in a more genial clime.

The next race that invaded this country belonged to the Newer Stone age, and its members were much more advanced, being to a certain extent cultivators of the soil, and accompanied by domestic animals. They doubtless arrived from an eastern or southern source, and in time spread over the whole of our islands. They are supposed to have belonged to the Iberic race and to have been of small stature with long or oval skulls of fair average capacity. Their implements are found frequently in barrows, etc.

In course of time another invasion took place, from an eastern or north-eastern direction, by the Celtic race, and it was an admixture of these two races that the Romans found here when they first reached this country.

XVI.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1887.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 12th April, 1889.

Reports on the Rainfall in Hertfordshire have been contributed to the Society for eleven years,—for the four years 1876–79 by myself, and for the seven years 1880–86 by the Rev. C. W. Harvey. I have temporarily resumed the compilation of these reports owing to Mr. Harvey being unable to spare time to prepare those for 1887 and 1888, and now present the report for the year 1887.

I have thought it advisable to make a change in the sequence of the river-districts, which in this report is in conformity with the scheme followed in our 'Flora of Hertfordshire,' where the river-basins, clearly distinguished on the coloured map accompanying that work, are thus divided:—

I. Ouse.	1. Cam.	II. Thames.	3. Thame.
	2. Ivel.		4. Colne.
			5. Brent.
			6. Lea.

In this report I have included the rainfall at New Barnet, in the Lower Lea district, taken from Mr. Glaisher's "Remarks on the Weather" in the Registrar General's 'Returns.' With this exception the only alteration from the previous year in the staff of observers is the addition of Mr. Edward Harrison of Watford, an observer from whom we had returns for 1876 to 1881. By my own removal from Watford to St. Albans we have one more gauge in the Ver district, and the above addition makes up for the absence of my gauge from the Colne district. We are still without an observer in the river-basin of the Brent.

The number of stations from which the report for 1886 was drawn up was 26; for the present report there are by these additions 28, and from 20 of these I have returns of the daily rainfall. The number of gauges is 30.

The rainfall in the year 1887 was very small, the mean for the county being only 19·73 inches. This is 9·27 ins. below the mean of the 10 years 1876–85, to which period the term "mean," when not otherwise defined, will refer, and it is 6·62 ins. below the mean of the 40 years 1840–79 (26·35 ins.*). For a smaller rainfall than in 1887 we have to go back to the year 1864, when the mean fall in the county was 17·86 ins. The greatest recorded fall in the county was in the year 1852, when the mean was 37·59 ins., nearly double that of 1887.

Particulars of the rainfall stations, and the monthly rainfall at each station, are given in the accompanying tables (Tables I and II, pp. 156, 157).

* See "Rainfall in Hertfordshire, 1840–79," by the Rev. C. W. Harvey, in 'Trans. Herts Nat. Hist. Soc.,' Vol. I, pp. 151–158, where the mean for each decade is thus given:—1840–49, 25·82 ins.; 1850–59, 25·50 ins.; 1860–69, 26·11 ins.; 1870–79, 27·97 ins.

TABLE I.—HERTFORDSHIRE RAINFALL STATIONS.

River District.			Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.
					° ′ ″	° ′ ″	ins.	ft. ins.	ft.*
OUSE	CAM	Rhee	Royston	Hale Wortham	52 2 34 N	0 1 8 W	8	0 6	269 ⊼
			,, Odsey Grange	H. George Fordham	52 1 28 N	0 6 41 W	5	1 0	263 ⊼
	IVEL	Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238 ⊼
			,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422 ⊼
THAMES	THAME	Up. Thame	Tring Vicarage	Rev. W. Quennell	51 47 33 N	0 39 25 W	5	1 0	442 T
	COLNE	Gade	Cowroast	Hubert Thomas, C.E.	51 47 0 N	0 36 30 W	10	4 2	345 L
			Berkhamsted—Rose Bank	Edward Mawley	51 45 40 N	0 33 30 W	8	1 0	401 ⊼
		Bulbourne	Great Gaddesden Vicarage	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426 ⊼
			Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 44 0 N	0 26 40 W	12	3 9	237 T
		Ver	Kensworth	Miss S. Grace Jones	51 51 30 N	0 30 0 W	5	1 0	630 B
			Harpenden—Rothamsted	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	5	0 9	420 T
			,, ,, (2nd gauge)		51 48 10 N	0 21 30 W	8	0 9	420 T
			,, ,, (3rd gauge)		51 48 10 N	0 21 30 W	72 × 87	0 9	420 T
			St. Albans—The Grange	John Hopkinson	51 45 9 N	0 20 7 W	5	1 0	380 ⊼
			,, Gorhambury	Rt. Hon. Earl of Verulam	51 45 20 N	0 23 0 W	6 sqr.	2 6	413 T
		Lo. Colne	Watford—Oaklands	Edward Harrison	51 40 5 N	0 24 20 W	5	5 6	273 T
			,, Watford House	Alfred T. Brett, M.D.	51 37 25 N	0 23 35 W	5	1 3	240 T
			Rickmansworth—Moor Park	Rt. Hon. Lord Ebury	51 37 30 N	0 26 20 W	5	2 0	340 ⊼
	LEA	Mimram	Welwyn Rectory	Rev. C. L. Wingfield	51 49 50 N	0 12 30 W	5	0 6	228 T
			Datchworth Rectory	Rev. J. Wardale	52 2 0 N	0 10 0 W	5	1 0	386 T
		Beane	Knebworth Rectory	Late Rev. F. G. Jenyns	51 52 30 N	0 12 30 W	5	1 0	391 ⊼
			Bennington Lodge	Rev. J. D. Parker, LL.D.	51 53 45 N	0 5 20 W	5	1 0	408 ⊼
		Rib	Therfield Rectory	Rev. J. G. Hale	52 1 0 W	0 3 0 W	5	4 3	500
			Throcking Rectory	Rev. C. W. Harvey	51 57 5 W	0 3 0 W	5	1 0	484 T
		Ash	Much Hadham	T. Woodham Mott	51 51 24 N	0 4 38 E	5	1 0	222 B
		Up. Lea	Hertford—Bayfordbury	W. Clinton Baker	51 46 30 N	0 5 30 W	8	1 2	250
			Ware—Red House	Joseph Francis, C.E.	51 46 0 N	0 6 0 W	12	3 0	114 T
			,, Fanhams Hall	Miss Joyce Croft	51 49 30 N	0 1 30 W	8	1 0	253 T
		Lo. Lea	New Barnet—Gas Works	T. H. Martin, C.E.	51 39 5 N	0 10 15 W	8	0 9	212
			Southgate—The Lawns	George A. Church	51 37 40 N	0 8 0 W	5	0 6	240 T

* For explanation of these symbols see 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 226.

TABLE II.—RAINFALL IN HERTFORDSHIRE IN 1887.

STATIONS.	JAN.	FEB.	MAR.	APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
*Royston	1·54	·66	1·33	1·17	2·41	·42	·62	1·14	2·48	1·92	2·91	1·23	17·83	144
* ,, Odsey Grange	·94	·68	1·10	1·02	2·30	·53	·79	1·14	2·59	1·46	2·31	·98	15·84	160
Hitchin	2·00	·63	1·36	1·18	2·39	·87	·93	·99	2·60	1·58	2·94	1·23	18·70	153
,, High Down	2·21	·72	1·08	1·50	2·35	·96	·63	1·12	2·95	1·69	2·57	1·18	18·96	144
*Tring Vicarage	2·91	·85	2·44	1·47	2·80	·98	·83	·85	2·98	1·70	3·67	2·13	23·61	143
*Cowroast	2·02	·79	1·98	1·69	2·71	·97	·71	·93	2·80	1·78	3·19	1·98	21·55	122
*Berkhamsted—Rose Bank	2·71	·80	1·87	1·34	2·36	·88	·75	·89	2·60	1·77	3·24	1·77	20·99	168
*Great Gaddesden Vicarage	2·19	·80	1·86	1·21	2·16	·87	·73	·98	3·14	1·56	3·22	1·60	20·32	151
*Kensworth	2·35	·80	1·78	1·02	2·15	·77	·86	1·15	3·29	1·46	3·20	1·61	20·44	140
*Hml. Hempsted—Nash Mills	1·78	·87	1·50	1·94	2·50	·78	·62	1·02	2·67	1·28	3·10	1·51	19·57	137
Harpenden—Rothamsted	2·20	·90	1·63	1·12	2·25	·68	·69	·94	3·02	1·57	3·34	1·53	19·87	150
,, ,, (2nd gauge)	2·22	·88	1·64	1·10	2·22	·67	·71	·95	2·99	1·57	3·27	1·55	19·77	147
* ,, ,, (3rd gauge)	2·39	·95	1·76	1·19	2·35	·71	·79	1·04	3·11	1·69	3·41	1·66	21·05	172
*St. Albans—The Grange	1·88	·64	1·70	1·22	2·12	·65	·88	1·07	3·12	1·62	3·40	1·54	19·84	162
,, Gorhambury	2·29	·87	1·67	1·22	2·22	·69	·50	1·03	3·64	1·51	3·44	1·40	20·48	117
Watford—Oaklands	2·25	·76	1·94	1·58	2·10	·88	1·61	1·82	2·99	1·51	3·56	1·83	22·83	137
* ,, Watford House	2·02	·66	1·99	1·26	2·04	·80	1·59	1·60	2·58	1·30	2·93	1·35	20·12	138
*Rickmansworth—Moor Park	3·12	·72	1·84	1·39	2·57	·99	1·01	3·10	3·06	1·62	3·98	1·69	25·09	148
*Welwyn Rectory	1·98	·77	1·53	1·13	2·48	·51	·63	1·16	3·30	1·44	2·82	1·33	19·08	144
*Datchworth Rectory	1·73	·77	1·41	1·12	2·53	·66	·60	·56	3·01	1·51	2·88	1·05	17·83	149
Knebworth Rectory	2·15	·82	1·58	1·15	2·63	·75	·55	·97	2·85	1·60	3·17	1·18	19·40	159
*Bennington Lodge	1·52	·77	1·36	1·03	2·69	·77	·78	1·16	3·05	1·65	2·86	1·22	18·86	162
Therfield Rectory	1·46	·72	1·39	1·29	2·86	·56	·64	1·16	3·47	1·80	2·79	1·32	19·46	141
*Throcking Rectory	1·22	·75	1·33	1·12	2·15	·57	1·06	·85	3·56	1·66	2·87	1·12	18·26	150
*Much Hadham	1·48	·64	1·74	·96	2·36	·60	·90	1·57	2·97	1·71	3·04	1·24	19·21	140
†Hertford—Bayfordbury	1·53	·70	1·69	·90	2·68	·71	·78	1·52	2·84	1·44	2·82	1·45	19·06	154
*Ware—Red House	1·16	·59	1·29	1·10	2·19	·73	·80	1·77	2·54	1·80	2·99	1·06	18·02	133
* ,, Fanhams Hall	1·45	·62	1·71	·80	2·52	·59	·79	1·73	2·46	1·42	2·72	1·18	17·99	148
New Barnet—Gas Works	1·57	·57	1·36	1·22	1·63	·75	1·05	1·57	2·51	·94	3·50	1·17	17·84	125
*Southgate—The Lawns	1·52	·63	1·59	1·11	1·35	·65	·88	2·75	2·49	1·72	3·50	1·82	20·01	152
Mean for the County	1·93	·74	1·62	1·22	2·34	·73	·82	1·28	2·92	1·58	3·12	1·43	19·73	146

* Daily fall received from the observers at these stations. † Daily fall for this station taken from 'Hertfordshire Mercury.'

Distribution of Rainfall throughout the Year.—Of the total rainfall 21% fell during the winter months (Jan., Feb., and Dec.), 26% during the spring (March to May), 14% during the summer (June to Aug.), and 39% during the autumn (Sept. to Nov.). The fall of each quarter and of each season, and their deviation from the mean, was as follows:—

	Fall.	Diff.		Fall.	Diff.
1st quarter	4·29 ins.	—1·72 ins.	Winter	4·10 ins.	—1·91 ins.
2nd ,,	4·29	—2·35	Spring	5·18	—1·46
3rd ,,	5·02	—3·18	Summer	2·83	—5·37
4th ,,	6·13	—2·02	Autumn	7·62	—0·53
	19·73	—9·27		19·73	—9·27

Thus the fall was below the mean in every quarter and in every season, the defect being very great in the summer and but slight in the autumn.

February and June were the driest months, September and November the wettest; July also was very dry, and May was rather wet. The difference in each month from the mean was:

	in.		in.		in.		in.
Jan.	—0·10	April	—1·04	July	—1·71	Oct.	—1·20
Feb.	—1·71	May	+0·39	Aug.	—1·48	Nov.	+0·42
Mar.	+0·09	June	—1·70	Sept.	+0·01	Dec.	—1·24

The absolute maximum fall in any one day in each month and the station at which it occurred was:

	ins.		ins.
Jan. 3rd—Moor Park	1·22	July 24th—Oaklands	0·47
Feb. 2nd—Gorhambury	0·28	Aug. 17th—Moor Park	1·11
Mar. 24th— ,,	0·58	Sept. 1st—Nash Mills	0·67
Apr. 23rd—Cowroast	0·70	Oct. 29th—Moor Park	0·85
May 31st—Tring	0·82	Nov. 3rd—Throcking	0·79
June 2nd—Southgate	0·58	Dec. 8th—Moor Park	0·44

The wettest day in each month at 27 stations was:

Jan. 3rd at 23 stations; 7th at 3; 10th at 1.

Feb. 1st at 1; 2nd at 17; 17th at 4; 18th at 1; 1st and 17th equal at 2; 2nd and 17th equal at 1; 2nd and 18th equal at 1.

March 15th at 5; 22nd at 10; 23rd at 1; 24th at 1; 31st at 9; 22nd and 31st equal at 1.

April 1st at 1; 23rd at 25; 24th at 1.

May 3rd at 2; 8th at 1; 12th at 1; 19th at 14; 24th at 1; 31st at 8.

June 1st at 7; 2nd at 14; 3rd at 4; 1st and 2nd equal at 1; 1st, 2nd, and 3rd equal at 1.

July 14th at 2; 24th at 19; 25th at 1; 26th at 5.

Aug. 12th at 3; 16th at 1; 17th at 1; 28th at 2; 30th at 20.

Sept. 1st at 11; 16th at 15; 6th and 16th equal at 1.

Oct. 29th at all stations.

Nov. 2nd at 3; 3rd at 16; 4th at 1; 9th at 6; 3rd and 9th equal at 1.

Dec. 8th at 22; 12th at 1; 13th at 1; 14th at 1; 8th and 12th equal at 1; 8th, 12th, and 14th equal at 1.

The day in each month on which a heavy fall of rain was most general over the county was therefore:

Jan. 3rd.	April 23rd.	July 24th.	Oct. 29th.
Feb. 2nd.	May 19th.	Aug. 30th.	Nov. 3rd.
Mar 22nd.	June 2nd.	Sept. 16th.	Dec. 8th.

The number of wet days in the year (average of 30 gauges) was 146, being 24 less than the mean of our period. Of the total number there were 37 (or 26°/$_0$) in the winter months, 43 (or 29°/$_0$) in the spring, 21 (or 14°/$_0$) in the summer, and 45 (or 31°/$_0$) in the autumn.

The number of wet days in each month and the deviation from the mean was as follows:

Jan. ..... 13 —3	April..... 12 — 1	July ..... 8 —5	Oct. ..... 11 —3
Feb. ..... 7 —8	May ..... 19 + 6	Aug. .....17 —3	Nov. ..... 17 +1
Mar. ..... 12 —2	June ..... 4 —10	Sept. .....11 +2	Dec. ..... 17 +2

Distribution of Rainfall throughout the County.—Of the 30 rain-gauges 4 are in the river-basin of the Ouse for which they give a mean fall of 17·83 ins. in the year, and 26 are in the river-basin of the Thames for which they give a mean fall of 20·02 ins. The following table (Table III) gives the mean fall for each month and for the year in each of our six river-districts, and in the county, for comparison, and also the difference in the year from the mean of our period.

TABLE III.—RAINFALL IN THE RIVER DISTRICTS.

MONTHS.	CAM.	IVEL.	THAME.	COLNE.	LEA.	COUNTY.
January	1·24	2·10	2·91	2·26	1·56	1·93
February	·67	·67	·85	·80	·70	·74
March	1·21	1·22	2·44	1·78	1·50	1·62
April	1·10	1·34	1·47	1·33	1·08	1·22
May	2·35	2·37	2·80	2·29	2·34	2·34
June	·48	·91	·98	·80	·65	·73
July	·70	·78	·83	·88	·79	·82
August	1·14	1·06	·85	1·27	1·40	1·28
September	2·54	2·77	2·98	3·00	2·92	2·92
October	1·69	1·64	1·70	1·56	1·56	1·58
November	2·61	2·75	3·67	3·33	2·99	3·12
December	1·10	1·22	2·13	1·62	1·26	1·43
Year	16·83	18·83	23·61	20·92	18·75	19·73
Diff. from 1876-85	—7·67	—8·47	—8·29	—10·38	—8·13	—9·27

The mean fall in the year in each of the minor river-basins, or sub-districts, was as follows:—

District	Sub-district	ins.
CAM	Rhee	16·83
IVEL	Hiz	18·83
THAME	Upper Thame	23·61
COLNE	Gade	21·27
	Bulborne	20·38
	Ver	20·10
	Lower Colne	22·68
LEA	Mimram	18·45
	Beane	19·13
	Rib	18·86
	Ash	19·60
	Upper Lea	18·36
	Lower Lea	18·93

The total yearly fall ranged from 15·84 ins. at Odsey Grange, to 25·09 ins. at Moor Park; and the total monthly fall from 0·42 in. at Royston in June, to 3·98 ins. at Moor Park in November.

Chief falls of rain in each month.—In the following brief notice of the chief falls of rain the nomenclature used in previous reports is adopted, falls of ½ inch being styled *considerable*, of ¾ inch *very considerable*, and of 1 inch *great*. As 1¼ inch was never reached, the terms *very great*, *heavy*, *very heavy*, and *excessive* are not required.

January.—Nearly all the amount gauged during the month is due to snow, which fell heavily almost daily in the early part of the month. On 3rd the fall (rain and snow) was *great* at Moor Park (1·22 in), and at Nash Mills (1·01 in.), *very considerable* at four stations, and *considerable* at one.

February.—A very dry month, with no rain at all stations but three from 4th to 16th (13 days), and at those only 0·01 in.; and with no *considerable* fall at any station.

March.—From 21st Feb. to 10th March (18 days) no rain fell at half the stations, and at only one did the amount during this period reach 0·10 in. Most of the amount gauged during the month fell as snow. On 15th and 24th the fall (snow) was *considerable* at a few stations.

April.—Very little rain fell until 21st, and at most stations none from 8th to 21st (12 days). On 23rd only was there a *considerable* fall, and then only at three stations.

May.—Rainfall generally distributed over the month. On 3rd the fall was *very considerable* at one station, on 19th *considerable* at six, and on 31st *very considerable* at one and *considerable* at four.

June.—An excessively dry month. At several stations no rain whatever fell between 3rd June and 4th July, a period of 30 days; at Rothamsted 0·05 in. was gauged during this period; at Bayfordbury 0·04 in.; but at no other station was there more than 0·02 in. On 2nd and 3rd the fall was *considerable* at a few stations.

July.—The very small rainfall was generally distributed over the month; at no station was there a *considerable* fall.

August.—At only two stations was there any rain for the first 11 days, and at these there was only a slight fall on 1st. On 17th the fall was *great* at Moor Park (1·11 in.), on 28th *considerable* at two stations, and on 30th *great* at Moor Park (1·10), *very considerable* at three stations, and *considerable* at thirteen.

September.—Most of the rain fell during the first half of the month, at least to 17th. On 1st the fall was *considerable* at nine stations, and on 16th at fourteen.

October.—At most stations no rain fell during the first week nor from 15th to 22nd. On 29th the fall was *very considerable* at about half the stations and *considerable* at the rest.

November.—Nearly all the rain fell during the first nine days, the fall during the remainder of the month scarcely averaging half an inch. On 3rd the fall was *very considerable* at three stations and *considerable* at fourteen, and on 9th *considerable* at eight.

December.—The rainfall was generally distributed over the month. There was no *considerable* fall at any station.

XVII.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1888.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 26th April, 1889.

The number of observers from whom returns of the rainfall in 1888 have been received is the same as for the previous year, but there are a few alterations in the staff. Owing to Mr. H. George Fordham having left England we have no longer a return for Odsey; and by the death of the Rev. F. G. Jenyns, Rector of Knebworth, we lose that station, his successor not taking the rainfall. On the other hand we have for the first time a return for Broxbourne from Mr. G. J. Newbery, and one for Cheshunt College from the Rev. Dr. Reynolds. Both of these places are in the river-basin of the Lower Lea, the stations which disappear from our table being in the basins of the Rhee and Beane.

The districts without observers are the Upper Ivel (Baldock) in the north, the Chess in the south-west, the Brent (Totteridge) and the Upper Colne (the Colne above its junction with the Ver) in the south, and the Stort (Stortford, Sawbridgeworth, etc.) in the east. The western portion of the Rhee (Ashwell) is also now unrepresented, and there is only one observer in the large district of the Beane. It would be advisable for as many as possible of these deficiencies to be supplied before the commencement of the rainfall decade 1890-99.

The present report is drawn up from returns for 28 stations, as was the last, and from 24 of these I have the daily rainfall. The number of gauges is the same as before, namely 30.

The rainfall in the year 1888 was a little below the average of a long series of years, but considerably below that of the period chosen for comparison in the last few reports, the mean for the county being 26·09 inches. This is 2·91 inches below the selected mean, that of the 10 years 1876–85, and 0·46 in. below the mean of the 40 years 1840–79.

Particulars of the rainfall stations, and the monthly and total rainfall and number of days on which 0·01 in. or more fell, are given in the accompanying tables (Tables I and II, pp. 162, 163).

Distribution of Rainfall throughout the Year.—Of the total rainfall 13°/₀ fell during the winter months (Jan., Feb., and Dec.), 25°/₀ during the spring (March to May), 37°/₀ during the summer (June to Aug.), and 25°/₀ during the autumn (Sept. to Nov.). The fall of each quarter and of each season, and their deviation from the mean, was as follows:—

	Fall.	Diff.		Fall.	Diff.
1st quarter	5·20 in.	—0·81 in.	Winter	3·39 in.	—3 76 in.
2nd ,,	6·09	—0·55	Spring	6·52	+0·78
3rd ,,	7·96	—0·24	Summer	9·76	+2·04
4th ,,	6·84	—1·31	Autumn	6 42	—1·97
	26·09	—2·91		26·09	—2 91

Table I.—Hertfordshire Rainfall Stations.

River District.			Station.	Observer.	Latitude. ° ′ ″	Longitude. ° ′ ″	Diameter of Gauge. ins.	Height of Gauge above Ground. ft. ins.	Height of Gauge above Sea-level. ft.*
Ouse	Cam	Rhee	Royston	Hale Wortham	52 2 34 N	0 1 8 W	8	0 6	269 $\overline{\uparrow}$
Ouse	Ivel	Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238 ↑
			,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422 ↑
Thames	Thame	Up. Thame	Tring Vicarage	Rev. W. Quennell	51 47 33 N	0 39 25 W	5	1 0	442 T
	Colne	Bulbourne	Cowroast	Hubert Thomas, C.E.	51 47 0 N	0 36 30 W	10	4 2	345 L
			Berkhamsted—Rose Bank	Edward Mawley	51 45 40 N	0 33 30 W	8	1 0	401 $\overline{\uparrow}$
		Gade	Great Gaddesden Vicarage	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426 $\overline{\uparrow}$
			Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 44 0 N	0 26 40 W	12	3 9	237 T
		Ver	Kensworth	Miss S. Grace Jones	51 51 30 N	0 30 0 W	5	1 0	630 B
			Harpenden—Rothamsted	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	5	0 9	420 T
			,, ,, (2nd gauge)		51 48 10 N	0 21 30 W	8	0 9	420 T
			,, ,, (3rd gauge)		51 48 10 N	0 21 30 W	72 × 87	0 9	420 T
			St. Albans—The Grange	John Hopkinson	51 45 9 N	0 20 7 W	5	1 0	380 $\overline{\uparrow}$
			,, Gorhambury	Rt. Hon. Earl of Verulam	51 45 20 N	0 23 0 W	6 sqr.	2 6	413 T
		Lo. Colne	Watford—Oaklands	Edward Harrison	51 40 5 N	0 24 20 W	5	5 6	273 T
			,, Watford House	Alfred T. Brett, M.D.	51 37 25 N	0 23 35 W	5	1 3	240 T
			Rickmansworth—Moor Park	Rt. Hon. Lord Ebury	51 37 30 N	0 26 20 W	5	2 0	340 $\overline{\uparrow}$
	Lea	Mimram	Welwyn Rectory	Rev. C. L. Wingfield	51 49 50 N	0 12 30 W	5	0 6	228 T
			Datchworth Rectory	Rev. J. Wardale	52 2 0 N	0 10 0 W	5	1 0	386 T
		Beane	Bennington Lodge	Rev. J. D. Parker, LL.D.	51 53 45 N	0 5 20 W	5	1 0	408 ↑
		Rib	Therfield Rectory	Rev. J. G. Hale	52 1 0 N	0 3 0 W	5	4 3	500
			Throcking Rectory	Rev. C. W. Harvey	51 57 5 N	0 3 0 W	5	1 0	484 T
		Ash	Much Hadham	T. Woodham Mott	51 51 24 N	0 4 38 E	5	1 0	222 B
		Upper Lea	Hertford—Bayfordbury	W. Clinton Baker	51 46 30 N	0 5 30 W	8	1 2	250
			Ware—Red House	Joseph Francis, C.E.	51 46 0 N	0 6 0 W	12	3 0	114 T
			,, Fanhams Hall	Miss Joyce Croft	51 49 30 N	0 1 30 W	8	1 0	253 T
		Lower Lea	Broxbourne	G. J. Newbery	51 44 30 N	0 1 0 W	5	1 0	118 T
			Cheshunt College	Rev. Dr. Reynolds	51 42 5 N	0 2 50 W	5	1 1	94
			New Barnet—Gas Works	T. H. Martin, C.E.	51 39 5 N	0 10 15 W	8	0 9	212
			Southgate—The Lawns	George A. Church	51 37 40 N	0 8 0 W	5	0 6	240 T

* For explanation of these symbols see 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 226.

TABLE II.—RAINFALL IN HERTFORDSHIRE IN 1888.

STATIONS.	JAN.	FEB.	MAR.	APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
Royston	·66	1·25	2·58	2·02	·97	1·53	3·49	2·50	1·44	·76	3·29	1·14	21·63	156
Hitchin	·60	1·30	2·86	1·78	1·15	1·98	2·92	2·30	1·31	·80	3·82	1·26	22·08	183
* „ High Down	·47	1·34	2·77	2·06	1·21	2·56	3·25	2·11	1·48	·91	3·63	1·44	23·23	168
*Tring Vicarage	·96	1·74	3·39	2·04	1·59	2·27	4·55	1·98	1·31	·95	5·32	1·95	28·05	205
*Cowroast	1·00	1·40	3·50	1·87	1·84	2·45	4·63	2·20	·97	1·19	4·95	1·87	27·87	
*Berkhamsted—Rose Bank	·80	1·60	3·25	2·43	1·25	2·21	4·28	2·01	·92	1·15	4·78	1·68	26·36	202
*Great Gaddesden Vicarage	·80	1·51	2·80	1·71	1·27	3·12	4·51	2·28	·97	1·12	4·73	1·66	26·48	184
*Hml. Hempsted—Nash Mills	·68	1·14	4·55	2·56	1·33	2·30	3·94	3·43	·64	1·05	4·57	1·57	27·76	165
*Kensworth	·97	1·33	3·35	2·06	1·60	2·23	3·83	2·52	1·15	·99	4·54	1·91	26·48	154
Harpenden—Rothamsted	·81	·88	2·98	2·02	1·23	4·75	3·75	3·23	·87	·98	4·37	1·61	27·48	174
„ „ (2nd gauge)	·80	·97	2·97	2·03	1·21	4·74	3·59	3·14	·86	·96	4·34	1·57	27·18	165
* „ „ (3rd gauge)	·95	1·03	3·12	2·14	1·28	4·87	3·85	3·38	1·03	1·09	4·45	1·69	28·88	197
*St. Albans—The Grange	1·01	1·30	3·39	1·91	1·24	3·79	4·13	3·53	·72	1·10	4·70	1·47	28·29	194
„ Gorhambury	·69	1·49	3·11	1·99	1·05	3·63	3·69	3·07	·49	·92	4·76	1·59	26·48	
*Watford—Oaklands	1·05	1·32	3·68	2·36	1·59	2·29	4·39	3·13	·77	1·33	4·95	1·50	28·36	191
* „ Watford House	·88	1·05	2·96	1·83	1·30	2·21	3·74	2·76	·67	1·07	4·03	1·12	23·62	173
*Rickmansworth—Moor Park	1·07	1·34	3·35	2·76	1·57	4·20	5·21	3·03	·93	1·37	6·06	1·65	32·54	190
*Welwyn Rectory	·65	1·29	3·01	2·18	1·04	3·55	3·82	3·24	·73	1·62	3·80	1·01	25·94	189
*Datchworth Rectory	·61	1·12	2·80	2·03	·87	2·25	3·68	2·57	·73	1·02	4·06	·84	22·58	179
*Bennington Lodge	·79	1·05	2·83	2·14	1·05	1·82	4·20	3·03	·99	1·02	3·96	1·11	23·99	210
*Therfield Rectory	·81	1·43	3·03	2·13	·98	2·04	4·13	2·78	1·76	·78	3·81	1·21	24·89	170
*Throcking Rectory	·68	1·06	3·26	1·64	1·19	1·68	3·89	2·34	1·19	·81	4·03	1·10	22·87	178
*Much Hadham	·84	1·02	3·24	2·25	1·00	2·44	4·54	3·70	·89	1·01	4·39	1·19	26·51	176
†Hertford—Bayfordbury	·75	·98	3·19	1·95	1·07	2·31	3·26	3·03	·81	1·02	4·32	·85	23·54	183
*Ware—Red House	·69	·82	2·98	1·90	·84	2·78	3·47	3·46	·76	1·02	4·18	1·00	23·90	166
* „ Fanhams Hall	·59	1·01	3·14	2·23	·96	3·36	3·65	3·46	·84	1·15	4·03	·79	25·21	168
*Broxbourne	·94	·96	3·30	2·18	1·14	2·39	3·97	4·26	1·05	1·22	4·81	1·19	27·41	206
Cheshunt College	·78	·85	3·52	2·10	1·13	2·42	4·16	4·72	1·02	1·26	4·30	2·02	28·28	150
*New Barnet—Gas Works	·77	·92	2·53	2·14	1·26	2·17	3·68	3·72	·87	1·19	3·79	1·39	24·43	130
*Southgate—The Lawns	·95	1·44	4·61	2·69	1·25	2·69	4·50	4·13	·81	1·31	4·69	1·35	30·42	200
Mean for the County	·80	1·20	3·20	2·10	1·22	2·77	3·96	3·03	·97	1·07	4·38	1·39	26·09	179

* Daily fall received from the observers at these stations. † Daily fall for this station taken from 'Hertfordshire Mercury.'

Thus the fall was below the mean in every quarter, and about twice as much below the mean in the autumn and winter months together as it was above it in the spring and summer.

January was the driest month, November the wettest; September and October were very dry, March, July, and August very wet. The difference in each month from the mean was:

	in.		in.		in.		in.
Jan.	—1·23	April.....	—0·16	July	+1·43	Oct.	—1·71
Feb.	—1·25	May	—0·73	Aug.	+0·27	Nov.	+1·68
Mar.	+1·67	June.....	+0·34	Sept.	—1·94	Dec.	—1·28

The absolute maximum fall in any one day in each month and the station recording it was:

	ins.		ins.
Jan. 20—Moor Park	·33	July 2—Moor Park	·89
Feb. 13—Tring	·52	Aug. 1—Cheshunt	2·00
Mar. 14—Southgate	1·00	Sept. 9—Therfield	·84
April 20—Datchworth	·86	Oct. 30—Southgate	·55
May 17—Kensworth	·61	Nov. 2—Broxbourne	1·31
June 26—Rothamsted	3·24	Dec. 25—Kensworth	·56

The wettest days in each month at 27 stations were:

January 2nd at 10 stations; 3rd at 2; 19th at 1; 20th at 9; 21st at 3; 23rd at 1; 2nd and 20th equal at 1.

February 9th at 1; 11th at 1; 13th at 20; 14th at 2; 15th at 1; 16th at 1; 14th and 15th equal at 1.

March 10th at 9; 11th at 7; 13th at 1; 14th at 3; 15th at 1; 22nd at 2; 26th at 2; 27th at 1; 10th and 22nd equal at 1.

April 17th at 5; 18th at 6; 19th at 8; 20th at 7; 17th and 21st equal at 1.

May 2nd at 6; 16th at 7; 17th at 12; 19th at 1; 16th and 17th equal at 1.

June 14th at 2; 21st at 1; 25th at 1; 26th at 23.

July 2nd at 10; 15th at 7; 16th at 1; 22nd at 1; 27th at 3; 29th at 1; 30th at 3; 2nd and 15th equal at 1.

August 1st at 17; 28th at 9; 1st and 29th equal at 1.

September 2nd at 5; 3rd at 7; 9th at 10; 11th at 1; 23rd at 1; 27th at 1; 29th at 2.

October 28th at 9; 29th at 14; 30th at 3; 29th and 30th equal at 1.

November 1st at 1; 2nd at 26.

December 1st at 1; 8th at 2; 22nd at 1; 23rd at 1; 24th at 15; 25th at 1; 27th at 4; 28th at 2.

The day in each month on which a heavy fall of rain was most general over the county was therefore:

Jan. 2nd.	April 19th.	July 2nd.	Oct. 29th.
Feb. 13th.	May 17th.	Aug. 1st.	Nov. 2nd.
Mar. 10th.	June 26th.	Sept. 9th.	Dec. 24th.

The number of wet days in the year (average of 28 gauges) was 179, being rather more than the mean of our period. Of the total number there were 38 (or 21°/₀) in the winter months, 44 (or 24½°/₀) in the spring, 56 (or 31°/₀) in the summer, and 41 (or 23½°/₀) in the autumn.

The number of wet days in each month, and the deviation from the mean, was as follows:—

Jan.	12	—4	April	17	+4	July	24	+11	Oct.	8	—6
Feb.	13	—2	May	7	—6	Aug.	15	+ 1	Nov.	21	+5
Mar.	20	+6	June	17	+3	Sept.	12	— 1	Dec.	13	—2

Distribution of Rainfall throughout the County.—Of the 30 rain-gauges 3 are in the river-basin of the Ouse for which they give a mean fall of 22·31 inches in the year, and 27 are in the river-basin of the Thames for which they give a mean fall of 26·51 inches. The following table (Table III) gives the mean fall for each month and for the year in each of the five river-districts represented, and in the County for comparison, and also the difference in the year from the mean of our period.

TABLE III.—RAINFALL IN THE RIVER DISTRICTS.

MONTHS.	CAM.	IVEL.	THAME.	COLNE.	LEA.	COUNTY.
January	·66	·53	·96	·88	·76	·80
February	1·25	1·32	1·74	1·26	1·07	1·20
March	2·58	2·82	3·39	3·31	3·19	3·20
April	2·02	1·92	2·04	2·13	2·12	2·10
May	·97	1·18	1·59	1·37	1·06	1·22
June	1·53	2·27	2·27	3·29	2·45	2·77
July	3·49	3·08	4·55	4·12	3·92	3·96
August	2·50	2·22	1·98	2·90	3·42	3·03
September	1·44	1·39	1·31	·84	·96	·97
October	·76	·86	·95	1·10	1·11	1·07
November	3·29	3·72	5·32	4·71	4·16	4·38
December	1·14	1·35	1·95	1·61	1·16	1·39
Year	21·63	22·66	28·05	27·52	25·38	26·09
Diff. from 1876-85	—2·87	—4·64	—3·85	—3·78	—1·50	—2·91

The mean fall in the year in each of the minor river-basins, or sub-districts, was as follows:—

CAM	Rhee	21·63
IVEL	Hiz	22·66
THAME	Upper Thame	28·05
COLNE	Bulbourne	27·11
	Gade	27·12
	Ver	27·47
	Lower Colne	28·18
LEA	Mimram	24·26
	Beane	23·99
	Rib	23·88
	Ash	26·51
	Upper Lea	24·22
	Lower Lea	27·63

The total yearly fall ranged from 21·63 inches at Royston, to 32·54 ins. at Moor Park ; and the total monthly fall from 0·47 in. at High Down, Hitchin, in January, to 6·06 ins. at Moor Park, in November.

Distribution of Rainfall in each Month.—The nomenclature used in the following notice of the chief falls of rain is the same as in previous reports, falls of ½ inch being styled *considerable*, of ¾ inch *very considerable*, of 1 inch *great*, of 1¼ inch *very great*, of 1½ inch *heavy*, of 1¾ inch *very heavy*, and of 2 inches *excessive*. This analysis only applies to the 24 stations from which I have returns of the daily rainfall, except when the fall of at least half an inch was the maximum in the month.

January.—A very dry month. From 6th to 19th (14 days) no rain fell at three stations, and the average at all during the period was only 0·06 in., of which 0·02 in. fell on 6th. At Kensworth no rain fell from 4th to 19th, and at High Down, Hitchin, none from 5th to 19th. At no station was there a *considerable* fall.

February.—Nearly all the small amount gauged is due to snow falling during the first nineteen days, the average for the last ten days being only 0·10 in. (all snow). The only *considerable* fall (snow) was at Tring on 13th.

March.—A very wet month with rain or snow almost every day (at some stations every day) after 6th. On 11th the fall was *considerable* at three stations; on 14th *great* at Southgate (1·00 in.) and *considerable* at Cheshunt; and on 22nd, 26th, and 27th *considerable* at some one station.

April.—With about an average rainfall there was scarcely any rain for the first fortnight and the last week, but for the nine days 15th to 23rd the mean fall at all stations was nearly 0·20 in. *per day*, and at all but four there was rain every day during this period. On 17th the fall was *considerable* at Tring; on 18th at three stations; on 19th at two; and on 20th *very considerable* at two and *considerable* at three.

May.—Rainfall small, and nearly all on 2nd, 16th, 17th, and 29th. From 4th to 15th (12 days) no rain fell at all stations but three, and these give an average for the period at all of only 0·005 in.; and from 18th to 27th (10 days) none fell at all stations but ten which give an average for the period of only 0·02 in. On 2nd the fall was *considerable* at Cowroast, and on 17th at six stations.

June.—Rainfall a little above the average, owing to the amount gauged on 26th, without which it would have been much below it. On 21st the fall was *considerable* at Broxbourne; and on 26th it was *excessive* at Rothamsted (3·24 ins.), St. Albans (2·40 ins.), and Fanhams Hall, Ware (2·00 ins.); *very heavy* at Moor Park (1·96 in.); *heavy* at Gorhambury (1·73 in.), Welwyn (1·69 in.), and Great Gaddesden (1·55 in.); *very great* at the Red House, Ware (1·28 in.); *great* at Much Hadham (1·05 in.); *very considerable* at six stations; and *considerable* at ten.

July.—A very wet month, rain falling nearly every day. On 2nd the fall was *very considerable* at Moor Park, and *considerable* at twelve stations; on 10th *considerable* at two; on 15th *very considerable* at four and *considerable* at ten; on 18th *considerable* at Throcking; on 22nd at Welwyn; on 27th *very considerable* at two stations and *considerable* at three; on 29th *considerable* at Much Hadham; and on 30th at four stations.

August.—Rainfall slightly above the average. From 7th to 19th (13 days) no rain fell at three stations, and the average for the period at all was only 0·04 in. On 1st the fall was *excessive* at Cheshunt (2·00 ins.); *very heavy* at Broxbourne (1·80 in.), Southgate (1·80 in.), and New Barnet (1·78 in.); *very great* at Much Hadham (1·38 in.), Fanhams Hall, Ware (1·35 in.), and Red House, Ware (1·25 in.); *great* at Welwyn (1·10 in.), Moor Park

(1·09 in.), Bayfordbury (1·05 in.), Rothamsted (1·02 in.), St. Albans (1·01 in.), Gorhambury (1·00 in.), and Nash Mills (1·00 in.); *very considerable* at four stations; and *considerable* at one. On 24th it was *considerable* at Much Hadham; on 28th *very considerable* at eighteen stations and *considerable* at six; and on 30th *considerable* at Nash Mills.

September.—A very dry month. From 10th to 23rd (14 days) no rain fell at eight stations, and from 10th to 22nd none fell at twelve, the mean for this period being only 0·02 in. On 9th the fall was *very considerable* at two stations and *considerable* at two.

October.—Nearly all the small amount gauged fell during the last three days. From 6th to 23rd (18 days) no rain fell at nine stations, and the mean for the period at all was only 0·02 in. At Nash Mills none fell for 25 days (3rd to 27th), at Southgate none for 24 (5th to 28th), at New Barnet none for 22 (6th to 27th), and at Cowroast none for 20 days (5th to 24th). The fall was *considerable* at Moor Park on 29th and at Southgate on 30th.

November.—An excessively wet month, having the heaviest rainfall in the year. On 1st the fall was *very considerable* at Kensworth, and *considerable* at twenty-one stations; on 2nd *very great* at Broxbourne (1·31 in.) and Cheshunt (1·29 in.); *great* at Great Gaddesden (1·20 in.), Kensworth (1·19 in.), Bayfordbury (1·19 in.), Datchworth (1·18 in.), Fanhams Hall, Ware (1·18 in.), Welwyn (1·16 in.), Tring (1·15 in.), Rothamsted (1·15 in.), St. Albans (1·15 in.), Gorhambury (1·14 in.), Moor Park (1·11 in.), Cowroast (1·04 in.), Berkhamsted (1·02 in.), Southgate (1·02 in.), and Nash Mills (1·01 in.); *very considerable* at nine stations; and *considerable* at one, Therfield, the only station in the county at which less than 0·75 in. was gauged. On 12th the fall was *considerable* at Cowroast; on 25th *very considerable* at Moor Park, and *considerable* at nineteen stations; and on 28th *considerable* at Moor Park.

December.—A dry month. From 9th to 17th (9 days) no rain fell at eleven stations, and the average for the period at all was only 0·02 in. On 24th the fall was *considerable* at Tring, and on 25th at Kensworth.

XVIII.

THE HESSIAN FLY AND ITS INTRODUCTION INTO BRITAIN.

By Eleanor A. Ormerod, F.R.Met.Soc., F.E.S.

Read at St. Albans, 27th April, 1889.

It was at Revells' Hall, near Hertford, in 1886, that the first appearance of the Hessian fly ever recorded in Britain took place, and it was on the same farm that Mr. George Palmer (almost at the same time as Mr. Taylor at Daleally in Scotland) observed one of the simplest and most effective means of checking increase of the pest,—so simple and so effective that it was at once noted for adoption by the Director of the Government Farm Stations in Canada, and by the chief observer of the habits of this insect-pest in Russia; and in my own house I had the honour of bringing it under the notice of Professor Riley, the well-known Entomologist-in-chief of the United States of America, and of hearing from him that the plan was noted for adoption.

In appearance the Hessian fly is just like a very little dark brown gnat (say about a quarter of the size of a common gnat), with a pair of smoky grey wings, three pairs of uncommonly long legs, and a pair of antennæ or horns, very beautiful under the microscope by reason of their beaded structure. It is a sober-looking little creature when fairly launched into life, but when it can be watched as I have seen it in its first hours, before the brilliant mulberry-colour spotted with black velvet changes to the graver tints, it is as bright a little piece of coming mischief as may well be imagined.

The attack, as we have had it in Britain, happily as yet only affects the growing corn in summer, not the winter plants, and consists of the flies laying their eggs on the stem of the corn just above a knot. There the little white legless maggots begin their work beneath the sheathing leaf, sucking the juices continuously without moving from one spot. There one or more remain, and the natural result is that the stalk is very much weakened just at the point of injury, and presently when the ear at the top becomes a heavy weight, or a summer breeze passes through the standing corn, the stems bend down at the weakened part. So the appearance in the fields of the stems sharply elbowed down just above a knot is the regular sign of presence of infestation. The maggots do not stir from where they lie feeding, their outer coats simply harden and change to a bright brown colour as they turn to chrysalis state; and then from their size, their flattened shape, and their colour, they become so like the flaxseeds from which they take their name that when I have mixed the real and the so-called flaxseeds together, it has not been an easy task to distinguish at a glance the one from the other. From these so-called flaxseeds (really the puparia or chrysalis-cases of *Cecidomyia destructor*) the flies presently come out,—it may be in the autumn or it may be in the following spring after lying quiet through the winter,—and start a new attack.

All this is matter on record, but the anxieties and troubles of all concerned, on the appearance of a corn-pest which may be the cause of sweeping disaster here, as it has often been in other countries, are not so well known.

It was on one of the last days of July in 1886 that, opening my letters as usual, I found in one an enquiry as to the nature of the specimens enclosed which were doing much harm to the barley of the sender. It needed very few minutes to see that there lay the "flaxseeds," the outward sign of the attack so feared for more than a hundred years that it had been watched for, and at intervals, by Sir Joseph Banks, Kirby, Curtis, and others, reported as not present. But now there lay the pests and what was to be done?

Where it is merely a matter of identifying a common insect of no specially injurious habits, it is well to let discussion go on at leisure, but it is a very different matter with a known crop-pest, where delay may allow of the brood shortly to be hatched getting hold in the country; on the other hand it is no pleasant task to bring forward the first intelligence of the arrival of such a guest. I need not enter here upon the details of work, the careful examinations and consultations on the ground and in the library, and the special and official communications resulting in the course of a few days in circulars of warning being issued, and what may be termed "*the danger-flag*" raised throughout the country. And not a day too soon, for reports soon came in of the presence of the pest on other farms near Hertford, near Romford, and near Ware, and also from near Inverness and from Crieff in Scotland, but the mischief was done for that season so far as the growing crops were concerned, and we had to wait and watch for the future.

Those who were concerned with the matter will remember the general interest excited, also the very various expressions of opinion, of which necessarily many of the most energetic came to the first recorder of the trouble. Some persons had no doubt that the pest had *always* been here, some on the contrary that it was *not here now*, and all such views had to be met as they arose; some by quotation of contemporary record dating from before the commencement of the present century onward, and some by the simple proof from specimens in hand of the peculiar form of the puparia or flaxseeds, etc.; culminating in the fact that from the "flaxseed" the *real* Hessian fly had stepped out in all its characteristic beauties of crimson and black velvet, to subside into the sober livery of its common work-a-day dress.

This was in the autumn of 1886, and so things went on, and spring and early summer passed of 1887, and the public hoped the affair was as it was termed "a scare"; but those who were watching knew that Hessian flies were developing from "flaxseeds" which had been kept under supervision, and though the little gnatlets were not noticeable in the fields, it was only too likely before long, that when the due number of days had elapsed for eggs to be laid and maggots grown, fallen barley and wheat straw would show where the invader had set its camp.

At the exact time to be expected the notes of the first appearances of the trouble came in, on July 7th and 8th in Scotland, and on July 12th from Revells' Hall near Hertford; and from that time up to the latter end of August, reports, sometimes day by day, and sometimes several in one day, of presence of the pests, came in from English and Scottish observers.

About a hundred observations were sent to me, with specimens, or from observers whom I knew to be competent to identify the attack. Many of these referred to severe damage on farms or sometimes large districts of country, and they ranged in geographical distribution mainly up the east side of Britain, running more or less inland, from Kent in England to Cromarty in Scotland.

Some time or other we may learn the reason of this peculiarity of area, but that the infestation was not reported in the more northerly part of Scotland, and even on enquiry *was not* found in Caithness or in the Orkneys, is probably attributable to climatal agency.

It will be remembered that the summer of 1887 was one of remarkable heat and brightness, and to these conditions, so favourable for propagation of some kinds of insect-life, I attribute the great amount of attack of insect corn-stem pests which troubled us in 1887, as well as the mischief done in the earlier part of 1888. It is said from observation in the United States, the very headquarters of this entomological trouble, that damp and moisture are suitable to it, but then it must be remembered that the climate in summer of a great part of the States is so different to ours, owing to our insular position, that what *we* call dampness would be very different in degree to that which in the States gives moisture sufficient to aid development of the Hessian fly. This is a somewhat important meteorological consideration, and in talking the matter over with Professor Riley here, he agreed with me that this was the way to look at it. The last season (1888) happily gave us a marked reduction of the presence of the pest; instead of about a hundred returns, in many cases of widespread damage, about six were all that I am personally aware of, and of these only one was reported as a district attack.

As the facts stand at present the marked reduction in amount of presence is eminently satisfactory, but the two points to be considered are: Will the fly become acclimatized; or supposing it does not and we get rid of it as a naturalized pest, do we keep on importing new supplies? Up to this present day it remains a matter of discussion amongst leading entomologists of the United States of America as to what was the precise date when the fly was first recorded there, and also whether the pest was, so to say, their own property, or a transmitted evil from elsewhere. It was to some degree, and still is in some cases a settled belief that this Hessian fly which appeared there first about 1776, was conveyed across from Europe in the war of independence by the Hessian troops (in the straw on shipboard). This point, however, when weighed carefully appears to be unlikely, as there is no evidence or authentic notice of this so-called Hessian fly having been seen either in Hesse or in any other part of Europe, until possibly in Hungary in 1833, that is more than fifty years after it was first recorded in America; and the first *sure statement* of its observation in Europe is considered to be that of its discovery by Mr. J. Dana in 1834, at Mahon, Toulon, and Naples. As American vessels were then touching at these ports, these circumstances apparently point to the transmission being from North America to Europe, rather than from Europe to North America.

Those who wish to go into the dismal amount of loss caused by this fly will find it, with date of year, from 1879 at intervals onwards to the present time, in the United States Government returns, and in 1882 is a special report on the presence of this pest in America with notes of the amount of general prevalence of the fly. Also in the province of Ontario in Canada a report was given by Professor W. Saunders (a most excellent entomological authority, and now Director of the Experimental Farm Stations of the Dominion) in which he estimated the damage to the agricultural community in that province alone in 1882 at several hundred thousand dollars. In New York State U.S.A. alone the loss from the Hessian-fly attack in 1885 was estimated at 100,000 dollars, that is £25,000.

It was then found to exist in many parts of Europe; about nine years ago its presence was reported in Southern Russia, whence it spread so as rapidly to be distributed over about two-thirds of that vast country, and in the words of Dr. Karl Lindeman to be one of its worst crop-pests.

The next note of first observation or of greatly increased amount of presence was on the grain, growing near the coast of California, in the spring of 1885; England had its first record in 1886; and New Zealand followed next in date by reporting first presence in the spring of last year. The spread of the pest in California was attributed to an alteration in agricultural treatment of stubble—that the practice of burning had been discontinued or not carried on to the same extent as formerly—consequently the Hessian-fly flaxseeds remained safe and well on the stubble and afforded an insect-crop in due time to attack and lessen the coming harvest. In Russia the pest might have arrived in course of regular onward march, but in what way it came to ourselves was a matter for long investigation leading to a well-based opinion that it came from the East of Europe.

In the study of Economic Entomology, or in plainer words, the knowledge of insects bearing on the benefits or injuries we receive from them, the most important parts of the research are usually—firstly, the life-history of the insect, that is its habits and history, from the locality of deposit of the egg from which the larva, be it grub, maggot, or caterpillar, hatches, through all its changes up to its perfect condition, so that we may know in which of these it lies most under our power; and secondly, the measures by which most certainly and at the least expense we can destroy such kinds as ravage our crops, or can lessen the amount of injury we receive.

In the investigation, however, which threw light on whence the Hessian fly came to us, we had an instance of how in some cases what is needed is the most complete scientific knowledge of structure, and every point that can be observed of the appearance of the insect itself under consideration, and also knowledge of its geographical distribution.

We knew that the Hessian fly was an insect which was found at the present day in many parts of America and Europe, but those who had to study the subject *in extenso*, knew also that this was not the case with its parasites. One kind of these parasites certainly is found both in America and Europe, but the others belonged respectively to North America, or to Eastern Europe, not to both countries; so to find which set of parasites accompanied our new arrival of Hessian flies, appeared to me would be equivalent to finding from what country the visitation had arrived.

It is just possible that some may not know what a parasitic fly is, so I will just mention that in this case the parasites are small flies, four-winged or two-winged as the case may be, which lay their eggs on the Hessian-fly maggot, or at least in it in some early condition, and as the parasitic maggot preys on the young of the Hessian fly, it thus lessens the numbers of its hosts and our pest. It turns to its own chrysalis state within that of the Hessian fly, and in due time those who carefully keep the *Cecidomyia destructor* chrysalids, see produced from out of these flaxseeds a parasite or a Hessian fly. To identify these parasites was a labour of great difficulty, and was brought about by the skill and research, and I should add the kind and patient labour bestowed on the subject for our benefit, by Dr. Lindeman the well-known Russian Entomologist, and Prof. Riley the Entomologist of the United States.

The presence of these parasites was noticed almost from the beginning of the attack, but there was great difficulty in certain identification, as there was nothing to aid us excepting published descriptions, and for some time we worked without the help of either American or Russian specimens.

After long and careful examination of British specimens, at a Conference at which I had the advantage of being present, Prof. Riley stated that none of those submitted to him appeared to agree with specimens of the kinds known to him in North America, and that the points laid before him inclined him to consider that the attack was of European rather than American origin. As a further step I forwarded in the autumn of 1887 a collection of parasites bred from puparia of *Cecidomyia destructor*, that is to say from Hessian-fly flaxseeds, by Mr. Taylor our best North British observer, to Dr. Lindeman at Moscow, from whom I received the valuable communication that four of the five kinds sent were of Russian species, and the fifth he was inclined to consider was the *Merisus destructor* of America, a kind, I may remark in passing, which is distributed in Europe as well as on the other side of the Atlantic, and thus we became aware that all the geographical "*test-flies*" sent were solely European, except one which belonged to both continents.

Somewhat later I received a communication from Prof. Riley, who had devoted two days whilst in England to comparison of British specimens with those of which Dr. Lindeman and I had sent him a small collection, with the result that his (Prof. Riley's) views were quite confirmed as to the visitation being of European origin, as every one of Dr. Lindeman's forms had been reared in England. As I have already, by permission of my kind friends and helpers, published the names of these species, I will not trouble you with a mere list of names.

But looking now at what had to be done practically, for we had learnt whence the trouble had apparently come, the next question was *How did it come?* The first thing that suggested itself was that it came, in flaxseed form, on imported wheat or barley straw, and the only way to get to a knowledge of this matter was by *careful examination.* The management of this was intrusted to me, and for weeks or rather months I had careful watch kept and examination made by qualified observers at Dundee, Leith, Hull, Goole, and other places. Bales of straw were opened, sweepings of straw-laden ships examined, and my co-operators also obtained permission to have a watch kept at stables and other places to which straw was conveyed for use.

Thousands of bales of straw were examined at Hull, and a stevedore there who was well acquainted with the appearance of the flaxseeds took great pains in having the sweepings of the vessels carefully examined. That my co-operators were well acquainted with the appearance of what they were searching for was proved by the successive consignments to me of various things (such as real flaxseed) for verification, which much resembled the object of investigation, but which never turned out to be it.

We only once met with a specimen, in all the months of our search, and that was a single *puparium* still adhering to a barley straw, grown in Belgium, thus, curiously enough, showing at last the presence of attack in a country which has not yet been on the infested lists.

It is not of course all kinds of straw, or all conditions of straw, that are liable to be carriers of infestation. Oat straw is considered safe, and wheat or barley straw is not likely to carry much evil, if it is cut high,—much above the second knot from the ground, which is the spot apparently most preferred for attack.

Sometimes also the straw has gone through such treatment as to ensure its being a safe import. In the course of our investigations Mr. Edmund Riley, who was superintending investigations for me at Hull, wrote to me that in the week ending Nov. 5, 1887, it was stated that there was the largest importation of eggs in one week which had ever been reported, and chiefly from Russian ports. One vessel had 60 tons; another 46 tons; and the "Cato" had 823 cases each containing some thousands. These eggs came in long cases with a layer of straw at top and bottom and between each layer of eggs. At first sight this would appear to be the exact place to supply a plentiful coming crop of the Hessian fly, but we soon found on investigation that the straw was so totally crushed to render it soft for packing, that it appeared to have been put through a bruiser, and in this way a good percentage of the chrysalids were likely to have been destroyed, if not all. But further, we found from information kindly given us by Mr. G. Becker, the great egg-importer, that the straw from the central, eastern, and south-eastern districts of Russia was so prepared to meet necessities of transmission as to ensure its freedom at the same time from insect presence. As any amount of damp in the straw would be ruinous to the eggs, which are a length of time in transmission, every possible precaution is taken to ensure that it should be *perfectly dry*, and for this reason it is dried on racks in heated chambers.*

After months of investigation it appeared proved that though Hessian-fly flaxseeds certainly *could* come in straw, there was no reason to believe that it was in this way that they *were* being transmitted to us, and so far as we see at present the most likely way for them to arrive is in the rubbish of which such a great amount is transmitted in corn cargoes.

The specimens shown are samples of some of the different kinds of screenings which are separated from wheat imported from various countries before this wheat is fit to be ground by our millers.

The wheat from Southern Russia and from Egypt is especially known to be deteriorated by much admixture of material other than pure grain. During the past season I was favoured with communications on this head from some of the chief corn-factors at our great ports, such as Liverpool, Hull, Gloucester, and other places, from which it appears, as I have noted at length in my recently-published report, that a very detrimental quantity of admixture (purposely, or through want of proper care, present in the cargoes) arrives here as a regular thing.

One of my reporters mentioned regarding Russian wheats, and more especially South Russian wheat, for Russia in some parts ships cleaner than she did, that "this impurity consists of pieces of dirt, rye, cockle, oil seed, vetches, thin shrivelled grains of wheat, and frequently stones, etc." The lower qualities of Odessa and Azov wheat would contain not less than 40 per cent. of impurities, mainly rye. Where, as in the River-Plate wheat, it is threshed or rather trodden out by horses being driven round on it, the presence of stones and a variety of extraneous and undesirable material in the grain shipped need cause no surprise.

I need not weary you with details of the condition of wheat received from various exporting countries, but it is obvious that where such an amount of dirt, rubbish, bad grain, weed seed, etc., comes with the corn, it is no wonder that much insect presence, some of which is only too plainly to be seen, and is a well-known

* I have mentioned this more especially as giving an example of the many points for investigation which are constantly occurring in running up the methods of prevention of an insect-pest, more especially when it is one which like the Hessian fly may be said to be almost a world-wide trouble.

cause of loss, and some of which is not noticeable without search, should come over also. The *addenda*, so to describe them, are so numerous and so varied that they are cleared from the corn in some cases by different processes, and there are various proceeds of the results of such operations, sold under different appropriate names. The larger form of material is sometimes known as "rubble"; this consists of bodies larger than the wheat grains, such as beans, Indian corn (more or less infested as the case may be), ergot, a fungus well known to be most pernicious, rubbish of other kinds, and weed seeds too numerous to particularize, and also bits of iron, and pieces of metal binders, stones, dirt, and lumps of earth, requiring in some cases that the corn should go through a process of washing to melt out the soluble dirt. It would weary you if I paused to give my authorities for these statements, but they are taken from special reports placed, at my request, in my hands by the managers or heads of some of our well-known and chief firms. Another kind of "addendum" is of short broken bits of straw, which as you will see is admirably adapted to convey Hessian-fly infestation; this straw is sold for bedding pigs, etc. Another kind of screenings (that is material separated by screens from the grain) is known as "hen-corn"; this is sold for food for poultry. Screenings have to be removed from the foul corn, and are sold at excessively cheap rates, and thus they and their contents, detrimental or not as may happen, are distributed all over the country.

Is it to be wondered at that, if we have what may so well carry infestation amongst us, infestation comes?

There appears to me to be a hope that this cause of evil may be checked. The millers object to it greatly because expensive machinery is requisite to clear the corn to a state fit for use, and in some cases trade associations are formed to prevent more than a certain amount per cent. of impurity being forwarded, through which, the corn being subject to analysis before purchase, such as is found to be adulterated above a fixed percentage can be refused or purchased subject to award on arbitration. The plan has been found to succeed, and I have reason to believe may be the cause of great benefit. This plan, and arrangements such as this instituted by our importers, would clear away much fear of foreign infestation.

But with regard to home treatment, returning once more to the Hessian fly, there are three or four broad principles of condition, or of action, which seem to me to give good reason for belief that we need not fear that this attack, which has sometimes been such a fearful scourge in other countries, will desolate our British fields.

One of these is that in ordinary course we sow our wheat at a time when the Hessian flies of the summer brood are dead. In America, where (unlike us) they sow early in usual course, it is laid down as a rule where Hessian-fly attack is feared, to vary from this as far as they can and sow later, so that sowing at this date (with us happily the natural course of agricultural arrangement) is a great safeguard so far as our wheat is concerned, and to this I conjecture we owe the safety which we have enjoyed hitherto from attack to the young winter wheat-plant, which I am told by Prof. Riley is the worst half of the attack in America.

Further, our British discovery that the "flaxseeds" were thrown down by our threshing machines amongst the fine light screenings, where they might be gathered up and destroyed without any appreciable trouble or expense, is of enormous importance.

Thus we can take up the germ of the coming attack in our hands, and burn it in the fire, or choke it in pond mud, and so get rid of it thoroughly. It has been advanced that this is dangerous, for we may destroy the parasites that would have killed the fly. But why, I reply, should we not do this, when if we had a quantity here to-day, and I thrust the whole on to a fire, we have done with it; if on the other hand I leave it, the Hessian flies develop and fly to everybody's wheat round the place, and then the parasites would fly after and doubtless would lay eggs and so prevent a quantity of the Hessian maggots turning to Hessian flies. But meanwhile all the wheat and barley crops in the neighbourhood would have suffered. The present attack would *not* have been prevented, and it would be a very curious thing if all the Hessian maggots had received parasitic prevention. The plan has not prevented the Hessian fly from wasting and ravaging for more than a hundred years in America, and I think that if at this minute I had a heap of infested chaff outside this window and asked any of my agricultural friends whether we should destroy it, or leave it for the parasites to come out and kill the maggots which would be ruining their crop towards July, I feel pretty sure that they would themselves assist in the operation rather than that I should subject them to such an unneighbourly visitation.

Such is my belief, and I have full confirmation of it from the chief authorities on this subject in Russia, Canada, and the United States of America.

Dates of Flowering of Plants observed in 1887 and 1888, with the Mean Date for 1876–86.

No.	Species.	1887. St. Albans.	1887. Harpenden.	1887. Hertford.	1887. Hitchin.	1888. St. Albans.	1888. Harpenden.	1888. Hertford.	1888. Hitchin.	Mean. 1876–86.
1.	*Anemone nemorosa* (wood anemone)	Apl. 7	Apl. 5	Apl. 5	Apl. 6	Apl. 11	Apl. 14	Apl. 2	Apl. 11	Mar. 13
2.	*Ficaria verna* (lesser celandine)	Mar. 23	Apl. 2	Mar. 13	Mar. 29	Mar. 22	Apl. 6	.....	Mar. 17	Feb. 21
3.	*Ranunculus acris* (upright crowfoot)	.....	May 14	Apl. 19	Apl. 26	.....	May 10	May 6	May 14	Apl. 23
4.	*Caltha palustris* (marsh marigold)	Apl. 19	May 2	Apl. 20	Apl. 12	Apl. 21	Apl. 27	Apl. 15	Apl. 17	Mar. 24
5.	*Papaver Rhœas* (red poppy)...................	June 8	June 8	.....	June 10	June 9	.....	June 7	June 12	May 29
6.	*Nasturtium officinale* (water-cress).....	.....	.....	.....	.....	.....	.....	May 10	June 22	June 5
7.	*Cardamine pratensis* (cuckoo-flower)	May 1	May 6	May 4	Apl. 24	May 6	May 8	Apl. 22	May 6	Apl. 13
8.	*Alliaria officinalis* (garlic-mustard).....	Apl. 27	May 2	.....	May 3	May 2	May 11	Apl. 29	Apl. 28	Apl. 14
9.	*Erophila vulgaris* (whitlow grass)	.....	Apl. 2	Apl. 10	Mar. 29	.....	Mar. 15	Feb. 26	Mar. 7	Mar. 9
10.	*Viola odorata* (sweet violet)..................	Mar. 4	Mar. 12	Apl. 2	Mar. 17	Mar. 27	Mar. 28	Mar. 25	Apl. 1	Feb. 13
11.	*Polygala vulgaris* (milkwort)	.....	June 18	.....	May 30	.....	June 11	May 27	May 25	May 8
12.	*Lychnis Flos-cuculi* (ragged Robin).....	June 10	June 9	.....	June 11	June 10	June 10	June 7	June 10	May 24
13.	*Stellaria Holostea* (greater stitchwort)	.....	Apl. 23	May 6	Apl. 27	Apl. 30	Apl. 26	Apl. 19	Apl. 30	Apl. 5
14.	*Malva silvestris* (common mallow).....	June 21	July 11	.....	June 19	June 24	June 27	June 8	June 18	June 6
15.	*Hypericum quadratum*(squareSt J.w.)	.....	July 16	.....	July 26	.....	.....	.....	Aug. 4	July 5
16.	*H. pulchrum* (upright St. John's wort)	.....	July 17	.....	.....	.....	July 4	.....	.....	June 28
17.	*Geranium Robertianum* (herb Robert)	May 18	May 21	.....	May 14	.....	May 20	May 21	May 19	Apl. 26
18.	*Euonymus europæus* (spindle-tree)	.....	.....	June 15	June 7	.....	June 14	June 3	June 2	June 1
19.	*Acer Pseudo-platanus* (sycamore)	May 20	May 13	.....	May 8	May 16	May 16	May 13	May 13	Apl. 28
20.	*Æsculus Hippocastanum* (h. chestnut)	May 24	May 23	.....	May 20	.....	May 21	May 20	May 21	May 5
21.	*Cytisus Laburnum* (laburnum)...............	May 31	June 2	.....	May 26	.....	May 27	.....	May 27	May 15
22.	*Trifolium repens* (Dutch clover)..........	June 6	June 9	June 7	May 31	June 10	June 11	June 1	May 27	May 17
23.	*Lotus corniculatus* (bird's foot trefoil)	June 11	June 13	June 4	May 31	June 3	June 2	May 28	May 27	May 20
24.	*Vicia Cracca* (tufted vetch)	.....	June 29	June 23	June 17	June 19	June 18	June 21	June 22	June 24
25.	*V. sepium* (bush vetch)	May 24	May 17	May 15	May 30	.....	May 22	May 13	May 27	Apl. 27
26.	*Lathyrus pratensis* (meadow vetchling)	June 11	June 14	.....	June 14	June 9	June 14	June 17	June 14	June 3
27.	*Prunus spinosa* (blackthorn)	Apl 17	Apl. 22	.....	Apl. 27	Apl. 30	Apl. 28	Apl. 19	Apl. 20	Mar. 25
28.	*Spiræa Ulmaria* (meadow sweet)	.....	July 7	June 26	July 8	.....	.....	June 28	July 27	June 15
29.	*Potentilla anserina* (silver-weed)..........	June 4	June 4	June 3	May 30	June 3	June 8	May 21	May 25	May 16
30.	*Rosa canina* (dog rose)............................	June 17	June 11	June 15	June 15	June 18	June 12	June 13	June 10	June 3
31.	*Sorbus Aucuparia* (mountain ash)	.....	June 1	June 14	May 31	.....	.....	.....	May 27	May 18
32.	*Cratægus Oxyacantha* (hawthorn)	May 29	June 2	.....	May 21	.....	May 27	May 21	May 21	May 12
33.	*Epilobium hirsutum* (hair willow-herb)	.....	July 15	July 17	July 19	.....	July 18	.....	July 18	July 5
34.	*E. montanum* (broad willow-herb)	June 22	June 30	June 12	June 19	June 19	June 18	June 24	June 23	June 11
35.	*Angelica silvestris* (wild angelica)	.....	.....	.....	Aug. 23	.....	.....	Aug. 5	Aug. 10	July 28

38.	*Cornus sanguinea* (dog-wood)	.....	June 26	.....	June 19	June 30	June 28	June 24	June 23	June 16
39.	*Syringa vulgaris* (lilac)	May 20	May 17	.....	May 15	.....	May 18	.....	May 19	May 7
40.	*Galium Aparine* (cleavers)	June 4	June 2	May 24	May 17	May 18	May 22	May 17	May 21	May 15
41.	*G. verum* (yellow bedstraw)	.....	June 30	June 19	July 9	.....	July 7	.....	June 26	June 29
42.	*Dipsacus silvestris* (wild teazel)	.....	.....	.....	Aug. 8	.....	.....	Aug. 5	Aug. 22	July 26
43.	*Succisa pratensis* (devil's bit)	.....	.....	.....	Aug. 8	.....	.....	Aug. 16	Aug. 6	July 25
44.	*Petasites vulgaris* (butter-burr)	.....	.....	Apl. 1	.....	.....	.....	Apl. 1	Apl. 28	Mar. 20
45.	*Tussilago Farfara* (coltsfoot)	.....	Mar. 24	.....	Feb. 28	.....	Apl. 5	Feb. 29	Mar. 22	Feb. 25
46.	*Achillea Millefolium* (milfoil)	June 21	June 23	June 25	July 3	June 20	June 23	June 10	June 23	June 21
47.	*Leucanthemum vulgare* (ox-eye)	May 25	June 3	June 3	May 26	.....	May 31	May 30	May 27	May 18
48.	*Artemisia vulgaris* (mugwort)	.....	.....	.....	.....	.....	.....	Aug. 5	July 29	July 30
49.	*Senecio Jacobæa* (ragwort)	.....	July 15	June 30	July 10	July 7	.....	.....	Aug. 8	June 28
50.	*Centaurea nigra* (black knapweed)	June 25	June 30	June 25	July 3	July 1	July 2	June 24	July 18	June 17
51.	*Cirsium lanceolatum* (spear thistle)	June 18	July 5	June 26	July 25	July 11	.....	July 21	July 27	June 19
52.	*C. arvense* (field thistle)	.....	July 6	.....	July 25	.....	July 7	.....	July 3	June 19
53.	*Sonchus arvensis* (corn sow-thistle)	.....	July 11	July 19	July 28	.....	July 9	.....	July 21	July 7
54.	*Hieracium Pilosella* (mouse-ear)	.....	June 16	June 1	May 23	.....	June 7	May 23	June 3	May 16
55.	*Campanula rotundifolia* (hair-bell)	.....	June 26	June 26	July 10	.....	June 24	.....	July 3	July 7
56.	*Ligustrum vulgare* (privet)	.....	June 25	June 29	June 21	.....	June 28	.....	June 22	June 17
57.	*Calystegia sepium* (greater bindweed)	July 23	July 22	.....	July 25	.....	Aug. 4	.....	July 22	July 1
58.	*Symphytum officinale* (comfrey)	.....	.....	June 7	May 31	.....	.....	May 23	May 27	May 7
59.	*Pedicularis silvatica* (red rattle)	.....	.....	June 6	.....	.....	.....	May 27	.....	May 14
60.	*Veronica Chamædrys* (speedwell)	May 8	May 10	May 11	May 5	May 13	May 19	May 6	May 9	Apl. 21
61.	*Mentha hirsuta* (water mint)	.....	.....	.....	July 8	.....	.....	Aug. 5	Aug. 4	July 29
62.	*Thymus Serpyllum* (wild thyme)	.....	July 8	June 9	June 8	.....	June 27	.....	June 2	June 8
63.	*Prunella vulgaris* (self-heal)	.....	June 24	June 30	July 10	.....	June 30	June 17	June 26	June 19
64.	*Glechoma hederacea* (ground-ivy)	Apl. 10	Apl. 6	Apl. 1	Apl. 6	Apl. 20	May 3	Apl. 22	Apl. 30	Mar. 26
65.	*Galeopsis tetrahit* (hemp-nettle)	.....	.....	June 30	.....	.....	.....	.....	.....	June 30
66.	*Stachys silvatica* (hedge woundwort)	June 18	June 20	June 25	June 22	June 20	June 14	June 17	June 18	June 6
67.	*Ajuga reptans* (bugle)	May 24	May 10	.....	May 29	.....	May 27	May 20	May 25	May 3
68.	*Primula officinalis* (cowslip)	Apl. 14	Apl. 17	Apl. 17	Apl. 16	Apl. 17	Apl. 5	Apl. 2	Apl. 15	Mar. 19
69.	*Plantago lanceolata* (ribwort plantain)	.....	May 3	.....	Apl. 22	.....	May 18	May 6	May 6	Apl. 20
70.	*Mercurialis perennis* (dog's mercury)	Apl. 4	Apl. 10	Apl. 5	Apl. 22	Apl. 2	Mar. 19	Mar. 30	Mar. 28	Feb. 17
71.	*Ulmus montana* (wych elm)	.....	Mar. 30	Mar. 12	.....	.....	Apl. 1	Mar. 25	Mar. 28	Mar. 2
72.	*Salix Caprea* (great sallow)	Mar. 25	Mar. 31	Mar. 27	Mar. 31	Apl. 1	Apl. 1	Apl. 2	Mar. 30	Mar. 8
73.	*Fagus silvatica* (beech)	.....	May 27	.....	May 16	.....	.....	May 10	May 10	May 14
74.	*Corylus Avellana* (hazel)	Feb. 3	Feb. 13	Jan. 25	Feb. 5	Jan. 28	Jan. 27	Feb. 12	Feb. 15	Jan. 26
75.	*Orchis maculata* (spotted orchis)	.....	June 20	June 23	July 10	.....	June 17	June 11	June 10	June 3
76.	*Iris Pseudacorus* (yellow iris)	.....	June 18	June 21	June 20	.....	June 30	June 10	June 21	June 3
77.	*Narcissus Pseudo-narcissus* (daffodil)	Mar. 31	Apl. 4	Mar. 31	Mar. 31	Apl. 13	Mar. 30	Apl. 15	Apl. 1	Mar. 6
78.	*Galanthus nivalis* (snowdrop)	Feb. 2	Feb. 4	Jan. 30	Feb. 5	Jan. 20	Feb. 2	Feb. 19	.....	Jan. 22
79.	*Scilla nutans* (blue-bell)	Apl. 28	May 8	May 7	May 7	May 7	May 8	May 6	May 3	Apl. 14

Dates of Flowering of Plants observed in 1887 and 1888, with the Mean Date for 1876–86.

No.	Species.	1887. St. Albans.	1887. Harpenden.	1887. Hertford.	1887. Hitchin.	1888. St. Albans.	1888. Harpenden.	1888. Hertford.	1888. Hitchin.	Mean. 1876–86.
1.	*Anemone nemorosa* (wood anemone)	Apl. 7	Apl. 5	Apl. 5	Apl. 6	Apl. 11	Apl. 14	Apl. 2	Apl. 11	Mar. 13
2.	*Ficaria verna* (lesser celandine)	Mar. 23	Apl. 2	Mar. 13	Mar. 29	Mar. 22	Apl. 6	.....	Mar. 17	Feb. 21
3.	*Ranunculus acris* (upright crowfoot)	.....	May 14	Apl. 19	Apl. 26	.....	May 10	May 6	May 14	Apl. 23
4.	*Caltha palustris* (marsh marigold)	Apl. 19	May 2	Apl. 20	Apl. 12	Apl. 21	Apl. 27	Apl. 15	Apl. 17	Mar. 24
5.	*Papaver Rhœas* (red poppy)	June 8	June 8	.....	June 10	June 9	.....	June 7	June 12	May 29
6.	*Nasturtium officinale* (water-cress)	.....	.....	.....	.....	.....	.....	May 10	June 22	June 5
7.	*Cardamine pratensis* (cuckoo-flower)	May 1	May 6	May 4	Apl. 24	May 6	May 8	Apl. 22	May 6	Apl. 13
8.	*Alliaria officinalis* (garlic-mustard)	Apl. 27	May 2	.....	May 3	May 2	May 11	Apl. 29	Apl. 28	Apl. 14
9.	*Erophila vulgaris* (whitlow grass)	.....	Apl. 2	Apl. 10	Mar. 29	.....	Mar. 15	Feb. 26	Mar. 7	Mar. 9
10.	*Viola odorata* (sweet violet)	Mar. 4	Mar. 12	Apl. 2	Mar. 17	Mar. 27	Mar. 28	Mar. 25	Apl. 1	Feb. 13
11.	*Polygala vulgaris* (milkwort)	.....	June 18	.....	May 30	.....	June 11	May 27	May 25	May 8
12.	*Lychnis Flos-cuculi* (ragged Robin)	June 19	June 9	.....	June 11	June 10	June 10	June 7	June 10	May 24
13.	*Stellaria Holostea* (greater stitchwort)	.....	Apl. 23	May 6	Apl. 27	Apl. 30	Apl. 26	Apl. 19	Apl. 30	Apl. 5
14.	*Malva silvestris* (common mallow)	June 21	July 11	.....	June 19	June 24	June 27	June 8	June 18	June 6
15.	*Hypericum quadratum* (square St J.w.)	.....	July 16	.....	July 26	.....	.....	.....	Aug. 4	July 5
16.	*H. pulchrum* (upright St. John's wort)	.....	July 17	.....	.....	.....	July 4	.....	.....	June 28
17.	*Geranium Robertianum* (herb Robert)	May 18	May 21	.....	May 14	.....	May 20	May 21	May 19	Apl. 26
18.	*Euonymus europæus* (spindle-tree)	.....	.....	June 15	June 7	.....	June 14	June 3	June 2	June 1
19.	*Acer Pseudo-platanus* (sycamore)	May 20	May 13	.....	May 8	May 16	May 16	May 13	May 13	Apl. 28
20.	*Æsculus Hippocastanum* (h. chestnut)	May 24	May 23	.....	May 20	.....	May 21	May 20	May 21	May 5
21.	*Cytisus Laburnum* (laburnum)	May 31	June 2	.....	May 26	.....	May 27	.....	May 27	May 15
22.	*Trifolium repens* (Dutch clover)	June 6	June 9	June 7	May 31	June 10	June 11	June 1	May 27	May 17
23.	*Lotus corniculatus* (bird's foot trefoil)	June 11	June 13	June 4	May 31	June 3	June 2	May 28	May 27	May 20
24.	*Vicia Cracca* (tufted vetch)	.....	June 29	June 23	June 17	June 19	June 18	June 21	June 22	June 24
25.	*V. sepium* (bush vetch)	May 24	May 17	May 15	May 30	.....	May 22	May 13	May 27	Apl. 27
26.	*Lathyrus pratensis* (meadow vetchling)	June 11	June 14	.....	June 14	June 9	June 14	June 17	June 14	June 3
27.	*Prunus spinosa* (blackthorn)	Apl 17	Apl. 22	.....	Apl. 27	Apl. 30	Apl. 28	Apl. 19	Apl. 20	Mar. 25
28.	*Spiræa Ulmaria* (meadow sweet)	.....	July 7	June 26	July 8	.....	.....	June 28	July 27	June 15
29.	*Potentilla anserina* (silver-weed)	June 4	June 4	June 3	May 30	June 3	June 8	May 21	May 25	May 16
30.	*Rosa canina* (dog rose)	June 17	June 11	June 15	June 15	June 18	June 12	June 13	June 10	June 3
31.	*Sorbus Aucuparia* (mountain ash)	.....	June 1	June 14	May 31	.....	.....	.....	May 27	May 18
32.	*Cratægus Oxyacantha* (hawthorn)	May 29	June 2	.....	May 21	.....	May 27	May 21	May 21	May 12
33.	*Epilobium hirsutum* (hair willow-herb)	.....	July 15	July 17	July 19	.....	July 18	.....	July 18	July 5
34.	*E. montanum* (broad willow-herb)	June 22	June 30	June 12	June 19	June 19	June 18	June 24	June 23	June 11
35.	*Angelica silvestris* (wild angelica)	.....	.....	.....	Aug. 23	.....	.....	Aug. 5	Aug. 10	July 28
36.	*Daucus Carota* (wild carrot)	.....	.....	.....	.....	.....	July 11	.....	July 18	July 2
37.	*Hedera Helix* (ivy)	.....	.....	.....	Oct. 24	.....	.....	Oct. 7	Oct. 7	Sept 19
38.	*Cornus sanguinea* (dog-wood)	.....	June 26	.....	June 19	June 30	June 28	June 24	June 23	June 16
39.	*Syringa vulgaris* (lilac)	May 20	May 17	.....	May 15	.....	May 18	.....	May 19	May 7
40.	*Galium Aparine* (cleavers)	June 4	June 2	May 24	May 17	May 18	May 22	May 17	May 21	May 15
41.	*G. verum* (yellow bedstraw)	.....	June 30	June 19	July 9	.....	July 7	.....	June 26	June 29
42.	*Dipsacus silvestris* (wild teazel)	.....	.....	.....	Aug. 8	.....	.....	Aug. 5	Aug. 22	July 26
43.	*Succisa pratensis* (devil's bit)	.....	.....	.....	Aug. 8	.....	.....	Aug. 16	Aug. 6	July 25
44.	*Petasites vulgaris* (butter-burr)	.....	.....	Apl. 1	.....	.....	.....	Apl. 1	Apl. 28	Mar. 20
45.	*Tussilago Farfara* (coltsfoot)	.....	Mar. 24	.....	Feb. 28	.....	Apl. 5	Feb. 29	Mar. 22	Feb. 25
46.	*Achillea Millefolium* (milfoil)	June 21	June 23	June 25	July 3	June 20	June 23	June 10	June 23	June 21
47.	*Leucanthemum vulgare* (ox-eye)	May 25	June 3	June 3	May 26	.....	May 31	May 30	May 27	May 18
48.	*Artemisia vulgaris* (mugwort)	.....	.....	.....	.....	.....	.....	Aug. 5	July 29	July 30
49.	*Senecio Jacobæa* (ragwort)	.....	July 15	June 30	July 10	July 7	.....	.....	Aug. 8	June 28
50.	*Centaurea nigra* (black knapweed)	June 25	June 30	June 25	July 3	July 1	July 2	June 24	July 18	June 17
51.	*Cirsium lanceolatum* (spear thistle)	June 18	July 5	June 26	July 25	July 11	.....	July 21	July 27	June 19
52.	*C. arvense* (field thistle)	.....	July 6	.....	July 25	.....	July 7	.....	July 3	June 19
53.	*Sonchus arvensis* (corn sow-thistle)	.....	July 11	July 19	July 28	.....	July 9	.....	July 21	July 7
54.	*Hieracium Pilosella* (mouse-ear)	.....	June 16	June 1	May 23	.....	June 7	May 23	June 3	May 16
55.	*Campanula rotundifolia* (hair-bell)	.....	June 26	June 26	July 10	.....	June 24	.....	July 3	July 7
56.	*Ligustrum vulgare* (privet)	.....	June 25	June 29	June 21	.....	June 28	.....	June 22	June 17
57.	*Calystegia sepium* (greater bindweed)	July 23	July 22	.....	July 25	.....	Aug. 4	.....	July 22	July 1
58.	*Symphytum officinale* (comfrey)	.....	.....	June 7	May 31	.....	.....	May 23	May 27	May 7
59.	*Pedicularis silvatica* (red rattle)	.....	.....	June 6	.....	.....	.....	May 27	.....	May 14
60.	*Veronica Chamædrys* (speedwell)	May 8	May 10	May 11	May 5	May 13	May 19	May 6	May 9	Apl. 21
61.	*Mentha hirsuta* (water mint)	.....	.....	.....	July 8	.....	.....	Aug. 5	Aug. 4	July 29
62.	*Thymus Serpyllum* (wild thyme)	.....	July 8	June 9	June 8	.....	June 27	.....	June 2	June 8
63.	*Prunella vulgaris* (self-heal)	.....	June 24	June 30	July 10	.....	June 30	June 17	June 26	June 19
64.	*Glechoma hederacea* (ground-ivy)	Apl. 10	Apl. 6	Apl. 1	Apl. 6	Apl. 20	May 3	Apl. 22	Apl. 30	Mar. 26
65.	*Galeopsis tetrahit* (hemp-nettle)	.....	.....	June 30	.....	.....	.....	.....	.....	June 30
66.	*Stachys silvatica* (hedge woundwort)	June 18	June 20	June 25	June 22	June 20	June 14	June 17	June 18	June 6
67.	*Ajuga reptans* (bugle)	May 24	May 10	.....	May 29	.....	May 27	May 20	May 25	May 3
68.	*Primula officinalis* (cowslip)	Apl. 14	Apl. 17	Apl. 17	Apl. 16	Apl. 17	Apl. 5	Apl. 2	Apl. 15	Mar. 19
69.	*Plantago lanceolata* (ribwort plantain)	.....	May 3	.....	Apl. 22	.....	May 18	May 6	May 6	Apl. 20
70.	*Mercurialis perennis* (dog's mercury)	Apl. 4	Apl. 10	Apl. 5	Apl. 22	Apl. 2	Mar. 19	Mar. 30	Mar. 28	Feb. 17
71.	*Ulmus montana* (wych elm)	.....	Mar. 30	Mar. 12	.....	.....	Apl. 1	Mar. 25	Mar. 28	Mar. 2
72.	*Salix Caprea* (great sallow)	Mar. 25	Mar. 31	Mar. 27	Mar. 31	Apl. 1	Apl. 1	Apl. 2	Mar. 30	Mar. 8
73.	*Fagus silvatica* (beech)	.....	May 27	.....	May 16	.....	.....	May 10	May 10	May 14
74.	*Corylus Avellana* (hazel)	Feb. 3	Feb. 13	Jan. 25	Feb. 5	Jan. 28	Jan. 27	Feb. 12	Feb. 15	Jan. 26
75.	*Orchis maculata* (spotted orchis)	.....	June 20	June 23	July 10	.....	June 17	June 11	June 10	June 3
76.	*Iris Pseudacorus* (yellow iris)	.....	June 18	June 21	June 20	.....	June 30	June 10	June 21	June 3
77.	*Narcissus Pseudo-narcissus* (daffodil)	Mar. 31	Apl. 4	Mar. 31	Mar. 31	Apl. 13	Mar. 30	Apl. 15	Apl. 1	Mar. 6
78.	*Galanthus nivalis* (snowdrop)	Feb. 2	Feb. 4	Jan. 30	Feb. 5	Jan. 20	Feb. 2	Feb. 19	.....	Jan. 22
79.	*Scilla nutans* (blue-bell)	Apl. 28	May 8	May 7	May 7	May 7	May 8	May 6	May 3	Apl. 14

XIX.

REPORT ON PHENOLOGICAL PHENOMENA OBSERVED IN HERTFORDSHIRE DURING THE YEARS 1887 AND 1888.

By JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 12th April, 1889.

THE present Report is for the two years 1887–88 owing to a slight reduction in the number of observers of Phenological Phenomena making it convenient to embrace in one table the principal observations of the dates of flowering of plants made in the two years, instead of having, as in the previous eleven annual reports, a separate table for each year.

We have now no observer for Watford, but in its place St. Albans appears as a phenological station, and the only observer we had for the extreme east of the county, Miss Simpson, of High Wych, near Sawbridgeworth, has, I regret to say, discontinued her observations.

Although these are the only alterations from the year 1886, the records for two of our stations, Ware and Odsey, not being numerous, to economise space are given in a supplementary table, so that our principal table contains the records from only four stations—St. Albans, Harpenden, Hertford, and Hitchin. The following are our present phenological stations:—

River-basin.	Station.	N. Lat.		W. Long.		Observer.
Colne	St. Albans	51	45	0	20	Mrs. J. Hopkinson.
	Harpenden	51	48	0	21	Mr. J. J. Willis.
Lea	Hertford	51	48	0	5	Mr. R. T. Andrews.*
	Ware (Fanhams Hall)	51	49	0	1	Major R. B. Croft.
Ivel	Hitchin	51	57	0	16	Natural Hist. Club.
Cam	Odsey	52	1	0	7	Mr. H. G. Fordham.

In a third table the earliest observations only of the Insects and Birds are given. For details the reports of Mr. Silvester on the insects,† and of the late Mr. Littleboy and myself on the birds,‡ should be consulted. Frog spawn was observed in 1887 at St. Albans on the 17th of March, at Ware on the 23rd, and at Harpenden on the 26th; and in 1888 at St. Albans on the 27th of March, at Harpenden on the 30th, and at Ware on the 1st of April.

Phenology of 1887.

The year 1887 was a very backward year throughout. The mean of the 60 selected species, the observation of none of which has been omitted for more than two years in our period, while nearly all have been observed every year, shows that vegetation was on the average 11·7 days late. Of these 60 species 52 came into flower later than the mean of 1876–86, 5 earlier, and 3 on the same day as the mean.

Of the 30 species which come into flower before the middle of

* Continued from February, 1888, by Mr. W. Graveson.

† *Ante*, pp. 89 and 134. ‡ *Ib.*, pp. 76 and 139.

Dates of Flowering of Plants observed in 1887 and 1888.
(Supplementary Table.)

No.	Species.	1887. Ware.	1887. Odsey.	1888. Ware.	1888. Odsey.
1	*Anemone nemorosa*	Apl. 14	.....	.....	.....
2	*Ficaria verna*	.....	.....	Apl. 9	.....
4	*Caltha palustris*	May 5	.....	Apl. 24	.....
5	*Papaver Rhœas*	.....	June 23	.....	May 26
10	*Viola odorata*	.....	Mar. 6	.....	Mar. 29
11	*Polygala vulgaris*	.....	May 29	.....	.....
13	*Stellaria Holostea*	Apl. 24	.....	.....	.....
14	*Malva silvestris*	June 14	June 24	.....	June 23
20	*Æsculus Hippocastanum*	May 20	.....	.....	.....
21	*Cytisus Laburnum*	.....	June 3	.....	May 27
22	*Trifolium repens*	June 6	.....	.....	.....
25	*Vicia sepium*	May 25	.....	.....	.....
27	*Prunus spinosa*	Apl. 28	Apl. 22	.....	.....
29	*Potentilla anserina*	.....	June 4	.....	May 26
30	*Rosa canina*	June 13	June 16	.....	June 13
32	*Cratægus Oxyacantha*	.....	May 28	.....	May 26
37	*Hedera Helix*	.....	Sept. 25	.....	.....
39	*Syringa vulgaris*	.....	May 18	.....	May 18
40	*Galium Aparine*	May 31	May 28	.....	May 26
41	*G. verum*	....	July 4	.....	.....
45	*Tussilago Farfara*	Apl. 2	Feb. 27	.....	Mar. 28
47	*Leucanthemum vulgare*	June 8	.....	.....	.....
49	*Senecio Jacobæa*	.....	July 2	.....	.....
56	*Ligustrum vulgare*	.....	.....	.....	June 28
64	*Glechoma hederacea*	Apl. 16	Apl. 7	.....	Apl. 22
67	*Ajuga reptans*	May 25	.....	.....	.....
68	*Primula officinalis*	Apl. 16	Apl. 17	Apl. 14	Apl. 15
69	*Plantago lanceolata*	May 8	.....	.....	.....
70	*Mercurialis perennis*	.....	.....	Apl. 1	.....
71	*Ulmus montana*	.....	Mar. 27	.....	Mar. 30
72	*Salix Caprea*	.....	.....	.....	Apl. 12
74	*Corylus Avellana*	.....	Feb. 5	.....	Feb. 5
76	*Iris Pseudacorus*	June 8	.....	.....	.....
77	*Narcissus Pseudo-narcissus*	.....	Mar. 31	.....	Sept. 6
78	*Galanthus nivalis*	Feb. 13	Feb. 2	Feb. 2	Jan. 23

May (our spring flowers), 28 appeared after the mean date and 2 before it; and of the 30 which come into flower after the middle of May (our summer flowers), 24 appeared after the mean date, 3 before it, and 3 on the same day as the mean. The spring flowers were on the average a little over a fortnight late (15·3 days), and the summer flowers a little over a week late (8·1 days).

Dividing the period of observation into three, the average date of the first 20 species flowering up to the third week in April is 16·0 days late; of the next 20 flowering up to the end of May or beginning of June, 12·7 days late; and of the last 20 flowering up to the end of July, 6·4 days late. Vegetation was thus most backward in the early spring, about three-fourths as backward towards

Earliest Dates of Observations of Insects, Birds, etc., in 1887 and 1888, with the mean date for 1876-86.

No.	Phenomena.	1887.	1888.	Mean.
	INSECTS.			
80	*Melolontha vulgaris* (cock-chafer) ap.	May 28	.....	May 27
81	*Rhizotrogus solstitialis* (fern-chafer) ap.	.....	.....	June 12
82	*Timarcha lævigata* (bloody-nosed beetle) ap.	Apl. 13	Apl. 17	Apl. 9
83	*Lampyris noctiluca* (glow-worm) ap.	June 22	July 8	May 29
84	*Apis mellifica* (honey-bee) ap.	Jan. 19	Jan. 9	Jan. 30
85	*Vespa vulgaris* (common wasp) ap.	Apl. 18	May 8	Mar. 16
86	*Pieris Brassicæ* (large white butterfly) ap.	Apl. 11	Apl. 30	Apl. 7
87	*P. Rapæ* (small white butterfly) ap.	Apl. 4	Apl. 13	Mar. 27
88	*Anthocaris cardamines* (orange-tip) ap.	Mar. 31	June 1	May 7
89	*Epinephele Janira* (meadow-brown) ap.	May 8	Apl. 16	May 28
90	*Bibio Marci* (St. Mark's fly) ap.	June 11	.....	Apl. 27
	BIRDS.			
91	*Syrnium Aluco* (tawny owl) hoots	.....	Mar. 14	Apl. 10
92	*Muscicapa Grisola* (flycatcher) arr.	Apl. 28	May 16	May 12
	——— eggs seen	.....	.....	May 30
	——— hatched	.....	June 21	June 30
	——— departs (last seen)	Sept. 16	.....	Aug. 30
93	*Turdus musicus* (song-thrush) sg.	Jan. 22	Jan. 7	Jan. 11
	——— eggs seen	Mar. 31	.....	Mar. 20
	——— hatched	May 8	.....	Apl. 9
94	*T. Pilaris* (fieldfare) arr.	Dec. 24	Dec. 2	Oct. 24
	——— departs (last seen)	Mar. 5	.....	Mar. 2
95	*Daulias Luscinia* (nightingale) sg.	Apl. 10	Apl. 18	Apl. 14
96	*Saxicola Œnanthe* (wheatear) arr.	Apl. 6	Apl. 10	Mar. 13
97	*Phylloscopus trochilus* (willow-wren) sg.	Apl. 18	Apl. 14	Mar. 25
98	*P. rufus* (chiff-chaff) sg.	Mar. 26	Apl. 2	Mar. 23
99	*Alauda arvensis* (sky-lark) sg.	Jan. 20	Jan. 7	Jan. 18
	——— hatches	May 29	.....	.....
100	*Fringilla cœlebs* (chaffinch) sg.	.....	.....	Feb. 4
101	*Corvus frugilegus* (rook) builds	Feb. 22	Mar. 3	Feb. 21
	——— hatches	Apl. 10	Apl. 11	Apl. 12
102	*Cuculus canorus* (cuckoo) calls	Apl. 13	Apl. 20	Apl. 10
	——— changes its note	June 4	.....	May 30
103	*Hirundo rustica* (swallow) arr.	Apl. 11	Apl. 15	Apl. 10
	——— flocks	Sept. 4	.....	Aug. 7
	——— departs (last seen)	Oct. 11	.....	Oct. 24
104	*Chelidon urbica* (house-martin) arr.	Apl. 18	Apl. 24	Apl. 17
105	*Cotile riparia* (sand-martin) arr.	May 8	Apl. 15	Apl. 16
106	*Cypselus Apus* (swift) arr.	May 3	May 10	May 5
	——— departs (last seen)	.....	Aug. 17	Sept. 7
107	*Caprimulgus europæus* (goat sucker) arr.	May 8	May 15	.....
108	*Turtur communis* (turtle-dove) coos	May 7	May 4	May 3
109	*Perdix cinerea* (partridge) pairs	Jan. 29	Feb. 4	Jan. 24
	——— hatches	.....	.....	June 15
110	*Scolopax Rusticola* (woodcock) arr.	Oct. 11	.....	Oct. 14
111	*Crex pratensis* (corncrake) arr.	Apl. 16	May 12	Apl. 24
	AMPHIBIAN.			
112	*Rana temporaria* (common frog) spawns	Mar. 17	Mar. 27	Mar. 10

ap.—first appears. arr.—arrives. sg.—song commences.

the end of spring, and half as much backward in summer as in the latter part of spring.

Taking each 10 species in succession there is not much difference in the first four groups, but there is a great change to the fifth, which is not nearly so backward as the fourth, while there is a very slight difference between the fifth and sixth. The average for February (22nd Jan. to 9th March) is 16·7 days late; for March (13th March to 20th April) 15·4 days late; for April (21st April to 15th May) 13·8 days late; for May (16th May to 3rd June) 11·6 days late; for June (5th to 21st) 6·6 days late; and for July (24th June to 25th July) 6·2 days late.

Phenology of 1888.

The year 1888 was very similar in character to 1887; backward throughout, but with a greater tendency to recovery in the summer months. The mean of the 60 selected species shows vegetation to have been on the average 11·1 days late, or about half a day less than in 1887. Of these 60 species 51 came into flower later than the mean of 1876–86 and 9 earlier.

Of our 30 spring flowers 28 appeared after the mean date and 2 before it (as in 1887); and of our 30 summer flowers 23 appeared after the mean date and 7 before it. The spring flowers were on the average a little over a fortnight late (15·5 days), and the summer flowers a little less than a week late (6·2 days).

The average date of flowering of the first 20 species is 16·5 days late; of the next 20, 11·0 days late; and of the last 20, 4·7 days late. Vegetation was thus most backward in the early spring, about two-thirds as backward towards the end of spring, and less than half as backward in summer as in the latter part of spring.

Of each group of 10 species the second is more backward than the first; the third not so much as the first; the fourth much less than the third; and the fifth and sixth less backward still. The average for February is 15·4 days late; for March 18·5; for April 13·7; for May 8·3; for June 5·3; and for July 4·0.

Thus the years 1887 and 1888 both bear out in a general way the conclusion arrived at in previous reports, that there is, after the early part of spring, a less departure from the mean as the year advances.

XX.

SOME NOTES ON THE *LEPIDOPTERA* OF ST. ALBANS AND ITS NEIGHBOURHOOD.

By A. E. Gibbs, F.L.S.

Read at Watford, 12th April, 1889.

In 1884 Mr. A. F. Griffith read a paper to us on the Lepidoptera observed by him and his brother in the neighbourhood of Sandridge, and in the course of his remarks he urged upon entomologists the importance of keeping a record of the exact locality at which each specimen occurred. His system of doing this is a very simple one (*vide* 'Transactions,' Vol. III, p. 61), and if carried out with the addition of a register in which each insect is recorded when removed from the drying-board, it is perhaps the best that can be devised. Unfortunately I had no system of recording my captures until I read Mr. Griffith's paper, so the lists I append may appear somewhat meagre, for they only contain the names of insects of which I have some written record of the place where they were caught, or can distinctly remember the circumstances under which they came into my possession.

My experience of sugaring during last autumn was not a happy one. I visited Bricket Wood several times on likely nights but failure invariably resulted. The cold, wet season seems to have been very fatal to insect life, and the autumn of 1888 was in striking contrast to that of 1887, when abundance of moths came to the sugar. The same trees this year were sugared, the only result being the capture of two or three common and valueless specimens.

I append lists of moths captured by me in three different localities—St. Albans, Bricket Wood, and Harpenden Common.

St. Albans.

In this list I include insects taken within a radius of two or three miles from the Town Hall. Most of the moths that I have caught at light are included in it, the gas-lamps on the outskirts of the town yielding good results to one who does not mind climbing the lamp-posts and exciting the astonishment of passers by.

A considerable number of the species mentioned in this list were taken in the garden at dusk.

A collection of night-flowering plants—by which I mean plants whose blossoms do not close up, or in other words "go to sleep," at night—is invaluable to an entomologist. Among the best of these plants I would include the evening primrose, the garden rocket, and the wallflower, the latter being especially valuable. As a rule white or light-coloured flowers of any sort are good ones to visit with the net at twilight, one of the best of our wild flowers being the white dead-nettle (*Lamium album*). In the twilight a light-coloured corolla shines out conspicuously among the darker foliage and at once catches the attention of the passing moth, which in return for the nectar it derives from the blossom performs the all-important function of conveying pollen from flower to flower to set the seed. If a moth taken feeding in this way be examined it will most probably be found to wear a collar of white or golden yellow pollen, some of which it would have left upon the stigma of the next flower it visited. The honeysuckle is said to be specially attractive to the swift-moving humming-bird hawk-moth (*Macroglossa stellatarum*), whose long tongue can reach the nectar at the bottom of the deep corolla tube, but my experience is that this insect will by preference visit other blossoms in the garden border, such as the wallflower, hovering for a moment over the blossom to extract the sweet juices and then darting away suddenly to some other plant. I should like to know what the experience of other collectors is with regard to this. In 1887 the convolvulus hawk-moth (*Sphinx convolvuli*) was rather abundant in the neighbourhood of St. Albans, and in 1888 I had a more than usual number of lime hawks (*S. tiliæ*) brought to me.

NOCTURNI.

Smerinthus
ocellatus
tiliæ
populi
Sphinx
convolvuli
Chærocampa
elpenor (*larva*)
Macroglossa
stellatarum
Zeuzera
æsculi
Hepialus
velleda
hectus
humuli
lupulinus
Cerura
vincula
Zygæna
filipendulæ
Chelonia
caja
Arctia
menthastri
Trichiura
cratægi
Bombyx
quercus
Odonestris
potatoria

GEOMETRINA.

Rumia
cratægata
Venilia
maculata
Eurymene
dolobraria
Selenia
illunaria
Crocallis
elinguaria
Odontopera
bidentata
Himera
pennaria
Ennomos
fuscantaria
Phigalia
pilosaria
Amphidasis
prodromaria
betularia
Boarmia
repandata
rhomboidaria
Hemerophila
abruptaria
Asthena
luteata
candidata
Acidalia
remutata
Cabera
pusaria
Abraxas
grossulariata
Lomaspilis
marginata
Hybernia
rupicapraria
progemmaria
defoliaria
Anisopteryx
æscularia
Cheimatobia
brumata
Oporabia
dilutata
Larentia
multistrigaria
Eupithecia
castigata
venosata
rectangulata
absynthiata
vulgata
Melanthia
albicillata
Thera
variata
Melanippe
rivata
montanata
fluctuata
Anticlea
badiata
derivata
Coremia
ferrugata
Camptogramma
bilineata
Eucosmia
cirtata
Cidaria
miata
corylata
suffumata
Eubolia
cervinata
Anaitis
plagiata

PSEUDO-BOMBYCES.

Cilix
spinula

Pygæra
  bucephala
Diloba
  cœruleocephala
Dasychira
  pudibunda (*larvæ*)
Spilosoma
  lubricepeda

NOCTUINA.

Bryophila
  perla
Acronycta
  psi
  megacephala
Leucania
  conigera
  pallens
Hydræcia
  micacea
Xylophasia
  polyodon
  rurea
Luperina
  testacea
Charæas
  graminis
Mamestra
  brassicæ
  persicariæ
Apamea
  basilinea
  gemina
Miana
  strigilis
Grammesia
  trilinea
Caradrina
  cubicularis
Agrotis
  segetum
  exclamationis
Triphæna
  ianthina
  pronuba
Noctua
  festiva
  rubi
  xanthographa
Tæniocampa
  gothica
  rubricosa
  munda
  instabilis
  stabilis
  cruda
Anchocelis
  lunosa
  pistacina
Cerastis
  vaccinii
  spadicea
Xanthia
  gilvago
  ferruginea
Cosmia
  trapezina
Dianthæcia
  carpophaga
Phlogophora
  meticulosa
Hadena
  proteus
  dentina
Xylocampa
  lithorhiza
Abrostola
  urticæ
Plusia
  chrysitis
  iota
  gamma
Gonoptera
  libatrix
Cotocala
  nupta

DELTOIDÆ.

Hypena
  proboscidalis
Herminia
  grisealis

PYRALIDINA.

Aglossa
  pinguinalis
Botys
  verticalis
  urticalis
Pionea
  forficalis
Stenopteryx
  hybridalis
Simæthis
  fabriciana

CRAMBITES.

Endorea
  ambigualis
Achroia
  grisella
Crambus
  pratellus

TORTRICIANA.

Tortrix
  ministrana
  transitana
Pardia
  tripunctana
Lithographia
  campoliliana
Halonota
  Brunnichiana
  bimaculana
Dierorampha
  plumbagana
Anchylopera
  lundana
Argyrotoza
  Conwayana
Semasia
  Wœberana
Grapholita
  ulicetana
Cnephasia
  hybridana
  subjectana (?)
Sericoris
  lacunana
Eupœcilia
  rupuola

TINEINA.

Tinea
  rusticella
  cloacella
  lapella
Nemophora
  Schwarziella
Micropteryx
  subpurpurella
Chimabacche
  phryganella
Phibalocera
  quercana
Hyponomenta
  euonymella
Pluletta
  cruciferarum
  porrectella
Depressaria
  arenellæ
  applana
Harpella
  Geoffrella
Dasycera
  sulphurella
Œcophora
  pseudospretella
Endrosis
  fenestrella
Glyphipteryx
  fuscoviridella
Gracilaria
  Swederella
Nepticula
  apicella

PTEROPHORINA.

Pterophorus
  pentadactylus
Alucita
  polydactyla

Bricket Wood.

This list enumerates species caught in the wood or its immediate neighbourhood. The sallows on the railway banks have yielded a large number of insects, and on some favourable nights it is no exaggeration to say that hundreds of moths have been shaken from one tree.

For the benefit of those who are not entomologists I may be permitted to make a few remarks upon sallow-beating. The spring, when the different species of *Salix* are in bloom, should be a busy time with the insect-hunter. A calm, moonless night should be chosen, if it is a little damp it will not matter; and then, armed with a bull's-eye lantern, some chip-boxes, and a bundle of old newspapers, the hunting-ground should be visited. The method I adopt is to first examine with the aid of the lantern those parts of the tree that are within reach, transferring all the specimens that are required to the chip boxes. The insects are attracted to the sallow by the sweet juices contained in the nectaries of the florets composing the catkins, and when they are busy feeding, or perhaps indisposed for exertion after a good meal, they fall an easy prey. When all the rarer insects within reach have been captured, the newspapers may be spread upon the ground and the tree vigorously shaken, when the insects fall down in dozens on to the sheets, and may be selected and boxed at leisure. Bricket Wood has proved a capital spot for this kind of work. Most of the insects taken "at sallow" belong to the family *Orthosidæ*, and the commoner ones to the genus *Tæniocampa*. *T. gothica*, *stabilis*, *instabilis*, and *cruda* may be taken in great numbers on a favourable night, and indeed it would be no exaggeration to say that occasionally I could easily have taken several hundred specimens of the last-named moth, on the many sallow bushes to be found within the radius of a mile of the station. It is said that the chrysalids of these four moths may be found in equally large numbers by digging at the foot of oak trees in October, but of this I cannot speak from experience.

Some scarce day-flying moths may also be taken at Bricket Wood, and the district will well repay working.

I have alluded to the success which has occasionally attended sugaring here. I have principally visited Bricket Wood for this purpose in the autumn, and have then taken scores of specimens of *diluta*, *oxyacanthæ*, *aprilina*, *proteus*, and other moths. I find it best to select trees in a clearing or by one of the ridings, and to visit the same tree on successive nights. The insects appear to get used to looking for the sugar at the same place, and larger numbers come under these circumstances than when one wanders about from one spot to another. A mild, cloudy night, without too much wind, but just enough breeze to spread the scent of the sugar, is the best time to choose. My experience shows that no better preparation can be used than coarse treacle with enough rum added to strongly scent it. This should be applied by means of a large paint-brush to the bark of selected trees, about four or five feet from the ground. I cannot say whether the rum has any intoxicating effect upon insects, but moths fall an easy prey after they have partaken of this mixture, and often present the appearance of being in a semi-conscious condition. The sallow blossoms, however, appear to have the same effect.

NOCTURNI.

Hepialus
  lupulinus
Lithosia
  mesomella
Zygæna
  filipendulæ

GEOMETRINA.

Rumia
  cratægata
Venilia
  maculata
Epione
  apiciaria
Iodis
  lactearia
Ephyra
  punctaria
Asthena
  candidata
Acidalia
  remutata
  aversata
Cabera
  pusaria
Corycia
  temerata
Strenia
  clathrata
Numeria
  pulveraria
Ematurga
  atomaria
Abraxas
  grossulariata
Emmelesia
  decolorata
Larentia
  didymata
Lomaspilis
  marginata
Eupithecia
  vulgata
Coremia
  unidentaria
Melanippe
  rivata
  subtristata
  montanata

PSEUDO-BOMBYCES.

Diloba
  cæruleocephala

NOCTUINA.

Cymatophora
  diluta
Xylophasia
  lithoxylea
  rurea
Agrotis
  segetum
Triphæna
  pronuba
Noctua
  xanthographa
Tæniocampa
  gothica
  instabilis
  stabilis
  munda
  cruda
Anchoielis
  rufina
  lunosa
Xanthia
  ferruginea
Cosmia
  trapezina
Miselia
  oxyacanthæ
Agriopis
  aprilina
Hadena
  proteus
Xylocampa
  lithorhiza
Helvides
  arbuti
Cerastis
  vaccinii
Amphipyra
  pyramidia
  tragopogonis
Gonoptera
  libatrix
Erastria
  fuscula
Cotocala
  nupta
Enclidia
  mi

PYRALIDINA.

Scoparia
  ambigualis

CRAMBITES.

Crambus
  pratellus
  tristellus
  culmellus

TORTRICINA.

Tortrix
  ministrana
  viridana
Antithesia
  pruniana (?)
Pardia
  tripunctana
Lithographia
  Penkleriana
Peronea
  comparana
  favillaceana
Halonota
  Brunnichiana
Dictyopteryx
  contaminana
  Lœflingiana
Cnephasia
  hybridana
Sericoris
  lacunana
Eupœcilia
  maculosana

TINEINA.

Nemophora
  Schwarziella
Micropteryx
  subpurpurella
Nemotois
  minimellus
Phibalocera
  quercana
Plutella
  cruciferarum
Depressaria
  applana
Glechia
  cinerella
Harpella
  Geoffrella
Endrosis
  fenestrella

PTEROPHORINA.

Alucita
  polydactyla

Harpenden Commom.

I have taken Harpenden Common as a convenient centre, though very few of the species in this list have been caught on the Common itself, most of them occurring in the lanes and woods and on the railway slopes behind Bamville Wood Farm, just within the parish of Wheathampstead, at the south-eastern end of the Common. This list is the result of a very few, probably not more than three, excursions with a net. At the same time I have included a few moths taken at light in Harpenden itself. Perhaps this district in its south-eastern parts may overlap that for which Mr. Griffith has furnished a list.

Nocturni.

Smerinthus
tiliæ
Hepialus
lupulinus

Geometrina.

Rumia
cratægata
Asthena
candidata
Cabera
pusaria
Strenia
clathrata
Abraxas
grossulariata
ulmata
Hybernia
progemmaria
Anisopteryx
æscularia
Melanippe
montanata
Camptogramma
bilineata
Cidaria
miata
Eubolia
cervinata
Anaitis
plagiata

Pseudo-Bombyces.

Cilix
spinula

Noctuina.

Gortyna
flavago
Xylophasia
lithoxylea
Helioplaobus
popularis
Luperina
testacea
Triphæna
pronuba
Anchocelis
lunosa
Gonoptera
libatrix

Deltoidæ.

Herminia
grisealis

Pyrolidina.

Simaethis
faleriana

Tortriciana.

Tortrix
ministrana
Pardia
tripunctana
Lithographia
Penkleriana
Dicrorampha
acuminatana
plumbagana
Anchylopera
lundana
Argyrotoza
Conwayana
Peronea
variegana
Cnephasia
hybridana
Sericoris
lacunana
Argyrolepia
Baumanniana

Tineina.

Tinea
rusticella
arcella
Harpella
Geoffrella
Endrosis
fenestrella
Glyphipteryx
fuscoviridella
Chrysoclista
flavicaput
Elachista
cygnipennella

XXI.

METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, DURING THE YEAR 1887.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 12th April, 1889.

The meteorological observations, some of the results of which I have now to communicate to the Society, are in continuation of observations which have been taken at Watford for nearly eleven years, having been commenced in February, 1876. At the end of December, 1886, my instruments were removed to St. Albans, where they have been read daily, without intermission, since that time; the observations during absence from home being made by one of our servants.

This being the first report for St. Albans, a few particulars of the locality and the position of the instruments may be given. For information as to the instruments themselves and the method of observation, reference should be made to the report for Watford for the year 1883.* It may however be repeated that the observations are made at 9 a.m.

The longitude is 0° 20′ 7″ W., and the latitude, 51° 45′ 9″ N. The situation is very open and well elevated above the valley of the Ver. The ground slopes downwards slightly towards the south for a short distance and then much more steeply in the same direction. It also falls on either side of this main gradient, so that the contour is convex, being made up of a south-westerly slope to the River Ver, which is half a mile distant, and of a south-easterly slope to the River Colne, distant about three miles. The height above Ordnance Datum is 379 feet at the rain-gauge and 380 feet at the thermometer screen. The top of the rain-gauge is one foot above the ground and therefore 380 feet above sea-level. The height of the cistern of the barometer is 388 feet, part of this increase in altitude being due to the slope of the ground and part to the height of the ground-floor of the house above the ground-level and the height of the barometer above the floor.† The ground rises to about 410 feet half a mile to the north-east, and falls to about 250 feet half a mile to the south. There are a few large trees on the north and east of the thermometer-screen, rain-gauge, and wind-vane,—sufficiently distant to have no effect on either the temperature or the rainfall recorded, but perhaps sometimes slightly affecting the indications of the vane, which is 30 feet above the ground. The subsoil is gravel on chalk, and there is a considerable depth of surface soil, but this, having very little clay in its composition, soon transmits to the pervious gravel underneath the rain which falls upon it.

* 'Transactions,' Vol. III, p. 181.

† These elevations were ascertained by levelling from a bench-mark (384·3 ft.) on the wall by one of my own gate-posts about 40 feet from the barometer.

Results of Meteorological Observations taken at The Grange, St. Albans, in 1887.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the Air.		
		9 a.m.	Means of		Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°		°		°	°	in.	%
January	30·018	34·0	29·0	39·6	34·2	10·6	13·7	2nd	48·8	26th	35·1	2·8	·175	89
February	·357	36·9	31·8	44·8	37·8	13·0	20·8	17th	54·2	5th	33·4	2·6	·198	90
March	·087	37·0	31·5	45·1	37·9	13·6	21·9	14th	55·6	28th	33·7	3·4	·193	88
April	·021	42·5	34·7	51·4	42·9	16·7	26·3	17th	62·0	19th	35·7	5·8	·218	80
May	·035	49·1	42·1	57·6	49·5	15·5	34·0	1st	66·7	8th	32·7	6·2	·276	79
June	·212	60·3	49·8	71·2	60·4	21·4	42·4	27th	82·2	15th	39·8	10·1	·364	69
July	·064	66·1	54·0	75·8	65·3	21·8	44·8	18th	86·0	3rd	41·2	13·2	·401	63
August	·011	61·2	51·3	71·4	61·3	20·1	43·2	15th	84·7	6th	41·5	11·2	·361	67
September	29·942	53·5	46·8	60·9	53·7	14·1	35·3	29th	67·3	9th	32·0	6·4	·324	79
October	30·102	44·4	38·3	51·1	44·6	12·8	25·9	26th	59·7	8th	33·8	4·6	·245	84
November	29·710	38·9	34·7	44·8	39·5	10·1	18·6	17th	54·6	4th	36·0	2·1	·218	92
December	·853	36·1	31·6	42·4	36·7	10·8	23·9	27th	52·6	8th	28·7	3·0	·188	90
Year	30·034	46·7	39·6	54·7	47·0	15·2	13·7	Jan.	86·0	July	72·3	6·0	·263	81

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, IN 1887—*(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.										
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount, 0–10.	No. of days of		Mean Force, 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Over-cast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January.....	1·88	·41	3rd	16	9	8·0	3	19	1·2	0	2	2	3	7	4	3	3	7
February	·64	·22	2nd	8	0	6·2	6	12	1·6	2	3	4	2	3	4	1	4	5
March	1·70	·41	15th	12	7	7·4	3	16	1·6	2	8	3	2	1	7	3	2	3
April	1·22	·32	23rd	12	2	5·6	6	10	2·1	6	10	1	0	1	7	2	3	0
May	2·12	·52	19th	22	0	8·0	2	18	1·8	6	6	3	2	0	2	2	7	3
June	·65	·41	2nd	4	0	5·7	7	10	1·6	5	8	3	1	0	5	3	3	2
July	·88	·28	26th	11	0	4·6	7	1	1·7	3	3	1	2	4	7	4	5	2
August	1·07	·61	30th	7	0	4·5	7	5	1·3	4	0	2	2	4	3	4	5	7
September	3·12	·65	1st	18	0	5·8	5	8	1·8	3	7	1	0	1	6	5	6	1
October.....	1·62	·67	29th	13	2	7·0	6	15	1·9	5	2	0	0	1	4	4	10	5
November	3·40	·68	3rd	20	1	7·1	4	12	1·6	7	5	1	1	3	3	2	3	5
December	1·54	·36	8th	19	4	7·5	5	18	1·9	2	1	0	1	4	5	6	9	3
Year	19·84	·68	Nov.	162	25	6·5	61	144	1·7	45	55	21	16	29	57	39	60	43

The monthly means and other results of the daily observations in 1887 are given in the accompanying tables (pp. 188, 189); and from these tables the following summary for the seasons is deduced. For the winter of 1886–87 it has been necessary to take the values for December from the observations at Watford as given in the previous report.

MEANS FOR THE SEASONS FROM DEC. 1886 TO NOV. 1887.

Seasons, 1886-87.	Pressure.	Temperature. Mean.	Temperature. Daily Range.	Tension of Vapour.	Humidity.	Rainfall. Total.	Rainfall. Days.	Cloud, 0-10.
	ins.	°	°	in.	%	ins.		
Winter	30·028	36·0	11·6	·186	89	7·02	43	7·1
Spring	30·048	43·4	15·3	·229	82	5·04	46	7·0
Summer.....	30·096	62·3	21·1	·375	66	2·60	22	4·9
Autumn.....	29·918	45·9	12·3	·262	85	8·14	51	6·6

Having extended the computation of the observations taken at Watford from the means of the eight years 1878-85 as given in my report for the year 1885, to those of the ten years 1877-86, I now give the difference in each month and in the year between the chief results for 1887 at St. Albans and the means for these ten years at Watford.

DIFFERENCE IN 1887 FROM MEANS OF 1877-86 AT WATFORD.

Months.	Pressure.	Temperature. Mean.	Temperature. Daily Range.	Tension of Vapour.	Humidity.	Rainfall. Total.	Rainfall. Days.	Cloud, 0-10.
	in.	°	°	in.	%	ins.		
January.....	—·011	—2·4	+1·1	—·019	— 1	—0·71	— 1	+0·4
February	+·399	—2·0	+2·8	—·017	+ 1	—1·95	— 9	—1·4
March	+·111	—3·2	—1·2	—·017	+ 5	+0·04	=	+1·1
April	+·145	—3·2	+2·3	—·025	+ 4	—1·16	— 3	—0·9
May	+·070	—2·6	—3·0	—·015	+ 7	—0·29	+ 7	+1·6
June	+·243	+1·9	+3·3	—·003	— 4	—2·21	—10	—0·6
July	+·112	+4·1	+4·6	—·006	—11	—1·65	— 4	—0·9
August	+·080	+0·3	+3·8	—·058	—10	—1·55	— 7	—2·4
September	—·029	—2·7	—2·2	—·056	— 4	+0·51	+ 5	—0·6
October	+·174	—3·7	—0·7	—·050	— 3	—1·44	— 4	+0·5
November	—·202	—2·5	—1·9	—·016	+ 3	+0·38	+ 2	+0·6
December	—·113	—0·6	+0·7	—·011	=	—1·09	+ 2	+0·2
Year	+·082	—1·4	+0·8	—·025	— 1	—11·12	—22	—0·2

The cold weather which commenced in December, 1886, lasted without intermission until the summer of 1887. July was particularly warm, August was about the average, but in September another cold period set in and prevailed almost continuously until near the end of 1888. The mean pressure of the atmosphere was rather high; the lowest pressures recorded at 9 a.m. were 28 888 ins.

on 5th Jan. and 28·820 ins. on 3rd Nov., and the highest pressure was 30·863 ins. on 7th Feb., giving a range of 2·043 ins. The mean temperature of the year was very low, and on the 2nd of January the low minimum of 13°·7 was recorded. The mean daily range was rather high, the rainfall was very small, the rainy days were few, and the air was generally rather dry, May only showing a considerable degree of humidity.

In the winter of 1886-87 (Dec. to Feb.) the mean pressure of the atmosphere was rather high and the mean temperature was low. In the spring (March to May) mean pressure was high, mean temperature very low, relative humidity great, and rainfall rather small. In the summer (June to Aug.) mean pressure was very high, mean temperature high (the daily range being great), relative humidity very low, and rainfall very small. In the autumn (Sept. to Nov.) mean temperature was very low. No mention is here made of any phenomena about the average. The deviations from the means of our period are as follows :—

DIFFERENCE IN 1886–87 FROM MEANS OF 1877–86 AT WATFORD.

Seasons, 1886–87.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud, 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	+·044	−1·9	+1·6	−·017	− 0	−0·79	− 8	−0·3
Spring	+·109	−3·1	−1·1	−·019	+ 5	−1·41	+ 4	+0·6
Summer.....	+·145	+2·1	+3·9	−·019	− 9	−5·41	−21	−1·7
Autumn.....	−·019	−3·0	−1·6	−·041	− 1	−0·55	+ 3	+0·1

NOTES ON THE MONTHS.

JANUARY.—Very cold and dull, with an atmosphere of average humidity and pressure, and a small amount of rain chiefly falling in the form of snow. Coldest day 2nd, mean 23°·7 ; warmest day 29th, mean 45°·3. Min. below 32° on 20 days (every day from 1st to 11th), below 22° on 5 (above 40° on 29th); max. above 42° on 11 (below 32° on 13th and 16th).

FEBRUARY.—Very cold, bright, with an atmosphere of average humidity and very high pressure, and a very small amount of rain with no snow. No rain fell from 4th to 16th (13 days). Coldest day 17th, mean 29°·4 ; warmest day 4th, mean 49°·3. Min. below 32° on 17 days, below 22° on 1 (17th) ; max. above 42° on 18, above 52° on 1 (5th).

MARCH.—Very cold, rather dull, with a rather humid atmosphere of considerable pressure, and an average amount of rain chiefly falling as snow, on 15th to the depth of 6 inches (measuring 0·41 in. of rain). No rain fell from 25th Feb. to 10th March (14 days). Coldest day 4th, mean 30°·3 ; warmest day 27th, mean 49°·4. Min. below 32° on 18 days (all before 23rd), below 22° on 1 (14th); max. above 52° on 3 (27th, 28th, and 29th).

APRIL.—Very cold, bright, with an atmosphere of average humidity and more than average pressure, and a small rainfall. No rain fell from 9th to 20th (12 days). Coldest day 9th, mean 38°·9; warmest day 19th, mean 51°·4. Min. below 42° on 27 days, below 32° on 6; max. above 52° on 13.

MAY.—Very cold and dull, with a very humid atmosphere of more than average pressure, and an average rainfall. Coldest day 1st, mean 44°·7; warmest day 9th, mean 56°·9. Min. below 42° on 13 days; max. above 62° on 5 (8th to 10th, 26th, and 31st).

JUNE.—Very warm, bright, with a very dry atmosphere of high pressure, and a very small rainfall. From 4th June to 3rd July (30 days) the only rain which fell was 0·01 in. on 6th, the smallest quantity measurable; there were thus 27 days with absolutely no rain. Coldest days 1st and 2nd, mean of each 51°·3; warmest day 19th, mean 68°·3. Min. below 52° on 22 days; max. above 62° on 27 (all but 1st, 2nd, and 3rd), above 72° on 14 (11th to 20th and 27th to 30th), above 82° on 1 (15th).

JULY.—Very warm and bright, with a very dry atmosphere of considerable pressure, and a very small rainfall. Coldest day 18th, mean 57°·3; warmest day 3rd, mean 72°·6. Min. below 52° on 8 days (above 60° on 9th, 12th, and 27th); max. above 62° every day, above 72° on 25 days, above 82° on 3 (2nd, 3rd, and 4th).

AUGUST.—Rather warm, very bright, with a very dry atmosphere of more than average pressure, and a very small rainfall. From 30th July to 12th Aug. (14 days), and again from 18th to 27th (10 days), no rain fell. Coldest day 20th, mean 54°·6; warmest day 6th, mean 68°·9. Min. below 52° on 20 days; max. above 62° every day, above 72° on 15 days, above 82° on 2 (6th and 8th).

SEPTEMBER.—Very cold, rather bright, with a dry atmosphere of rather low pressure, and a heavy rainfall. During the first seven days 2·11 ins. fell, being an average of 0·3 in. per day. Coldest day 29th, mean 44°·6; warmest day 6th, mean 60°·5. Min. below 42° on 5 days; max. above 62° on 11 (every day to 9th).

OCTOBER.—Very cold, rather dull, with a rather dry atmosphere of considerable pressure, and a small rainfall. A little snow fell on 11th and 12th. Coldest day 25th, mean 35°·4; warmest day 8th, mean 54°·1. Min. below 42° on 21 days (every day after 10th), below 32° on 5; max. above 52° on 14 (every day to 9th).

NOVEMBER.—Very cold, dull, with a very humid atmosphere of low pressure, and a heavy rainfall. Coldest day 17th, mean 26°·4; warmest day 4th, mean 48°·2. Min. below 32° on 9 days, below 22 on 2 (17th and 18th) (above 42° on 9th and 10th); max. above 52° on 4 (2nd, 4th, 5th, and 6th).

DECEMBER.—Rather cold, with an average amount of cloud, an atmosphere of average humidity and rather low pressure, and a small rainfall. Coldest day 27th, mean 28°·1; warmest day 9th, mean 44°·3. Min. below 32° on 15 days (above 40° on 2nd, 3rd, and 4th); max. above 42° on 16, above 52° on 1 (8th).

XXII.

METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, DURING THE YEAR 1888.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 26th April, 1889.

There has been no alteration in the meteorological observations in any respect from the previous year, and therefore the results for the year 1888 may at once be entered upon.

The accompanying tables (pp. 194, 195) give the monthly means, etc., and the following is the usual summary for the seasons, from Dec. 1887 to Nov. 1888.

Means for the Seasons from Dec. 1887 to Nov. 1888.

Seasons, 1887–88.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud, 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	30·032	35·8	9·9	·182	89	3·85	49	7·7
Spring	29·866	43·8	13·8	·277	79	6·54	48	7·1
Summer	29·903	57·8	15·3	·383	80	11·43	59	7·8
Autumn	30·019	49·0	13·3	·298	87	6·52	43	7·5

The next table gives the difference in each month and in the year between the chief results for 1888 at St. Albans and the mean of the same for ten years at Watford.

Difference in 1888 from Means of 1877-86 at Watford.

Months.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud, 0–10.
		Mean.	Daily Range.			Total.	Days.	
	in.	°	°	in.	%	ins.		
January	+·235	=	+1·0	—·002	+ 1	—1·58	— 2	—0·1
February	+·021	—5·6	—1·9	—·048	— 4	—1·29	— 2	+0·6
March	—·361	—4·5	—5·0	—·019	+ 8	+1·73	+11	+0·7
April	+·028	—3·2	—3·2	+·038	— 4	—0·47	+ 2	+1·2
May	+·113	—0·2	+0·4	+·069	+ 1	—1·17	— 7	+0·3
June	—·022	—1·7	—1·5	+·018	+ 8	+0·93	+ 2	+1·9
July	—·206	—3·8	—4·0	—·022	+ 8	+1·60	+11	+2·5
August	+·084	—2·6	—0·3	—·041	+ 1	+0·91	+ 3	—0·7
September	+·208	—0·7	—0·9	—·015	+ 1	—1·89	— 1	+1·2
October	+·154	—2·0	+2·8	—·042	— 2	—1·96	— 8	—0·4
November	—·115	+3·4	—3·9	+·042	+ 2	+1·68	+ 4	+2·4
December	+·032	+1·6	—0·1	+·019	+ 5	—1·16	— 3	—0·8
Year	+·015	—1·7	—1·4	=	+ 2	—2·67	+10	+0·7

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, IN 1888.

MONTHS.	PRESSURE OF THE ATMOSPHERE.	TEMPERATURE OF THE AIR. 9 a.m.	Means of Min.	Means of Max.	Mean.	Mean Daily Range.	Absolute Min.	Date.	Absolute Max.	Date.	Absolute Range.	HUMIDITY OF THE AIR. Dryness.	Tension of Vapour.	Relative Humidity.
	ins.	°	°	°	°	°	°		°		°	°	in.	%
January	30·264	36·0	31·7	42·1	36·6	10·4	22·8	30th	57·6	9th	34·8	2·5	·192	91
February	29·979	33·9	30·1	38·5	34·2	8·4	18·4	25th	49·8	6th	31·4	3·9	·167	85
March	·615	35·9	32·1	41·9	36·6	9·8	22·2	2nd	53·5	10th	31·3	2·5	·191	91
April	·904	42·7	36·4	49·6	42·9	13·2	27·2	6th	61·4	30th	34·2	8·6	·281	72
May	·30·078	51·9	42·6	61·1	51·9	18·5	33·5	11th	72·6	19th	39·1	8·5	·360	73
June	29·947	55·6	49·1	65·7	56·8	16·6	44·1	7th	82·2	25th	38·1	5·7	·385	81
July	·746	57·1	50·9	64·1	57·4	13·2	40·6	11th	69·4	19th	28·8	5·3	·385	82
August	30·015	58·3	50·5	66·5	58·4	16·0	42·6	19th	83·8	10th	41·2	7·0	·378	78
September.....	·179	55·0	48·4	63·8	55·7	15·4	38·1	30th	71·7	15th	33·6	4·7	·365	84
October	·082	44·7	38·1	54·4	45·7	16·3	28·2	23rd	66·7	27th	38·5	4·1	·253	85
November	29·797	45·3	41·4	49·5	45·4	8·1	32·9	28th	58·3	16th	25·4	2·4	·276	91
December ...	·998	38·0	34·3	44·3	38·9	10·0	23·9	18th	55·8	5th	31·9	1·2	·218	95
Year	29·967	46·2	40·5	53·5	46·7	13·0	18·4	Feb.	83·8	Aug.	65·4	4·7	·288	84

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THE GRANGE, ST. ALBANS, IN 1888—*(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount, 0-10.	No. of days of		Mean Force, 0-12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Over-cast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	1·01	·18	2nd	15	2	7·5	3	17	1·6	2	4	1	4	3	5	4	4	4
February	1·30	·36	13th	15	12	8·2	0	15	2·2	6	10	1	0	0	2	5	5	0
March	3·39	·43	22nd	23	8	7·0	2	18	2·4	5	4	1	2	2	6	4	6	1
April	1·91	·28	19th	17	1	7·7	3	16	2·2	6	7	1	0	1	7	5	2	1
May	1·24	·40	17th	8	0	6·7	3	11	2·1	2	8	1	3	4	5	5	2	1
June	3·79	2·40	26th	16	0	8·2	2	18	1·8	8	3	2	1	6	2	3	2	3
July	4·13	·46	2nd	26	0	9·0	0	24	1·7	4	2	1	1	7	7	3	5	1
August	3·53	1·01	1st	17	0	6·2	5	12	2·0	4	3	1	1	7	7	3	4	1
September	·72	·15	2nd	12	0	7·6	1	14	1·5	7	6	2	2	1	2	2	5	3
October	1·10	·34	29th	9	1	6·1	10	14	1·5	4	3	2	1	4	3	4	5	5
November	4·70	1·15	2nd	22	0	8·9	2	24	2·4	1	2	6	4	1	5	6	1	4
December	1·47	·30	24th	14	0	6·5	7	16	1·5	2	1	2	4	10	4	3	3	2
Year	28·29	2·40	June	194	24	7·4	38	199	1·9	51	53	21	23	46	55	47	44	26

The mean temperature of the year was very low, the mean daily range was small, and there was no very low minimum nor high maximum. With the exception of January, which had the average temperature of our period, every month up to November was cold, February and March being especially so. The last four months of 1887 being cold also, there were thus fourteen consecutive months with their mean temperature never above the average adopted for comparison and frequently much below it. November and December were warm. The mean pressure of the atmosphere was about the average; the lowest pressures recorded at 9 a.m. were 28·885 ins. on 11th and 28·837 ins. on 28th March, and the highest pressure was 30·742 ins. on 10th Jan., giving a range of 1·905 in. The rainfall was below the average, but the days of rain were numerous. The air was rather moist and the sky was cloudy.

In the winter of 1887–88 (Dec. to Feb.) the mean pressure of the atmosphere was rather high, the mean temperature was low, and the rainfall was very small. In the spring (March to May) mean pressure was low and mean temperature very low (the daily range being small). In the summer (June to Aug.) mean pressure was rather low, mean temperature low, relative humidity great, and rainfall very heavy. In the autumn (Sept. to Nov.) mean pressure was high and rainfall small. Phenomena about the average are not here mentioned, as in 1887. The deviations from the mean of our period are as follows:—

Difference in 1887–88 from Means of 1877–86 at Watford.

Seasons, 1887–88.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	in.	°	°	in.	%	ins.		
Winter	+·048	—2·1	—0·1	—·021	— 1	—3·96	— 2	+0·3
Spring	—·073	—2·7	—2·6	+·029	+ 2	+0·09	+ 6	+0·5
Summer.....	—·048	—2·4	—1·9	—·011	+ 5	+3·42	+16	+1·2
Autumn.....	+·082	+0·1	—0·6	—·005	+ 1	—2·17	— 5	+1·0

Notes on the Months.

January.—Of average temperature and cloudiness, with an atmosphere of average humidity and very considerable pressure, and a small rainfall with very little snow. During the first half of the month there was much fog; for the 6 days 9th to 14th prevailing without intermission. Coldest day 30th, mean 27°·5; warmest day 8th, mean 48°·1. Min. below 32° on 17 days (above 40° on 8th and 9th); max. above 42° on 17 days, above 52° on 2 (8th and 9th).

February.—Very cold ($2\frac{1}{2}$° colder than January) and dull, with a rather dry atmosphere of average pressure, and a small amount of rain almost entirely falling as snow. Coldest day 2nd, mean 29°·5; warmest day 6th, mean 45°·8. Min. below 32° on 21 days, below 22° on 3 (2nd, 25th, and 26th); max. above 42° on 8 (3rd to 10th) (below 32° on 22nd, 23rd, 24th, 26th, 28th, and 29th).

March.—Very cold (=January), rather cloudy, with a very humid atmosphere of very low pressure, and a heavy rainfall, about one-third in the form of snow. From 7th to 29th the only days without rain (or snow) were 18th and 20th. Coldest day 1st, mean 25°·5; warmest day 9th, mean 48°·8. Min. below 32° on 19 days; max. above 52° on 1 (10th).

April.—Very cold and dull, with a dry atmosphere of average pressure, and a rather small rainfall. Coldest day 3rd, mean 35°·4; warmest day 30th, mean 50°·9. Min. below 42° on 24 days, below 32° on 9; max. above 52° on 8.

May.—Of average temperature and cloudiness, with an atmosphere of average humidity and considerable pressure, and a small rainfall. From 4th to 15th (12 days), and again from 19th to 27th (9 days), no rain fell. Coldest day 2nd, mean 45°·7; warmest day 19th, mean 65°·3. Min. below 42° on 18 days; max. above 62° on 14, above 72° on 1 (19th).

June.—Rather cold, very dull, with an exceptionally humid atmosphere of average pressure, and a heavy rainfall, due to a thunderstorm on the 26th. The storm was severe between 7·10 and 11·0 p.m., and at its height between 7·15 and 7·45. From 7 p.m. to 4 a.m. the following morning (27th) 2·40 ins. of rain fell, being at the rate of nearly 0·27 in. per hour for nine hours. Coldest day 19th, mean 48°·0; warmest day 25th, mean 70°·8. Min. below 52° on 21 days; max. above 62° on 22, above 72° on 6, above 82° on 1 (25th).

July.—Very cold and very dull, with a very humid atmosphere of low pressure, and an excessive rainfall. From 5th June to 6th August (63 days) rain fell on 47 days, or on all but 16, and of these only 5 were in July. Coldest day 11th, mean 46°·8; warmest day 22nd, mean 62°·5. Min. below 52° on 14 days, below 42° on 1 (11th); max. above 62° on 22 days, never so high as 70°. The month is remarkable for the almost continuous rainfall and the very low mean and extreme maximum temperature. Thunderstorms were of frequent occurrence.

August.—Rather cold, very bright, with a humid atmosphere of rather high pressure, and a heavy rainfall. On 1st 1·01 in. fell, and on 28th 0·80 in., making more than half the total amount in the month. From 7th to 19th (13 days) only 0·01 in. fell (on 12th). Coldest day 1st, mean 51°·8; warmest day 10th, mean 72°·1. Min. below 52° on 18 days; max. above 62° on 25, above 72° on 5, above 82° on 1 (10th).

September.—Rather cold, cloudy, with an atmosphere of average humidity and considerable pressure, and a very small rainfall. From 20th August to 9th September (21 days) rain fell every day but two (31st Aug. and 1st Sept.). A dry period followed, no rain falling for the 14 days, 10th to 23rd Sept. Coldest day 30th, mean 48°·1; warmest day 14th, mean 57°·5. Min. below 42° on 4 days (1st, 12th, 13th, and 30th); max. above 62° on 20.

October.—Rather cold, very bright, with a rather dry atmosphere of rather high pressure, and a very small rainfall. From 5th to 23rd (19 days) no rain fell. On 2nd there was a slight fall of snow. Coldest day 24th, mean 38°·3; warmest day 27th, mean 60°·9. Min. below 42° on 23 days (all before 26th), below 32° on 3 (3rd, 5th, and 8th); max. above 52° on 20, above 62° on 2 (27th and 28th).

November.—Very warm and cloudy, with a humid atmosphere of rather low pressure, and an excessively heavy rainfall. On 1st 0·69 in. fell, on 2nd 1·15 in., and on 25th 0·70 in., making more than half the total amount in the month. From 8th to 19th (12 days) rain fell every day. There were dense fogs on several days, mostly during the first half of the month. Coldest day 28th, mean 37°·0; warmest day 16th, mean 54°·8. Min. never below 32° (above 42° on 16 days); max. above 52° on 11 days.

December.—Very mild, rather bright, with a rather humid atmosphere of average pressure, and a small rainfall. No rain fell from 9th to 17th (9 days), but there was a considerable deposition of moisture from fogs, which prevailed for most of this time. Coldest day 15th, mean 29°·9; warmest day 5th, mean 52°·2. Min. below 32° on 13 days (above 42° on 3rd and 6th); max. above 42° on 19, above 52° on 4 (2nd, 4th, 5th, and 6th).

XXIII.

NOTES ON THE CHALK ROCK.

By John Morison, M.D., F.G.S.

Read at Watford, 12th April, 1889.

The Chalk Rock is one of three hard beds which occur in the Chalk of this district. These beds are, from below upwards, the Totternhoe Stone, the Melbourne Rock, and the Chalk Rock. The Chalk Rock lies at the top of the Middle Chalk or Turonian Series, in the zone of *Holaster planus*. It is a band of somewhat cream-coloured limestone rather rubbly in character, jointed at right angles to the plane of bedding, and breaking with an even or sometimes slightly conchoidal fracture. It readily weathers and breaks down on exposure to the air. The upper surface is well defined, but the lower border shades off gradually into the soft chalk beneath. It contains numerous grains of glauconite and also a number of irregularly-shaped nodules slightly phosphatic in composition and coloured green on the outside by a coating of glauconite. Whether these nodules are of a coprolitic nature I cannot undertake to say. There are also found in the Chalk Rock many curious somewhat cylindrical branching cavities, which may be empty, or filled by a ferruginous sandy clay, or may contain nodules of iron-pyrites. These cavities Mr. Whitaker considers were originally occupied by tubular sponges.

The Chalk Rock varies in thickness from a few inches to 10 or even 20 feet. In the section at Boxmoor* it is 18 inches thick. In some places we can trace two rocky bands, one a few feet above the other, as in the section on the Midland Railway between Luton and Chiltern Green stations, while in the sections near Baldock three such beds may sometimes be seen, but the upper bands are always comparatively thin and much less defined. It is the lower or principal band which contains the green-coated nodules and the Gasteropoda and other characteristic fossils; but it is the upper band which is considered to form the top of the Middle Chalk.

Where there is more than one rocky band we find between the two layers from 7 to 15 feet of rubbly chalk consisting of hard yellowish lumps in a matrix of soft whitish marly chalk. Fossils are here abundant, especially *Micraster cor-testudinarium*, *M. breviporus*, *Ananchytes ovatus*, and *Rhynchonella plicatilis*. Mr. Whitaker calls this bed, from the abundance of Micrasters, "the Micraster Bed."

I have not seen any flints in the Chalk Rock. It is important to mention, however, that on one occasion I found a pebble of quartzite in it.

It is the Chalk Rock which, resisting denudation more than the softer chalk, protects the slope of the Chalk escarpment to the north of our county, and is mainly instrumental in forming the outline of the Chiltern Hills.

* It is here that the Chalk Rock was first observed, by Dr. John Evans, who pointed it out to Mr. Whitaker by whom the name was afterwards given.—Ed.

Unweathered Chalk Rock soils the fingers very slightly, and if looked at through a good lens is seen to contain a number of small crystals. Indeed I think the hardness of the rock is mainly due to the development in it of crystals of calcium carbonate, to the conversion in fact of the original soft chalk into something like crystalline limestone. Sometimes crystallisation proceeds a stage further, and we have large crystals of calcite formed. This is well seen in a small pit on the top of the Dunstable Downs.

The Chalk Rock differs very markedly in chemical composition from soft chalk. I here give two analyses of the Chalk Rock of Boxmoor which I owe to the kindness of Mr. Whitaker.

Analysis by C. W. Meanwell, from 'London Geological Field Club: Excursions during 1888,' p. 19 (1889):—

Silicates of iron and of alumina	·97
Phosphoric acid	·61
Oxides of lime, iron, and of manganese	1·11
Carbonate of lime	96·77
Loss on ignition, other than carbonic acid	·11
Sulphuric acid	trace
	99·57

Another analysis, by P. G. Sanford, from the same work. Specimen dried at 100° C:—

Insoluble residue, sand, silica, etc.	1·003
Soluble silica	·128
Lime	54·900
Magnesia	·374
Iron and alumina ($Fe_2O_3+Al_2O_3$)	·347
Sulphuric acid	·465
Phosphoric acid	·713
Carbonic acid	42 101
	100·031

Total calcium carbonate	97·001
,, magnesium ,,	·785

It therefore contains nearly twice as much magnesium carbonate, nearly twice as much silica, and more than three times as much sulphuric acid (in the form mainly of sulphate of magnesium and sulphate of calcium) as ordinary chalk does. The most marked peculiarity is, however, the relatively very large amount (viz. 0·6 to 0·7 per cent.) of phosphoric acid in the form of phosphates which it contains, only a mere trace being found in chalk of the ordinary type. No doubt the peculiarity of its chemical composition has much to do with the hardness as well as with the yellowish tinge of the rock.

The Chalk Rock comes to the surface in various parts of Hertfordshire; we notice it in the valley of the Lea near Harpenden; at various points in the neighbourhood of Baldock; near Markyate Street, Berkhamsted, and Boxmoor, etc. At Boxmoor it is well seen in the large chalk-pit close to the railway-station. But by far the best section in this neighbourhood, and perhaps in this country, occurs in a cutting on the Midland Railway between

Luton and Chiltern Green stations, just outside our county. From this section most of the fossils in my collection have been obtained. The section is about a quarter of a mile long, and the thickness of the principal band of Chalk Rock is between three and four feet. In places we can distinctly trace a second much thinner band of the rock a few feet above the other. The section is very much faulted, there being three large faults besides many smaller ones. The down-throw in one case is from ten to twelve feet.

The Fauna of the Chalk Rock is of a peculiar character; the most noteworthy peculiarity being the number and variety of the Gasteropoda. The Sponges also are very numerous and varied.

Opinions differ very much as to the depth of the sea in which our Chalk was laid down. Mr. Jukes-Browne believes that the soft white chalk was the deposit of a fairly-deep sea, as he calls it, some 500 or 600 fathoms in depth; analogous, in fact, to the globigerina-ooze now forming at the bottom of the Atlantic. But we know that the Chalk differs from the modern ooze in some very important respects. It consists not only of the remains of Foraminifera, but in great part of fragments of the shells of Mollusca, Echinodermata, and other marine organisms, and also contains those shells entire. The Chalk also contains a much smaller amount of silica in proportion to the calcium-carbonate than does the modern ooze. Dr. A. Geikie thinks that though the Chalk was accumulated in a sea tolerably free from land-derived sediment, the evidence shows that the depth of the water in which it was deposited did not at all approach that of the abysses in which the globigerina ooze is being laid down at the present day; and that the organic remains found in the Chalk present rather the character of a comparatively shallow-water fauna. But at any rate there can be no doubt that the Chalk Rock must have been laid down in a comparatively shallow sea; shallow at least as compared with the much deeper water in which the greater part of the chalk was deposited. The great abundance of Gasteropoda would seem to show this, for they are not specially abundant in other parts of the Chalk, and we know that they usually inhabit a shallow sea at no great distance from land.

Appended is a list of the fossils in my collection from the Chalk Rock in the cutting on the Midland Railway between Luton and Chiltern Green, which have been determined for me by Mr. E. T. Newton and Mr. Sharman.

List of Fossils.

Spongida.

Ventriculites impressus
,, radiatus
,, mammillaris
,, muricatus
,, alcyonoides?
,, (4 undetermined sps.)
Camerospongia campanulata
,, (2 undetermined sps.)
Cephalites perforata
,, (2 undetermined sps.)
Coscinopora infundibuliformis
Plocoscyphia convoluta
,, (4 undetermined sps.)
Polyjerea, sp.
Guettardia deltata
,, stellata?
Placotrema cretaceum
and 14 undetermined sponges.

ACTINOZOA.

Parasmilia centralis ?
,, sp.

ECHINODERMATA.

Micraster breviporus
,, cor-anguinum
,, cor-testitudinarium
,, cor-bovis, var.
Holaster planus
,, trecensis
,, sp. nov.
Cyphosoma radiatum
Cidaris, sp ?
Ananchytes ovatus

ANNELIDA.

Serpula plexus

CIRRIPEDIA.

Balanus, sp.

POLYZOA.

An undetermined form.

BRACHIOPODA.

Rhynchonella Cuvieri
,, Mantelli
,, plicatilis
,, sp.
Terebratula biplicata
,, carnea
,, semiglobosa

LAMELLIBRANCHIATA.

Ostrea normaniana ?
Lima spinosa
,, Hoperi
,, sp.
Inoceramus latus
,, mytiloides
,, Brongniarti
,, (4 undetermined sps.)
Mytilus, sp ?
Arca galliennia
,, sp.
Cardita tenuicosta ?
,, sp.
Cypricardia trapezoidalis

GASTEROPODA.

Trochus Marcaisi
,, (2 undetermined sps.)
Turbo, sp.
Avellana, sp.
Rostellaria (2 undetermined sps.)
Turritella, sp.
Pleurotomaria perspectiva
,, (3 undetermined sps.)

CEPHALOPODA.

Nautilus lævigatus ?
Ammonites prosperianus
,, varians ?
Scaphites Geinitzii
,, æqualis
Baculites, sp.
Helicoceras (2 undetermined sps.)
Ancyloceras, sp.
Heteroceras, sp.
Turrilites senequieriamus ?

PISCES.

Otodus, sp. (tooth)
Corax falcatus (tooth)
Ptychodus mammillaris (tooth)
,, (tooth)
Fish-scale.


MAP OF
HERTFORDSHIRE
showing its
Climatological Stations
English Miles.
0 2 4 6 8 10 12
Natural Scale 1·506880.
CAMBRIDGESHIRE
BEDFORDSHIRE
BUCKINGHAMSHIRE
MIDDLESEX
ESSEX
ROYSTON
BENNINGTON
ST ALBANS
BERKHAMSTED
NEW BARNET
R. Ivel
R. Rhee
R. Hiz
R. Beane
R. Rib
R. Quin
R. Stort
R. Ash
R. Lea
R. Mimram
R. Ver
R. Colne
R. Gade and Canal
R. Chess
R. Brent
R. Thame
R. Bulbourne and Canal
Canal
New River
Lea and Stort Navigation
52° 5'
52°
55'
50'
45'
40'
35'
40'
30'
20'
10'
0°
10'
J. Hopkinson, del. 1889.
E. Weller, lith.

XXIV.

CLIMATOLOGICAL OBSERVATIONS TAKEN IN HERTFORDSHIRE IN 1887.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 12th April, 1889.

PLATE III.

For several years meteorological observations have been taken at Throcking by the Rev. C. W. Harvey, and at Watford by myself, and the results have been communicated to the Society and have appeared in our 'Transactions,' and also in the 'Meteorological Record' of the Royal Meteorological Society. At the close of the year 1886 both places had ceased to be meteorological stations of that Society, and although the observations which until then were made at Watford are continued at St. Albans, this seems to be a suitable time to commence a new departure by giving some of the principal results of observations taken at several places in the county, and the mean of those results.

There are, I believe, only five places in Hertfordshire where meteorological observations are made with verified instruments and with sufficient uniformity for the more important results to be strictly comparable with each other and with observations made in other parts of the kingdom. These are Royston, Berkhamsted, St. Albans, Bennington (near Stevenage), and New Barnet.

These meteorological stations are well situated for the purpose of obtaining a knowledge of the climate of Hertfordshire. Our principal river-basins are represented by them, the Cam by Royston, the Colne by Berkhamsted and St. Albans, and the Lea by Bennington and New Barnet. Their geological distribution is representative of the chief geological features of the county, Royston being on the bare or almost bare Middle Chalk; Berkhamsted, St. Albans, and Bennington being on the Upper Chalk covered more or less by glacial or other superficial deposits of gravel, sand, or clay, which is the prevailing geological structure of by far the greater part of Hertfordshire; and New Barnet being on the London Clay. They represent every part of the county but the extreme east, Royston being in the north, Berkhamsted in the west, New Barnet in the south, and St. Albans and Bennington fairly central, the one towards the south-west and the other towards the north-east. And lastly, their height above the sea, from about 200 to 400 feet, is about the average height of the surface of our county; we have but a very small area below 100 or above 500 feet.

Royston and New Barnet are stations from which returns are communicated to Mr. James Glaisher, F.R.S., for his "Meteorology of England" appended to the 'Quarterly Reports of the Registrar-General' and to the Royal Meteorological Society's 'Meteorological Record.' At these stations, and also at St. Albans, the observations are made at 9 a.m., the minimum temperature is entered to the day of observation, and the maximum temperature and rainfall are entered to the previous day. Berkhamsted and Bennington are stations of the Royal Meteorological Society ranking as "Second-Order Stations" in the classification of the Government Meteorological Office. At these the observations are made at 9 a.m. and 9 p.m.; the maximum and minimum temperatures are read at 9 p.m. and entered to the same day, but all the other observations utilised for the present report are made at 9 a.m., the rainfall being entered to the previous day. This, however, is *the invariable rule* to be carried out at all meteorological and (solely) rainfall stations. The results for Berkhamsted and Bennington are published in the 'Meteorological Record.'

In addition to the "Second-Order Stations" the Royal Meteorological Society a few years ago instituted a number of stations called "Climatological Stations" at which fewer observations are taken, and at 9 a.m. only. The returns for these, also, are published in the Society's 'Meteorological Record.' All the observations required for such stations, and more, are made at our five selected stations, and they are made in strict conformity with the rules of the Society. The other observations are of the height of the barometer, direction and force of the wind, general character of the weather, etc., but I have thought it advisable to restrict this report to the results of such observations as are considered by the Royal Meteorological Society to be of climatological value.

In the 'Flora of Hertfordshire' published by our Society I have given, in the Introduction, the mean temperature and rainfall of each month, each season, and the year, at some of these and at some other places in the county, for various periods terminating, with two exceptions, with the year 1886. The annual means there given may be re-stated here, but for the seasonal and monthly means the 'Flora' must be referred to.

The mean annual rainfall at five stations for the 27 years 1860 to 1886 is as follows:—At Royston, 23·76 ins.; at Hitchin, 25·18 ins.; at Rothamsted, Harpenden, 29·01 ins.; at Nash Mills, Hemel Hempstead, 28·24 ins.; and at Bayfordbury, Hertford, 25·96 ins.; giving a mean for the county of 26·43 ins., or nearly 26½ inches. The mean annual temperature at six stations for various periods ranges between 47°·2 and 48°·4, thus:—At Royston for the 27 years 1860 to 1886, 48°·4; at Hitchin for the 30 years 1849 (Oct.) to 1879 (Sept.), 47°·2; at Berkhamsted (High Street) for the 6 years 1860 to 1865, 47°·9; at Watford (Wansford House) for the 9 years 1878 to 1886, 48°·4; at Throcking Rectory, near Buntingford, for the 7 years 1880 to 1886, 47°·2; and at New Barnet for the 6 years 1881 (incomplete at commencement of year) to 1886, 47°·7; giving a mean for the county of 47°·8.

It will be seen that we have in the present report a continuation of observations at Royston and New Barnet, and also at Berkhamsted, though at a new meteorological station there. The rainfall at St. Albans may be compared with that at Rothamsted, distant four miles, and the temperature with that at Watford, distant seven miles; and the temperature at Bennington may be compared with that at Throcking, distant five miles.

In the 'Flora' results are also given of climatological observations (temperature, humidity, rainfall, and cloud) at Royston, Watford, and New Barnet, and also, for comparison, at Greenwich, for the 5 years 1882 to 1886, the longest period during which the required observations have been made at all these places, Barnet having the shortest complete record and consequently giving the limit. The table in the 'Flora' does not give the mean minimum and maximum temperatures, and the mean temperature given is not the simple mean of the minimum and maximum readings, the mean in Mr. Glaisher's tables from which the results for Royston and Barnet were taken being corrected (reduced to mean values) for diurnal range of temperature.* I therefore here substitute for this table one giving data with which the results in the present report are strictly comparable, the mean temperature being the mean of the min. and max. readings. It will be noticed that the mean temperature for these five years is one degree higher than that deduced above for a longer period, and that the mean rainfall is two-tenths of an inch less. It is perhaps scarcely necessary to state that the temperature throughout, being that of the air, is the temperature in the shade.

Results of Climatological Observations, 1882–86.

Stations	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Royston	49·1	41·2	57·0	15·8	7·7	92·2	84	6·2	24·56	154
Watford	48·9	41·6	56·2	14·6	13·7	90·0	82	6·8	28·82	181
Barnet	48·4	39·5	57·2	17·7	7·0	90·8	83	6·5	25·32	150
Mean	48·8	40·8	56·8	16·0	9·5	91·0	83	6·5	26·23	162

From the last of the following tables it will be seen that the mean temperature of Hertfordshire in 1887, as far as can be determined from observations at our five meteorological stations, was 1°·8 lower than the mean of our period of five years, 1882–86, that the mean daily range of temperature was 0°·2 greater, the relative humidity 2 per cent. less, the amount of cloud the same, and the rainfall 7·16 ins. less on 11 fewer days.

The year 1887 therefore appears to have been cold, and dry, not only having a small rainfall and a small number of rainy days, but also a comparatively dry atmosphere.

* For the reports for my own meteorological station I have deduced the mean temperature from the minimum, maximum, and 9 a.m. readings. The mean at 9 a.m. for the 5 years 1882–86 being 48°·9, exactly the same as the mean of the min. and max., the exclusion of the 9 a.m. values in computing the present table makes no difference in the result, the mean temperature for Watford here stated thus being the same as that given in the 'Flora.'

BERKHAMSTED.

(Rose Bank.)

Latitude: 51° 45′ 40″ N. Longitude: 0° 33′ 30″ W. Altitude: 400 feet.

Observer: *Edward Mawley, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	33·5	27·8	39·1	11·3	11·2	50·2	93	8·4	2·72	16
Feb.	37·8	31·1	44·5	13·4	17·9	52·4	89	6·6	·80	8
March	37·8	30·6	45·1	14·5	19·3	56·6	82	7·1	1·87	15
April	43·1	34·0	52·2	18·2	23·3	63·5	76	6·6	1·34	11
May	48·7	40·9	56·4	15·5	32·6	67·1	78	7·7	2·36	23
June	58·9	48·2	69·7	21·5	39·5	82·0	70	5·5	·88	4
July	63·5	51·8	75·1	23·3	40·1	84·9	63	4·5	·75	10
August	60·4	49·0	71·8	22·8	37·8	85·0	65	5·1	·89	7
Sept.	53·2	45·9	60·6	14·7	33·1	66·9	79	7·0	2·60	17
Oct.	44·4	36·9	51·9	15·0	23·2	60·2	84	7·0	1·77	12
Nov.	39·7	34·7	44·7	10·0	16·8	53·4	91	7·8	3·24	18
Dec.	36·8	32·1	41·4	9·3	22·7	52·9	90	7·4	1·77	18
Year	46·5	38·6	54·4	15·8	11·2	85·0	80	6·7	20·99	159

ST. ALBANS.

(The Grange.)

Latitude: 51° 45′ 9″ N. Longitude: 0° 20′ 7″ W. Altitude: 380 feet.

Observer: *John Hopkinson, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·3	29·0	39·6	10·6	13·7	48·8	89	8·0	1·88	16
Feb.	38·3	31·8	44·8	13·0	20·8	54·2	90	6·2	·64	8
March	38·3	31·5	45·1	13·6	21·9	55·6	88	7·4	1·70	12
April	43·0	34·7	51·4	16·7	26·3	62·0	80	5·6	1·22	12
May	49·9	42·1	57·6	15·5	34·0	66·7	79	8·0	2·12	22
June	60·5	49·8	71·2	21·4	42·4	82·2	69	5·7	·65	4
July	64·9	54·0	75·8	21·8	44·8	86·0	63	4·6	·88	11
August	61·4	51·3	71·4	20·1	43·2	84·7	67	4·5	1·07	7
Sept.	53·8	46·8	60·9	14·1	35·3	67·3	79	5·8	3·12	18
Oct.	44·7	38·3	51·1	12·8	25·9	59·7	84	7·0	1·62	13
Nov.	39·8	34·7	44·8	10·1	18·6	54·6	92	7·1	3·40	20
Dec.	37·0	31·6	42·4	10·8	23·9	52·6	90	7·5	1·54	19
Year	47·2	39·6	54·7	15·1	13·7	86·0	81	6·5	19·84	162

BENNINGTON.
(Bennington Lodge.)

Latitude: 51° 53′ 45″ N. Longitude: 0° 5′ 20″ W. Altitude: 407 feet.

Observer: *Rev. J. D. Parker, LL.D., F.R.Met. Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·2	29·7	38·7	9·0	17·2	50·8	92	8·7	1·52	18
Feb.	38·2	31·9	44·4	12·5	22·2	54·4	89	7·0	·77	8
March	37·7	30·6	44·8	14·2	21·1	56·0	85	7·5	1·36	13
April	43·2	34·5	52·0	17·5	27·2	63·6	78	7·4	1·03	11
May	48·8	41·3	56·2	14·9	33·0	69·6	82	8·6	2·69	20
June	58·9	48·7	69·1	20·4	41·6	82·6	74	6·0	·77	3
July	64·5	53·3	75·8	22·5	40·9	85·1	70	4·7	·78	8
August	61·5	50·9	72·0	21·1	42·8	85·1	64	6·9	1·16	11
Sept.	53·0	46·1	60·0	13·9	36·5	66·6	79	8·4	3·05	21
Oct.	44·5	38·0	51·0	13·0	26·0	59·5	84	7·4	1·65	11
Nov.	39·3	34·5	44·0	9·5	19·1	53·6	92	8·2	2·86	20
Dec.	36·1	31·9	40·4	8·5	23·4	53·5	89	7·7	1·22	18
Year	46·7	39·3	54·0	14·7	17·2	85·1	82	7·4	18·86	162

NEW BARNET.
(Gas Works.)

Latitude: 51° 39′ 5″ N. Longitude: 0° 10′ 15″ W. Altitude: 212 feet.

Observer: *T. H. Martin, C.E.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	33·6	27·5	39·8	12·3	8·0	53·0	92	7·6	1·57	10
Feb.	37·8	29·7	45·8	16·1	13·0	55·0	89	5·9	·57	6
March	37·3	28·1	46·5	18·4	17·0	58·0	86	5·7	1·36	8
April	43·4	32·4	54·5	22·1	17·8	66·0	76	5·7	1·22	10
May	49·4	40·3	58·5	18·2	29·5	70·5	80	6·9	1·63	17
June	59·5	46·5	72·4	25·9	34·0	84·5	73	4·5	·75	3
July	64·6	50·8	78·5	27·7	38·0	88·5	63	3·4	1·05	11
August	60·3	46·9	73·7	26·8	35·0	86·0	68	4·6	1·57	7
Sept.	53·5	44·4	62·5	18·1	28·9	69·8	82	6·2	2·51	15
Oct.	45·0	36·4	53·7	17·3	20·0	62·2	82	5·7	·94	6
Nov.	39·9	33·9	45·9	12·0	17·7	62·5	87	7·3	3·50	20
Dec.	36·2	30·9	41·5	10·6	20·3	59·0	88	6·4	1·17	12
Year	46·7	37·3	56·1	18·8	8·0	88·5	81	5·8	17·84	125

ROYSTON.

(London Road.)

Latitude : 52° 2′ 34″ N. Longitude : 0° 1′ 8″ W. Altitude : 301 feet.

Observer : *Hale Wortham, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·2	29·4	39·0	9·6	12·0	50·7	91	6·9	1·54	15
Feb.	38·6	32·2	45·0	12·8	20·2	53·6	87	5·8	·66	7
March	38·6	30·5	46·7	16·2	19·8	57·2	77	6·2	1·33	10
April	44·6	34·7	54·5	19·8	26·2	64·9	80	6·2	1·17	12
May	49·8	41·2	58·5	17·3	29·4	71·0	87	7·2	2·41	19
June	62·7	50·6	74·7	24·1	39·0	86·1	78	5·0	·42	3
July	66·2	53·0	79·5	26·5	42·0	89·4	70	4·3	·62	8
August	62·6	50·8	74·4	23·6	42·9	89·1	67	5·1	1·14	9
Sept.	54·3	46·1	62·4	16·3	32·3	70·0	79	6·4	2·48	19
Oct.	44·9	38·2	51·7	13·5	27·3	59·7	82	5·9	1·92	13
Nov.	39·8	34·8	44·7	9·9	23·9	53·9	88	6·3	2·91	16
Dec.	36·2	31·2	41·3	10·1	21·0	52·0	90	7·1	1·23	18
Year	47·7	39·4	56·0	16·6	12·0	89·4	81	6·0	17·83	149

HERTFORDSHIRE.

Means of Climatological Observations (with extremes of temperature) in 1887, at Royston, Berkhamsted, St. Albans, Bennington, and New Barnet.

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	34·0	28·7	39·3	10·6	8·0	53·0	91	7·9	1·85	15
Feb.	38·1	31·3	44·9	13·6	13·0	55·0	89	6·3	·69	7
March	38·0	30·3	45·7	15·4	17·0	58·0	84	6·8	1·52	12
April	43·5	34·1	52·9	18·8	17·8	66·0	78	6·3	1·20	11
May	49·3	41·2	57·5	16·3	29·4	71·0	81	7·7	2·24	20
June	60·1	48·8	71·4	22·6	34·0	86·1	73	5·3	·69	3
July	64·8	52·6	77·0	24·4	38·0	89·4	66	4·3	·82	10
August	61·2	49·8	72·7	22·9	35·0	89·1	66	5·2	1·16	8
Sept.	53·6	45·9	61·3	15·4	28·9	70·0	80	6·8	2·75	18
Oct.	44·7	37·6	51·9	14·3	20·0	62·2	83	6·6	1·58	11
Nov.	39·7	34·5	44·8	10·3	17·7	62·5	90	7·3	3·18	19
Dec.	36·5	31·6	41·4	9·8	20·3	59·0	89	7·2	1·39	17
Year	47·0	38·9	55·1	16·2	8·0	89·4	81	6·5	19·07	151

XXV.

CLIMATOLOGICAL OBSERVATIONS TAKEN IN HERTFORDSHIRE IN 1888.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 26th April, 1889.

At all the meteorological stations from which the report for the year 1887 was drawn up, observations have been continued in 1888, and therefore I have only to give similar tables to those for that year, and to make a few brief remarks on the general result.

The mean temperature of Hertfordshire in 1888, as deduced from observations at our five stations, was exactly the same as in the previous year, and therefore again 1°·8 below the mean of our period, 1882–86. The mean daily range of temperature was 2°·0 less than in 1887, the mean min. being 1°·0 higher and the mean max. 1°·0 lower. The extremes of temperature were much less, and the relative humidity, amount of cloud, rainfall, and number of days of rain, much greater than in 1887. Although the rainfall was 1·29 in. less than the mean rainfall of our period, there were 22 more days of rain, which doubtless partly accounts for the small range of temperature, the great humidity, and the cloudy sky.

The general character of the weather in 1888 appears therefore to have been cold, damp, and gloomy, and although there was not a heavy rainfall, there were comparatively few fine days, rain falling on more than half the number of days in the year.

ROYSTON.

(London Road.)

Latitude: 52° 2′ 34″ N. Longitude: 0° 1′ 8″ W. Altitude: 301 feet.

Observer: *Hale Wortham, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·9	32·3	41·6	9·3	21·9	54·0	88	6·5	·66	11
Feb.	34·9	30·1	39·6	9·5	17·2	50·0	89	8·3	1·25	12
March	38·4	32·1	44·7	12·6	22·1	56·1	86	6·9	2·58	19
April	43·5	35·5	51·5	16·0	23·5	64·3	85	7·0	2·02	14
May	53·1	42·2	64·0	21·8	30·1	75·7	76	5·1	·97	5
June	58·9	48·4	69·4	21·0	42·6	86·4	82	7·6	1·52	17
July	59·3	50·7	67·9	17·2	41·9	72·8	88	7·9	3·49	19
August	60·0	50·2	69·8	19·6	39·1	86·5	86	6·0	2·50	12
Sept.	56·3	48·2	64·5	16·3	40·3	69·0	87	6·0	1·44	12
Oct.	46·3	38·0	54·6	16·6	28·3	67·1	85	4·6	·76	8
Nov.	46·6	42·3	50·8	8·5	33·2	59·3	91	7·8	3·29	18
Dec.	39·8	34·9	44·7	9·8	21·7	57·4	87	6·2	1·14	12
Year	47·8	40·4	55·2	14·8	17·2	86·5	86	6·7	21·62	159

BERKHAMSTED.

(Rose Bank.)

Latitude: 51° 45′ 40″ N. Longitude: 0° 33′ 30″ W. Altitude: 400 feet.

Observer: *Edward Mawley, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·9	32·1	41·6	9·5	19·4	56·8	94	7·9	·80	10
Feb.	34·0	29·6	38·4	8·8	16·9	52·1	88	8·0	1·59	14
March	37·2	31·7	42·8	11·1	20·4	54·3	87	8·0	3·25	24
April	42·5	35·4	49·6	14·2	22·7	61·0	83	8·2	2·43	18
May	51·0	41·4	60·6	19·2	30·4	72·8	69	6·4	1·25	7
June	56·8	48·3	65·3	17·0	41·7	84·3	77	8·7	2·21	16
July	56·9	50·2	63·6	13·4	39·3	71·8	81	8·9	4·28	26
August	57·8	49·7	65·8	16·1	40·5	81·5	78	7·0	2·01	16
Sept.	55·4	47·1	63·8	16·7	34·1	73·0	85	7·4	·92	15
Oct.	45·5	35·8	55·2	19·4	23·3	65·5	86	6·6	1·15	9
Nov.	46·0	41·9	50·1	8·2	30·1	59·4	90	9·4	4·78	21
Dec.	39·2	34·2	44·2	10·0	23·1	57·1	96	7·7	1·69	17
Year	46·6	39·8	53·4	13·6	16·9	84·3	85	7·9	26·36	193

ST. ALBANS.

(The Grange.)

Latitude: 51° 45′ 9″ N. Longitude: 0° 20′ 7″ W. Altitude: 380 feet.

Observer: *John Hopkinson, F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·9	31·7	42·1	10·4	22·8	57·6	91	7·5	1·01	15
Feb.	34·3	30·1	38·5	8·4	18·4	49·8	85	8·2	1·30	15
March	37·0	32·1	41·9	9·8	22·2	53·5	91	7·0	3·39	23
April	43·0	36·4	49·6	13·2	27·2	61·4	72	7·7	1·91	17
May	51·8	42·6	61·1	18·5	33·5	72·6	73	6·7	1·24	8
June	57·4	49·1	65·7	16·6	44·1	82·2	81	8·2	3·79	16
July	57·5	50·9	64·1	13·2	40·6	69·4	82	9·0	4·13	26
August	58·5	50·5	66·5	16·0	42·6	83·8	78	6·2	3·53	17
Sept.	56·1	48·4	63·8	15·4	38·1	71·7	84	7·6	·72	12
Oct.	46·3	38·1	54·4	16·3	28·2	66·7	85	6·1	1·10	9
Nov.	45·5	41·4	49·5	8·1	32·9	58·3	91	8·9	4·70	22
Dec.	39·3	34·3	44·3	10·0	23·9	55·8	95	6·5	1·47	14
Year	47·0	40·5	53·5	13·0	18·4	83·8	84	7·4	28·29	194

BENNINGTON.

(Bennington Lodge.)

Latitude: 51° 53′ 45″ N. Longitude: 0° 5′ 20″ W. Altitude: 407 feet.

Observer: *Rev. J. D. Parker, LL.D., F.R.Met.Soc.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·5	31·7	41·2	9·5	21·7	59·3	91	7·9	·79	17
Feb.	33·4	29·5	37·4	7·9	17·2	49·7	85	9·3	1·05	15
March	36·7	31·5	41·9	10·4	22·5	54·6	87	9·0	2·83	22
April	42·4	35·6	49·1	13·5	26·9	62·5	81	8·7	2·14	17
May	50·7	41·7	59·8	18·1	33·9	72·8	69	7·4	1·05	6
June	56·8	48·3	65·2	16·9	42·5	82·8	77	9·4	1·82	17
July	56·8	50·0	63·7	13·7	40·6	69·8	80	9·4	4·20	27
August	57·8	49·8	65·7	15·9	41·7	82·0	78	8·0	3·03	18
Sept.	55·6	48·2	63·0	14·8	37·2	71·6	82	7·4	·99	17
Oct.	45·9	37·7	54·1	16·4	27·3	66·2	84	6·4	1·02	13
Nov.	45·8	41·6	50·0	8·4	33·5	59·1	90	9·1	3·96	23
Dec.	39·5	35·0	44·1	9·1	22·8	56·4	94	7·6	1·11	18
Year	46·5	40·1	52·9	12·8	17·2	82·8	83	8·3	23·99	210

NEW BARNET.

(Gas Works.)

Latitude: 51° 39′ 5″ N. Longitude: 0° 10′ 15″ W. Altitude: 212 feet.

Observer: *T. H. Martin, C.E.*

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·4	30·8	41·9	11·1	19·0	53·0	91	6·1	·77	13
Feb.	34·7	29·4	40·0	10·6	14·6	52·5	91	8·1	·92	9
March	37·8	31·5	44·2	12·7	19·8	57·5	86	7·4	2·53	17
April	42·9	33·9	51·9	18·0	21·0	65·2	86	7·3	2·14	21
May	51·3	39·4	63·1	23·7	27·5	74·9	75	5·4	1·26	6
June	57·5	47·4	67·7	20·3	40·0	84·0	79	6·5	2·17	16
July	58·2	49·9	66·5	16·6	40·0	74·9	90	7·7	3·68	21
August	58·6	48·4	68·8	20·4	37·0	85·0	79	6·2	3·72	14
Sept.	56·3	46·2	66·3	20·1	33·2	77·5	86	6·0	·87	12
Oct.	45·4	34·4	56·5	22·1	22·5	68·5	86	4·7	1·19	7
Nov.	45·9	40·9	50·8	9·9	29·2	59·2	86	7·9	3·79	17
Dec.	38·7	32·4	45·0	12·6	16·7	59·0	91	5·6	1·39	9
Year	47·0	38·7	55·2	16·5	14·6	85·0	86	6·6	24·43	162

HERTFORDSHIRE.

Means of Climatological Observations (with extremes of temperature) in 1888, at Royston, Berkhamsted, St. Albans, Bennington, and New Barnet.

Months	Temperature of the Air						Humidity	Cloud, 0–10	Rain	
	Means				Extremes				Am'nt	Days
	Mean	Min.	Max.	Range	Min.	Max.				
	°	°	°	°	°	°	%		ins.	
Jan.	36·7	31·7	41·7	10·0	19·0	59·3	91	7·2	·81	13
Feb.	34·3	29·8	38·8	9·0	14·6	52·5	88	8·4	1·22	13
March	37·4	31·8	43·1	11·3	19·8	57·5	87	7·7	2·92	21
April	42·9	35·4	50·4	15·0	21·0	65·2	81	7·8	2·13	17
May	51·6	41·5	61·7	20·2	27·5	75·7	72	6·2	1·15	7
June..........	57·5	48·3	66·7	18·4	40·0	86·4	79	8·1	2·30	16
July	57·7	50·3	65·1	14·8	39·3	74·9	84	8·6	3·96	24
August.....	58·5	49·7	67·3	17·6	37·0	86·5	80	6·7	2·96	16
Sept.	55·9	47·6	64·3	16·7	33·2	77·5	85	6·9	·99	14
Oct.	45·9	36·8	55·0	18·2	22·5	68·5	85	5·7	1·04	9
Nov.	45·9	41·6	50·2	8·6	29·2	59·4	90	8·6	4·10	20
Dec.	39·3	34·2	44·5	10·3	16·7	59·0	93	6·7	1·36	14
Year	47·0	39·9	54·1	14·2	14·6	86·5	85	7·4	24·94	184

XXVI.

THE STUDY OF THE INJURIES AND DISEASES OF PLANTS.

By Alfred T. Brett, M.D.

Read at Watford, 12th April, 1889.

I wish to direct attention to a study which has not hitherto been undertaken by our Society—that of the injuries and diseases of plants. I hope to be able to show that it is a legitimate subject of research,—interesting in its nature, always before us both in town and country, and likely to have many practical and useful results.

I should like for a moment to explain how my attention has been directed to it. One day our Society was going over Kew Gardens under the direction of the Rev. George Henslow, and I gave expression to the regret that in our county, and perhaps in Great Britain, we have found all the plants that we are likely to discover, this field of discovery being thus closed. He replied that it is quite true that systematic botany is nearly complete, at least in this country, and probably we shall not make many more discoveries; yet, he said, physiological botany (the life-history of plants) is a study quite in its infancy, and there is a great deal of work to do, and a great deal for botanists to learn.

In following up this idea, it occurred to me that if the healthy life of plants is only just beginning to be studied, the unhealthy or diseased life of plants might afford an interesting, useful, and practical subject for study. The very word 'disease' frightens some people, but it need not, especially when it is confined to the vegetable kingdom. Nature proceeds in her operations on certain definite lines, and usually produces uniform results. When nothing interferes with her laws, the result is normal or healthy life; but when she is interfered with, the result is abnormal or diseased life. Of course one is as much under law as the other. While some of us are studying the healthy life of plants, others may be studying the diseased life of plants. The study of one may throw light on the study of the other. Not only may vegetable pathology throw light on vegetable physiology, but even enlighten animal physiology and pathology. And as we derive much pleasure and profit from the vegetable kingdom, to study its diseases may be useful in order to prevent them.

Sir James Paget is one of the best pathologists in Europe. Lately in a lecture he said that when a young man he derived great benefit from the study of botany; among other things it made him accurate in observation and careful in classifying. In a lecture on the nature of cancer he did not think it beneath him to refer to some of the diseases of plants in order to elucidate and explain the nature of cancer. I therefore wrote to him and asked him to tell me the best books to read on the diseases of plants, and the best method of proceeding in studying the subject. He replied: "You would find, I think, a great charm in the study of the diseases of plants; but as to 'what to read,' it is difficult to tell. There are ten or twelve admirable books in German, and one or two in French, but not one, as far as I know, in English. You may find several short but good papers in the 'Gardeners' Chronicle,' and among them admirable ones, some 20 years ago, by Berkeley (the best that I have read in English),* and there are some in the later volumes of the 'Transactions of the Pathological Society,' and a good one by Mr. Roger Williams was read at the last meeting of the Society, and published in the 'Lancet' of the 2nd of February, 1889. But really, for an introduction to what may be studied on the 'Injuries and diseases of plants,' I do not know in English anything but Berkeley's papers, and an address of mine which was printed some years ago in the 'British Medical Journal.'"

My object at present is only to bring the subject before the notice of our Society, and to ascertain if we may rely on the help of our members and others, especially of gardeners and horticulturists, in furthering its study.

* I cannot find these papers, but in the 'Journal of the Royal Horticultural Society,' vols. i-ix (1846-1855), there is a series of admirable papers by the late Rev. M. J. Berkeley on various diseases of plants caused by fungi. There are also papers by him on the same subject in Hooker's 'Journal of Botany,' vol. i (1849), the 'Journal of the Linnean Society,' vol. i (1857), etc. A short but interesting and suggestive paper on "Moss Parasites" by Berkeley will be found in the 'Intellectual Observer,' vol. ii (1863), p. 8.—Ed.

XXVII.

NOTE ON THE REARING OF CUCKOOS AT CASSIOBURY, WATFORD.

By John Powell.

Read at Watford, 12th April, 1889.

(Communicated by Dr. A. T. Brett.)

About the middle of June, I found a young cuckoo in a wagtail's nest, in ivy growing on a wall close to the front door of Cassiobury House. I took it with the nest with the intention of rearing it. I fed it on raw beef and hard-boiled eggs till it could feed itself, which it began to do about a fortnight after I took it, and two days after that it died, but it had become so tame that I could carry it about on my finger without its attempting to fly away, and when I took it to its cage it would hop quietly from my finger on to its perch.

A few days after this I found another in a wagtail's nest in ivy, on a wall not more than twelve yards from the first and directly opposite to it. Both nests were not more than twelve feet from the ground, and were rather exposed. The cuckoo could easily have got into the nest to lay the eggs. This second bird I put into a cage, and I hung it where I took the nest from, thinking the wagtails would feed it, which they did about every five minutes for quite a week; but as the bird was growing I found the cage too small, and I put it into a larger one. The wagtails came to the new cage as often as before, for two days, when they ceased coming. I looked into the cage and found the cuckoo dead, and I found at the bottom of the cage small grasshoppers, moths, and small beetles. The wagtails could have fed it more easily in the new cage, for the wires were farther apart, so the cuckoo must have known it was a new cage, and refused to take its food. Why I think so is, I remember that Mr. Wise, who kept a cuckoo for three years,* told me when I remarked that the cage he had it in was too small, that he had put it several times into a larger one, but directly he did so the bird refused its food, and when he put it back into its old cage it began to eat ravenously.

About a week after this second bird died I found another in the kitchen garden, in a hole in a wall in a wagtail's nest, but the cuckoo could only have got into this nest with difficulty to have deposited its egg, for the hole was rather small and the nest was three or four inches below the entrance in the wall. This bird was put into a cage and hung near to where the nest was taken. The wagtails fed it for quite a fortnight, and during that time the bird seemed to flourish, but two or three days afterwards I discovered only one small bird feeding it, which was the male bird,

* For the "Biography" of this cuckoo, by the late Mr. J. E. Littleboy, see 'Trans. Herts Nat. Hist. Soc.,' Vol. IV, p. 223.—Ed.

and it did not seem to satisfy it, though it worked very hard. The reason of the female being absent I thought was that she must be building another nest. I brought the cuckoo into the house, as it seemed to mope, and it died a few hours afterwards.

About a week after this bird died, I found another in a pear tree on a wall not more than twenty yards from the place where I found the second, only about eight feet from the ground, and well exposed. It could have only been hatched a very short time, for it could not see. There were no traces of any other eggs having been in the nest, for I examined all about the nest and on the ground. This bird I put into a cage. When it was well fledged, which was about a fortnight from the time I found it, the wagtails fed it for nearly a month, when some one put a piece of bread in the cage, and the cuckoo began to peck at it. I left it a little longer and threw bread on the ground to see if the wagtails would feed it from the bread. This they did for several days, and then ceased coming. I therefore brought the bird away, and fed it on hard-boiled eggs, bread, and raw meat, but it did not care for the meat, it would pick it up and drop it; it was very fond of bread and eggs. I gave it small young frogs and flies occasionally. The frogs seemed a great luxury to it. After shaking them it would swallow them whole. This bird still lives, and is very tame.*

* *Postscript.*—The bird died about the end of April.

INDEX.

A.

B.

C.

D.

E.

I.

K.

L.

M.

N.

O.

ERRATA, etc.

p. 7, line 18, for "resent" read "reject."
8, ,, 16, for "gayly" read "gaily."
8, ,, 28, for "Turk's cap-lily" read "Turk's-cap lily."
11, ,, 6, for "teasel" read "teazel."
35, ,, 35, the words "last seen" refer to the date "May 8" in line 34.
91, ,, 29, for "*rufinarius*" read "*rufimanus*."
156, first column, transfer the words "Gade" and "Bulbourne."
159, lines 7 and 6 from bottom, read "Bulbourne ..... 21·27," and "Gade ..... 20·38."
211, the number of rainy days at New Barnet exceeds that given on p. 163 owing to days on which less than 0·01 in. fell being included here.
xlv, line 24, for "Maiden's Bower" read "Maiden Bower."

The Editor regrets to find that he has inadvertently omitted to give, on p. xxxvi, a report of the field meeting held at St. Albans on the 27th of April, 1889, when Miss E. A. Ormerod, F.R.Met.Soc., F.E.S., very kindly received and entertained a large number of the members and their friends, and read a paper on "The Hessian Fly, and its Introduction into Britain." (*Vide ante*, pp. 168–176.)

APPENDIX.

LIST OF MEMBERS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB.

April, 1890.

PAST PRESIDENTS.

1875–77.	JOHN EVANS, D.C.L., LL.D., Treas. R.S., Pres. S.A.
1877–79.	ALFRED T. BRETT, M.D.
1879–81.	J. GWYN JEFFREYS, LL.D., F.R.S., F.L.S., F.G.S.
1881–83.	GEORGE ROOPER, F.Z.S.
1883–85.	RIGHT HONOURABLE EARL COWPER, K.G.
1885–87.	PROF. JOHN ATTFIELD, M.A., Ph.D., F.R.S., F.C.S.
1887–89.	F. MAULE CAMPBELL, F.L.S., F.Z.S., F.R.M.S.

TRUSTEES.

HONORARY MEMBERS.

Elected

1875 Allman, George James, M.D., LL.D., F.R.S., F.R.S.E., F.L.S., M.R.I.A., Emeritus Professor of Natural History, University of Edinburgh, *Ardmore, Parkstone, Dorset;* and *Athenæum Club, London, S.W.*

1880 Babington, Charles Cardale, M.A., F.R.S., F.S.A., F.L.S., F.G.S., Professor of Botany in the University of Cambridge, 5, *Brookside, Cambridge.*

1883 Brown, Isaac, F.R.A.S., F.R.Met.Soc., *Brantholme, Kendal, Westmoreland.*

1882 Cooke, M. C., M.A., LL.D., A.L.S., 146, *Junction Road, London, N.*

1879 Etheridge, Robert, F.R.S., F.R.S.E., F.G.S., *British Museum (Natural History), South Kensington;* and 14, *Carlyle Square, Chelsea, London, S.W.*

1890 Geikie, Archibald, LL.D., F.R.S., F.R.S.E., Pres. G.S., Director-General of the Geological Surveys of the United Kingdom, 28, *Jermyn Street, London, S.W.*

1875 Glaisher, James, F.R.S., F.R.A.S., F.R.M.S., F.R.Met.Soc., Superintendent of the Magnetic and Meteorological Department, Royal Observatory, Greenwich, 1, *Dartmouth Park, Blackheath.*

1879 Harting, James Edmund, F.L.S., F.Z.S., Memb. Brit. Orn. Union, *Linnean Society, Burlington House, London, W.*

1877 Henslow, Rev. George, M.A., F.L.S., F.G.S., Lecturer on Botany, St. Bartholomew's Hospital, *Drayton House, Ealing.*

1875 Hooker, Sir Joseph Dalton, R.N., K.C.S.I., C.B., M.D., D.C.L. (Oxon.), LL.D. (Cantab.), F.R.S., F.L.S., F.G.S., etc., *The Camp, Sunningdale, Berks.*

1883 Huxley, Thomas Henry, D.C.L. (Oxon.), LL.D. (Edin.), Ph.D., F.R.S., F.L.S., F.G.S., F.Z.S., etc., ex-Professor of Natural History in the Royal School of Mines, 4, *Marlborough Place, St. John's Wood, London, N.W.*

1886 Jackson, Benjamin Daydon, Sec. L.S., *Clevedon, Cautley Avenue, Clapham Common, London, S.W.*

1883 Jones, Thomas Rupert, F.R.S., F.G.S., ex-Professor of Geology at the Royal Military College, Sandhurst, 10, *Uverdale Road, King's Road, Chelsea, London, S.W.*

1875 Lubbock, Rt. Hon. Sir John, Bart., M.P., D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., *High Elms, Farnborough, Kent;* and 15, *Lombard Street, London, E.C.*

1881 Ormerod, Eleanor A., F.R.Met.Soc., F.E.S., Consulting Entomologist to the Royal Agricultural Society, *Torrington House, St. Albans.*

1885 Owen, Sir Richard, K.C.B., M.D., D.C.L., LL.D., F.R.C.S., F.R.S., F.L.S., F.G.S., etc., *Sheen Lodge, Richmond Park, East Sheen.*

1880 Sclater, Philip Lutley, M.A., Ph.D., F.R.S., F.L.S., F.G.S., Sec. Z.S., 3, *Hanover Square, London, W.*

1885 Seebohm, Henry, F.L.S., F.Z.S., 22, *Courtfield Gardens, Cromwell Road, London, S.W.*

1876 Symons, George James, F.R.S., Sec. R.Met.Soc., 62, *Camden Square, London, N.W.*

1876 Whitaker, William, B.A. (Lond.), F.R.S., F.G.S., Assoc. Inst.C.E., Geological Survey of England, 33, *East Park Terrace, Southampton;* and 28, *Jermyn Street, London, S.W.*

ORDINARY MEMBERS.

An asterisk before a name indicates a Life Member.

Elected.

1890 Acworth, Mrs., *The Hook, Northaw, Potter's Bar.*

1887 Allen, Henry S., 42, *High Street, Watford.*

1881 Allen, Richard C., *Musley Hill, Ware.*

1887 André, R., *Melrose, Bushey Grove, Watford.*

1879 Andrews, R. Thornton, *Castle Street, Hertford.*

1876 Arnold, Mrs., *Redbourn Bury, St. Albans.*

1890 Ashdown, C. H., F.R.G.S., *Belmont, St. Albans.*

1883 *Attenborough, Mrs., *Haydon Hill, Bushey, Watford.*

1877 *Attfield, John, M.A., Ph.D., F.R.S., F.C.S., F.I.C., Professor of Practical Chemistry to the Pharmaceutical Society of Great Britain, *Ashlands, Watford*; and 17, *Bloomsbury Square, London, W.C.*

1879 Austin, Vernon, *Blairgowrie, Bengeo, Hertford.*

1879 *Barclay, Robert, *High Leigh, Hoddesdon.*

1885 Barker, William R., *Overbury, Watford.*

1886 Barnett, Hon. Mrs., *Edge Grove, Aldenham, Watford.*

1878 Barraud, Allan, *Bushey Heath, Watford.*

1889 Bates, H. Leslie, L.R.C.P. (Lond.), *Victoria Street, St. Albans.*

1887 Beck, Ernest, *Hoddesdon.*

1879 Beningfield, Henry, *High Street, Ware.*

1877 Benskin, Mrs. Joseph, *Chalk Hill, Watford.*

1880 Berkeley, B. Comyns, *Collett Hall, Ware.*

1888 Berry, Edward E., *Much Hadham.*

1883 *Berry, F. Haycraft, M.D. (Lond.), *Wansford House, Watford.*

1883 *Bickersteth, John P., *Grove Mill House, Watford.*

1880 Bishop, Mrs., *The Platts, Watford.*

1885 Blathwayt, A. P., *Frogmore House, Watford.*

1888 Bloom, Rev. J. Harvey, B.A., *Hemsworth, Wakefield.*

1881 Blow, Thomas Bates, F.L.S., *Welwyn.*
1890 Bookey, R. H., B.A., *Oak Vale School, Berkhamsted.*
1887 Bosanquet, Percival, *Ponfield, Little Berkhamsted.*
1889 Bowers, W. D., *High Street, Watford.*
1889 Boys, A. H., L.R.C.P. (Edin.), *Chequer Lawn, St. Albans.*
1875 *Brett, Alfred T., M.D., *Watford House, Watford.*
1885 Broad, T. J., *Queen Street, Watford.*
1887 Brown, Arthur M., M.A., *Beech Grove, Tring.*
1885 Burchell-Herne, Rev. H. F. H., *Bushey Grange, Watford.*
1884 Burr, E. T., *Oakley Lodge, Clarendon Road, Watford.*
1881 *Bushby, Lady Frances, *Wormley Bury, Hoddesdon.*
1889 Butcher, Francis J., *Tring.*
1880 Butcher, Henry O. F., *High Street, Ware.*
1889 *Butler, Charles, *Warren Wood, Hatfield.*
1879 Buxton, Alfred Fowell, 5, *Hyde Park Street, London, W.*
1885 Buxton, John Henry, *Hunsdon Bury, Ware.*
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