THE FLORA OF SOUTH AFRICA

RUDOLF MARLOTH

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Volume I. Thallophyta. Bryophyta. Pteridophyta.
Gymnospermae. Dicotyledones: Part I. [Orders I—XI]
Piperales—Rhoecadales.

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Volume IV. Monocotyledones.

C. P. Thunberg

W. J. Burchell

J. F. Drège

W. H. Harvey

Peter MacOwan

Harry Bolus

Werner & Winter, Frankfort a/M.

BOTANISTS OF SOUTH AFRICA

THE FLORA OF SOUTH AFRICA

WITH SYNOPTICAL TABLES OF THE GENERA OF THE HIGHER PLANTS

by

RUDOLF MARLOTH
Author of "DAS KAPLAND"

VOLUME I

THALLOPHYTA
ARCHEGONIATAE
GYMNOSPERMAE
DICOTYLEDONES (PART I)
A. MONOCHLAMYDEAE
B. DIALYPETALAE (SECT. 1: RANALES, RHOEADALES)

With 36 coloured and 30 monochrome plates

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PREFACE

"*Nowhere on the Earth could the vegetation of a country be more attractive and yet so easily accessible to the botanist as at the Cape. Here Nature spreads her gifts in inexhaustible bounty and richness before his eyes as well as beneath his hands......everything is within his reach; reeds and rushes, bulbous herbs and flowers, shrublets and shrubs are there to delight him.*"

Adalbert von Chamisso, Reise um die Welt. 1818.

Thus sounded the poet, himself an accomplished botanist, the praise of the Cape flora nearly one hundred years ago, and many other authors have done so from time to time in language not less eloquent. In spite of this, no book hitherto issued can be regarded either as a satisfactory introduction to the charms presented by this flora, or as a sufficient guide to the student in his endeavours to find his way through the overwhelming mass of forms that surround him on all sides.

The idea of promoting the publication of a book with coloured illustrations which would meet this want is due to Lady Phillips.

Realizing that the majority of her countrymen, as well as the world at large, are unacquainted with the beautiful vegetation of South Africa, she generously provided the means necessary for the production of the book, although it gradually assumed much larger proportions than originally contemplated, and now includes the whole flora of South Africa, illustrated by 180 coloured and 100 monochrome plates, together with 300 figures in the text.

Lady Phillips attributes her interest in the subject to the teachings of her father, the late Albert Frederick Ortlepp, himself a keen naturalist and an ardent lover of his country.

While the lower plants are treated briefly only as an introduction to the study of the vegetable kingdom, the higher plants, from liverworts upwards, are dealt with more in detail, a complete synoptical table of the genera of each family being given. When the book is complete these synoptical tables, now scattered through the four volumes, will be re-issued together as an appendix for the use of the student in the herbarium as well as in the field.

In the North the Tropic of Capricorn is roughly adopted as our boundary, starting on the West Coast near Walfisch Bay and traversing German South-West Africa and Bechuanaland until the line reaches the Limpopo. In order not to exclude that portion of the Transvaal which is situated within the Tropics, the Limpopo is followed to its mouth at about the 25th degree of latitude. As in all floral delimitations based on geographical boundaries one does not obtain a natural botanical province in this way, but the scope of the book would have to be extended considerably, if one attempted to include Rhodesia and other regions situated between the Limpopo and the Zambesi. In a few instances specially remarkable plants from those districts have been mentioned.

An account of the botanical provinces of South Africa will be given in the supplementary volume.

The originals of the coloured plates, with few exceptions, have been painted at Capetown from living plants, principally by Miss Ethel Dixie of Claremont, Miss Esther Smith (Port Elizabeth), Miss Florence Thwaits, formerly of Wellington, Miss M. Franks (Durban) and Mr P. McManus (Capetown). The name of the artist is given on each plate; often, however, two or three of them share in the production of one plate, for as the fresh material became available only from time to time, five or more years have sometimes elapsed between the painting of the first and the last figure of a plate.

All photographs, unless marked otherwise, are by the author and unpublished. The list of the other contributors will be found in the index.

We take this opportunity of extending our thanks to all who have assisted in the production of the book. The authorities at Kew and at Dahlem (Berlin), our friend the late Dr H. Bolus, his niece Mrs Frank Bolus and the Rev. Dr F. C. Kolbe have given us valuable help and advice; Dr J. Medley Wood of Durban, Miss Alice Pegler of Kentani and Mr J. L. Drège of Port Elizabeth have contributed rare plants that were not otherwise obtainable; Professor L. Diels of the University of Marburg has helped in the construction of the keys for a large number of families, and Mr Spencer Moore of the British Museum has superintended the printing and binding.

We hope that by the combined efforts of all, the book has been made not only instructive but also attractive, and that it may be the means of spreading knowledge and a love of nature among the generation which is growing up in South Africa, thus creating a deeper interest in the country whose welfare is dear to all of us.

R. MARLOTH.

Cape Town,
July 1913

BIOGRAPHIES OF BOTANISTS

The portraits on the frontispiece of this book represent three periods in the history of South African Botany. THUNBERG and BURCHELL laid the foundations; DRÈGE and HARVEY, each in his own way, supplied the materials for the building, and constructed the edifice; MACOWAN and BOLUS, working hand in hand for a considerable time, fitted it up internally.

Let those who are taking their places see that the halls are made comfortable for the larger number of students expected from new South Africa.

Carl Pehr Thunberg, 1743—1828, a pupil of LINNAEUS, studied botany and medicine in Holland and came to the Cape in 1772, staying here until 1775. During his journeys into various parts of the country he made extensive collections of plants and published the results of his observations after his return to Sweden. While professor of botany at Upsala he issued numerous botanical papers and finally published his "Flora Capensis," 1807—1820, the first comprehensive description of Cape plants. It is remarkable that a considerable number of species collected by THUNBERG have not been re-found since.

The genus *Thunbergia* (Acanthaceae, Vol. III) with nearly 100 species is widely dispersed, occurring in South Africa, Tropical Africa and India.

William John Burchell, 1782—1863, a highly cultured explorer, had been at St Helena for five years when he came to Capetown in 1810. From here he undertook several journeys into the interior and penetrated into the countries beyond the Orange River as far north as Litakun, at that time a large native town, now a missionary establishment called Kuruman. In his book "Travels in the Interior of Southern Africa," which contains numerous coloured drawings from his own hand, painstaking accuracy is combined with a most charming style and beautiful language. Many of his descriptions of South African scenery, *e.g.* the view from the top of Table Mountain and the sight of the mighty Orange River when in full flood, are poems written in prose.

Among other valuable observations which he made he was the first to draw attention to the occurrence of mimicry plants, comparing them directly with the protective resemblances possessed by some toad locusts of the Karoo, which are indiscernible from the pebbles among which they rest.

The genus *Burchellia* (Rubiaceae, Vol. III) is a very ornamental evergreen shrub, with bright scarlet flowers.

Johann Franz Drège, 1794—1881, a citizen of Altona (Germany), came to South Africa in 1826 in order to explore it botanically. He spent nearly eight years in traversing the country from South to North and West to East in various directions and collected about 8000 species of plants, represented by over 200,000 specimens, recording in each case details of locality, season and peculiarities of the plant. Unfortunately the major portion of this collection was destroyed by fire during the great conflagration of Hamburg in 1842.

Drège was the first to establish distinct botanical regions in South Africa, and as Thunberg is the father of South African Botany so is Drège the founder of its Botanical Geography*.

Dregea floribunda, the type of the genus, established by Ernst Meyer in 1837, is considered by N. E. Brown to belong to the tropical genus *Marsdenia*. (Asclepiadaceae, Vol. III.)

William Henry Harvey, 1811—1866, had been placed at first in a merchant's office, but his enthusiasm for Natural History did not allow him to stay there. In 1835 he accompanied his brother to the Cape and conceived at once the plan of writing a general treatise on the Cape flora. His stay here, however, was very short; but he returned the following year, having been appointed Treasurer General for the Colony. Within two years he completed the first edition of the "Genera of South African Plants," but a year later failing health compelled him to return to England (1841).

For some time he held various offices, until in 1856 he was appointed professor of botany at Dublin. During this time he arranged with Dr O. Sonder of Hamburg to publish a *Flora Capensis*; three volumes had appeared (1859—1865), when his untimely death brought this work to a standstill. Unfortunately it remained so for about 30 years and is only now nearing completion (7 volumes in 10 sections).

But his fame as a botanist does not rest only on these works. A large portion of his time was devoted to the study of Marine Algae, of which he published a series of volumes with over 400 plates, all drawn and lithographed by himself.

In reading his accurate technical descriptions one would not imagine what a poetical mind Harvey had. In his letters he speaks of the sky-blue flowers of *Aristea cyanea* as "the purest that ever were fed upon dew," of *Bartholina pectinata* as "a plant to be dreamt of rather than seen," and of *Gleichenia* as "an object to stand and look at till your eyes overflow with that mixed feeling of gratitude and love that the sight of an exquisite production of nature inspires."

The genus *Harveya* (Scrophulariaceae, Vol. III) is well known to all lovers of flowers in South Africa.

Peter MacOwan, 1830—1909, the son of an English clergyman at Hull, came to South Africa in 1861. For some time he was principal of Shaw College, Grahamstown, and later on science professor at Gill College, Somerset East. In 1881 he became director of the Botanic Gardens at Capetown, and when these were handed over to the municipality as a park in 1892, he was appointed Government botanist and keeper of the Government herbarium. This collection was in a very neglected state when he first took

* See map in Drège, Zwei pflanzengeogr. Dokumente, Flora 1843, Band II, or its reprint in Marloth, Das Kapland, 1908.

charge of it in 1881, but under his administration it was developed into a national institution.

The collections which he made in the Eastern Province as well as in the West were very extensive, and he exchanged them freely with other botanists in various parts of the world. His own herbarium is now merged into that of the Albany Museum at Grahamstown.

His writings like his lectures sparkled with satire and humour, and many correspondents treasure his replies not only on account of the valuable information which they contain but often more for the sake of their witty language.

In 1901 the University of the Cape of Good Hope conferred the degree of Doctor of Science upon him. He retired from his official position in 1905 and spent the evening of his life in well earned leisure at Uitenhage.

The genus *Macowania* Oliver (Compositae, Vol. III) comprises one species, an eastern plant. *Macowanites* Kalchbr. is a genus of Hymenogastrinae.

Harry Bolus, 1834—1911, the son of an English merchant, arrived in South Africa in 1850, being at first at Grahamstown and later on at Graaff Reinet, where he occupied various positions as a business man. It was here that he made the acquaintance of Prof. GUTHRIE, under whose guidance he began to interest himself in botany. Soon, however, the new field occupied him to such an extent that he devoted all his leisure hours to its exploration. His enthusiasm for the science did not slacken when he moved to Capetown in 1874—on the contrary, it speedily became the ruling passion of his life. Circumstances permitted him to travel a great deal in South Africa, and he made the most of these opportunities for collecting, carefully recording his observations wherever he went. Thousands of sketches and drawings are to be found on the sheets of his herbarium, the richest collection of its kind in South Africa. In his will he dedicated it to the South African College at Capetown with an endowment sufficient for its proper housing and administration.

His beautifully illustrated books on South African orchids, his account of the genus *Erica* (in conjunction with his life-long friend Prof. GUTHRIE) in the Flora Capensis, his essays on the Floral Regions of South Africa* and numerous other publications make HARRY BOLUS, who, it must be remembered, took up botany as a recreation and not as a profession, rank equal with the famous men associated with him on the frontispiece.

In 1902 the University of the Cape of Good Hope conferred upon him the honorary degree of Doctor of Science.

Three genera bear his name, viz. *Bolusia* (Bentham 1873. Leguminosae, Vol. II), formed by two species of shrublets, *Neobolusia* (Schlechter 1895. Orchidaceae, Vol. IV) and *Bolusanthus* (Harms 1906. Leguminosae), a tree with beautiful flowers (Transvaal, Rhodesia).

* Science in South Africa, 1905.

TABLE OF CONTENTS

(***Figures*** *in heavy type indicate a coloured plate.*)

* In accordance with the international rules of nomenclature the natural groups of genera termed "orders" in the Flora Capensis and various other works are now designated as families, while the term "order" is used for groups of families more or less closely related to each other.

Series 2. DIALYPETALAE. Part I.

(Families 24—35.)

LIST OF PLATES

(Coloured plates are indicated by **figures** *in heavier type.)*

ERRATA AND ADDENDA

p. 4 line 12. Under Myxomycetes. *Replace the words* "Then large numbers of swarm-spores" *by* "Gradually they lose their motility and change into myxamoebae, of which a little later large numbers"

p. 90 „ 9. *Replace* "nucellar" *by* "prothallial"

p. 94 „ 18. *For* Fig. 63 *read* Fig. 64

p. 97 „ 5 from bottom. *For* Fig. 64 *read* Fig. 63

p. 100 and Pl. 16 *A*. *For* female *read* male

p. 103 line 4 from bottom. *For* podocarpium *read* epimatium

p. 115 „ 9. *Read* Vol. IV, Fig. 52

p. 132 Fig. 74. The twig *A* represents *M. cordifolia*

p. 136 line 26. For *Apocrypha* read *Apocrypta*

p. 151 and Pl. 31. For *L. medium* read *L. nutans* R. Br.

p. 170 last line. The East African plant has been named since: *S. Piriei* Hutchinson

p. 178 line 22. *Delete the words* "with 3-flowered shoots"

p. 180 „ 3. *For* page 189 *read* 192

p. 204 „ 19. *For* zuurvygen *read* zuurvijgen

p. 206 „ 12. *For* Fig. 90 *read* Fig. 91 *a*.

INTRODUCTION

For a long time it has been customary to subdivide the vegetable kingdom into Cryptogams (Non-flowering Plants) and Phanerogams (Flowering Plants). These designations are, however, misleading in various respects, creating the impression, at least among non-botanical readers, that all the former possess only primitive modes of reproduction, while in reality some of their groups are as highly organised in this respect as some of the flowering plants. Further, the various groups of cryptogams are totally different from each other, having only one feature in common, viz. the dispersal by means of spores, while the phanerogams, although also producing spores or corresponding organs at a certain stage of their life-cycle, are dispersed by means of seeds. Some botanists have consequently suggested the employment of the terms *sporophytes* (spore-bearing plants) and *spermatophytes* (seed-bearing plants), but the discovery of fossil seed-bearing ferns (Cycado-Filices) and various other reasons render such a distinction equally impracticable or at any rate not less inconvenient*.

As this book is written chiefly for the general reader and the beginner in botanical studies we have thought it best, in order to facilitate their work, to adopt Endlicher's grouping established in 1840 :

* See D. H. Scott's article on "The present position of Palaeozoic Botany" in Progressus Rei Botanicae, Vol. 1, 1907, where this question is summed up as follows: "The division of vascular plants into Spermophyta and Pteridophyta ceases to afford a natural line of cleavage when we are concerned with palaeozoic vegetation"; and Kidston's statement, quoted in the same article: "the Cycadofilices (pteridosperms) long antedated the advent of true ferns."

THALLOPHYTA. Lower Plants.

Plants without stems, leaves and vascular tissue. Either unicellular or consisting of a mass of cells called a "*thallus*."

CORMOPHYTA. Higher Plants.

Plants (except in the lowest forms) with leaves, stems and vascular tissue. All with an elaborate mode of sexual reproduction.

We wish, however, to emphasise the fact, that the thallophytes as well as the cormophytes comprise groups of plants which do not exhibit any special signs of mutual relationship, and that the arrangement is mainly one of convenience.

THALLOPHYTA. (Div. I to XI.)

CORMOPHYTA. (Div. XII to XV.)

A. Archegoniatae.

Division XII. BRYOPHYTA.

Class I. HEPATICAE. Liverworts.

Class II. MUSCI. Mosses.

Division XIII. PTERIDOPHYTA.

Class I. FILICINAE.

A. Filices. Ferns.

B. Hydropterides. Water-Ferns.

Class II. EQUISETINAE. Horse-tails.

Class III. LYCOPODIINAE. Clubmosses.

B. Anthophyta. Flowering Plants.

Division XIV. GYMNOSPERMAE.

Division XV. ANGIOSPERMAE.

Class I. DICOTYLEDONES.

Class II. MONOCOTYLEDONES.

Plate 2.

A: Protococcus pluvialis *Kuetz.* B: Splachnidium rugosum *(L.) Grev.*
C: Euglena gracilis *Klebs* D: Chara stachymorpha *Ganterer*
E: Enteromorpha intestinalis *(L.) Link* F: Navicula sp.
G: Codium tomentosum *(Huds.) Stackh.* H: Staurastrum gracile *Ralfs*
I: Hydrodictyon reticulatum *(L.) Lagerh.* K: Gelidium cartilagineum *(L.) Gaill.*
L: Cheilosporum cultratum *(Harv.) Aresch.* M: Nostoc edule *Berk. et Mont.*
N: Trentepohlia polycarpa *Nees et Mont.*

Plate 2.

Assimilating Thallophytes and Characeae.

A. *Sphaerella lacustris* (Girod) Wittr. B. *Splachnidium rugosum* (L.) Grev. C. *Euglena gracilis* Klebs. D. *Chara stachymorpha* Ganterer. E. *Enteromorpha intestinalis* (L.) Link. F. *Navicula* spec. G. *Codium tomentosum* (Huds.) Stackh. H. *Staurastrum gracile* Ralfs. I. *Hydrodictyon reticulatum* (L.) Lagerh. K. *Gelidium cartilagineum* (L.) Gaill. L. *Cheilosporum cultratum* (Harv.) Aresch. M. *Nostoc edule* Berk. & Mont. N. *Trentepohlia polycarpa* Nees & Mont.

Systematic Table.

Main division	Family	
Schizophyceae (Cyanophyceae) Blue-green Algae	Nostocaceae	M. *Nostoc edule.* 1. Colonies on rock from Victoria Falls. 2. Section of colony showing the threads of Nostoc embedded in the jelly. 70/1 3. One thread with heterocyst. 800/1 This species was formerly known only from rivers in Central Asia.
Flagellatae	Euglenaceae	C. *Euglena gracilis.* 1. Form with chlorophyll granules. 630/1 2. Form without chromatophores. 630/1
Zygophyceae		
Class Bacillariales	Diatomaceae	F. *Navicula* spec. 500/1
Class Conjugatae	Desmidiaceae	H. *Staurastrum gracile**. 1. Front view of plant. 375/1 2. Two cells in copulation.

* This alga was obtained from the water pipe of the author's laboratory in Capetown. A filter attached to the water service became suddenly choked and when opened was found to contain small pellets of a greenish substance. The microscope showed that these little lumps mainly consisted of desmids, principally *Staurastrum gracile*. My friend Professor N. Wille of the University of Christiania kindly identified the following species: Desmidiaceae: *Staurastrum gracile* Ralfs, *Euastrum amoenum* Gay, *Cosmarium bioculatum* Bréb.; Volvocaceae: *Gonium pectorale* Muell., *Eudorina elegans* Ehrb.; Pleurococcaceae: *Scenedesmus quadricauda* Bréb.

The little lumps of algae had probably been carried into the water main from the Disa stream on Table Mountain.

Main division	Family		
Chlorophyceae Green Algae Class Protococcales	Volvocaceae	A.	*Sphaerella lacustris* (*Haematococcus*). 1. Active plant. 300/1 2. Resting form. 300/1
	Hydrodictyaceae	I.	*Hydrodictyon reticulatum.* A colony from Cape Flats. Nat. size.
Class Confervales	Ulvaceae	E.	*Enteromorpha intestinalis.* Small plant from shore at Muizenberg.
Class Confervales	Chroolepidaceae	N.	*Trentepohlia polycarpa.* 1. Colony. Nat. size, from Table Mountain. 2. Fragment of thread. 200/1 Syn. *Chroolepus montis tabularis.*
Class Siphoneae	Codiaceae	G.	*Codium tomentosum.* End of a branch. 60/1. From Seapoint. (Sea)
Charales	Characeae	D.	*Chara stachymorpha.* Nat. size. From vlei in Cape Flats.
Phaeophyceae Brown Algae	Fucaceae	B.	*Splachnidium rugosum.* Nat. size. From False Bay.
Rhodophyceae Red Algae Class Florideae	Gelidiaceae	K.	*Gelidium cartilagineum.* Nat. size. From False Bay.
	Corallinaceae	L.	*Cheilosporum cultratum.* Nat. size. From False Bay.

Figs. A and F, ex Francé, vol. 1; Fig. C after Zumstein ex Strasburger; Fig. K by Miss G. Edwards; Figs. B, E, G, I, M 2, M 3 drawn by W. T. Saxton.

PART I

THALLOPHYTA. THE LOWER PLANTS.

The various main groups of plants which, owing to the absence of vascular tissue, show a superficial similarity of structure are often arranged under two heads, viz. as Algae and Fungi, omitting here for the present the lichens. This distinction is, however, mainly based on the presence or absence of chlorophyll*, without sufficient regard to relationship as evinced by their mode of reproduction. As some fungi are evidently closely related to some algae, differing from them mainly by the absence of chlorophyll and the consequent inability to assimilate, the separation into these two groups is to a large extent physiological and not genetic. In order to designate the assimilating thallophytes by a common name, the term "algae" is convenient, while for the bulk of the non-assimilating groups "fungi" may be retained, but for a systematic arrangement other characters of distinction deserve the preference†.

The Main groups of Thallophytes.

Division I. Myxomycetes (Amoeboid plants).
II. Schizomycetes (Bacteria).
III. Schizophyceae (Blue-green Algae).
IV. Flagellatae (Euglenaceae).
V. Chlorophyceae (Green Algae)‡.

* First pointed out by F. COHN (1872).

† While the view here adopted by the author of this book has been warmly supported by some eminent botanists, yet it may also be urged that, generally speaking, the Algae and Fungi are only connected at one or two points and have, as a whole, diverged markedly from one another in their more complex forms, structurally as well as physiologically. W. T. S.

‡ Excl. those in divisions VI and VII.

Division VI. Conjugatae (Desmids and their allies).
VII. Charales (Stone-worts).
VIII. Diatomaceae (Diatoms).
IX. Phaeophyceae (Brown Algae).
X. Rhodophyceae (Red Algae).
XI. Eumycetes (Fungi).
Appendix to XI. Lichenes (Lichens).

Description of the Classes*.

I. MYXOMYCETES.

Probably quite unrelated to the other fungi, the Myxomycetes only agree with them in the absence of chlorophyll, and in the fact that they form spores. In the vegetative condition these organisms consist of creeping, naked masses of protoplasm. Each is called a ***plasmodium***. After a time the whole plasmodium becomes converted into a single sporangium (rarely more than one). This sporangium consists of a hard outer wall enclosing a large number of spores, and a network of branched threads called the ***capillitium***. When the spores germinate, each produces a single motile "swarm-spore," which may reproduce by division. Then large numbers of the swarm-spores coalesce to form a new plasmodium. The myxomycetes, with one exception, are all saprophytic, growing either on the ground, or, like the example figured, on dead twigs or mosses, or on the bark of trees. One of the largest species is commonly met with in tan pits and is known as "Flowers of tan."

Fig. 1. *Leocarpus fragilis* Dicks. Group of sporangia, on moss. Nat. size. (From Strasburger, Text-book.)

II. SCHIZOMYCETES.

The Bacteria.

The Bacteria are generally looked upon as among the most primitive organisms known to us. In spite of their very small size (it would take about 20,000 bacteria of a medium sized species, placed end to end, to measure an inch) a great deal has been discovered about them, owing to the extreme importance attached to some of them as the causes of disease in man and animals, and their study has come to be regarded as a separate science, viz. bacteriology.

Most bacteria are single, often motile cells, either spherical, oval, rod-like, or spirally twisted, a few being filamentous. Those which are motile are

* By W. T. Saxton, M.A., F.L.S.

provided with one or more cilia, which propel them through the liquid in which they grow.

Bacteria do not contain chlorophyll, but are not infrequently coloured as seen in mass, though usually colourless when seen individually under the microscope.

Some live only on dead organic material (saprophytes), some only on living animals or plants (parasites), while the majority can carry on either a parasitic or saprophytic existence. To the last category belong most of the disease-causing (*pathogenic*) bacteria. Lastly, there are a few which are capable (like the green plants) of producing their organic food from the carbon dioxide of the atmosphere.

Owing to their small size, it is often impossible to distinguish different bacteria from one another under the microscope, and it is therefore customary to cultivate them on plates of sterilised jelly (made from gelatine dissolved in a nutrient solution), as it is found that each species shows characteristic features when grown in this way. By mixing a trace of the liquid containing the bacteria with the liquefied jelly, pouring this on sterilised glass plates, which are cooled by means of iced water in order to produce a quick setting of the jelly, and then keeping the plates at the ordinary temperature protected against infection from the atmosphere, it is possible to secure colonies, each developed from a single bacterium or spore. In this way different species can be isolated from a mixture of bacteria and "pure cultures" of each obtained.

Bacteria in the vegetative condition are readily destroyed by heat, but their spores, generally formed singly within the cells, are exceedingly resistant to high temperatures. It is this resistancy which causes such difficulty in sterilising substances thoroughly for human consumption, *i.e.* milk, bottled fruits, vegetables, etc. It is well known that in many cases boiling, unless very prolonged, is not sufficient to destroy all bacterial spores. This has led to what is known as the method of "discontinuous sterilisation."

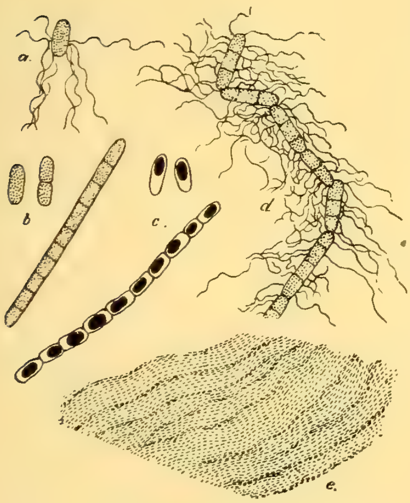


Fig. 2. *Bacillus subtilis* (Ehr.) Cohn *a*, Motile bacillus; *b*, non-motile bacilli, single and in a chain; *c*, spores from film *e*; *d*, a chain of motile bacilli; *e*, spores embedded in slimy film. *a–d*, 1500/1; *e*, 250/1. (From Fischer, Vorlesungen über Bakterien.)

To study the life history of a bacterium, the hay bacillus (*Bacillus subtilis*) is easily procured as a practically pure culture. The spores are very resistant to heat and are universally present in hay. To develop the bacillus it is only necessary to boil some hay in a little water for a few minutes, to pour off the infusion and leave it to itself. The boiling kills practically everything except the spores and these subsequently germinate to form minute rods, motile by means of a number of cilia scattered over their surface; the rods at first divide every half hour and subsequently more slowly, losing their motility after a day or two (Fig. 2 *b*) and forming a pellicle or scum on the surface of the liquid (Fig. 2 *c*). After a time spores are formed in the rods of the pellicle, these rods being usually united, at this stage, end to end in chains (Fig. 2 *b* and *c*). One spore is formed within each rod and is subsequently set free by the disappearance of the cell-wall.

It has of late years become a matter of common knowledge that the great value of leguminous plants in increasing the nitrogen-content of the soil is due to the bacteria (*rhizobium*) contained in the small tubercles always found on their roots, these bacteria being able to absorb and utilize the nitrogen of the atmosphere and to pass it on in an available form to the plant.

Pure cultures of these bacteria are now sold under the names of ***nitragin*** and ***azotogen***, although their practical utility as soil-fertilizers is not admitted by all bacteriologists, since the results obtained with them have proved somewhat contradictory.

It is a less familiar fact that the conversion of nitrogenous substances in the soil into a form available for plant food, *i.e.* into nitrates, is also carried on by bacteria. They belong to the genera *Nitromonas* and *Azotobacter*, and are specially valuable in dealing with sewage on so-called "sewage farms."

It would take us too far to go into the question of inoculation against diseases of bacterial origin by means of "anti-toxins" and similar substances. It will suffice to point out that it has been found that culture at a higher temperature (amongst various other factors) decreases the virulence of many pathogenic bacteria with each succeeding generation. The products of such weakened bacteria may then be used to impart the disease in a milder form, after recovery from which the patient is usually immune to the ordinary form of the complaint.

This method has been applied successfully in the case of bubonic plague and some other bacterial diseases, and present-day research in bacteriology is largely directed towards such problems.

III. SCHIZOPHYCEAE* (CYANOPHYCEAE).

The Blue-Green Algae.

This is a group of small but widely distributed algae in which the pure green colour of the chlorophyll is masked by another colouring matter, frequently blue, but often red or yellow. The plants, as seen with the naked eye, may be blue-green, olive-grey, nearly black, various shades of red, orange or yellow.

They occur in wet or damp situations, favourite habitats being water, still or running, containing a high percentage of organic substances in solution, and the wet vertical faces of rocks in waterfalls, etc.

* Details of some algae from several classes collected in South Africa are given by N. Wille in his paper: "Ueber einige von J. Menyhardt in Suedafrika gesammelte Suesswasseralgen," Oesterr. Bot. Zeitschr. 1903, No. 3. A large number of fresh-water algae recently collected by Prof. H. H. W. Pearson in Namaqualand and Angola are described by G. S. West in Annals S. A. Museum, vol. IX, pp. 61—89 (1912).

Some are unicellular, occurring either isolated or in colonies ; others are filamentous, a large number of the filaments being generally aggregated to form either a stratum or a definite colony.

Among the Blue-Green Algae commonly met with in South Africa, one of the most striking is a species of *Nostoc* (Plate 2, Fig. M 1, 2, 3). This consists of nearly spherical blue-green colonies, each made up of countless numbers of minute filaments embedded in a mass of jelly. Each filament consists of a row of barrel-shaped cells, with here and there a larger cell interposed, which is called a ***heterocyst***. The commonest method of reproduction is by the breaking up of the filaments at the heterocysts into shorter filaments, which then regain their former size by cell-division and growth. Less commonly some of the cells of certain filaments become converted into spores.

Some other species of *Nostoc* will be mentioned under *Encephalartos* (Vol. I page 94) and *Gunnera* (Vol. II).

IV. FLAGELLATAE.

The Flagellatae are a group of minute and very lowly organisms, all unicellular and with characters intermediate between those of plants and

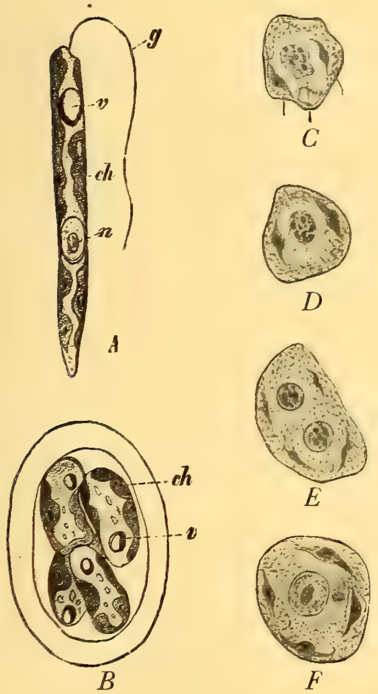


Fig. 3. *Euglena gracilis* Klebs *A*. Form with green chromatophores (*ch*); *n*, nucleus; *v*, vacuole with eye spot (red); *g*, flagellum. *B*. Division of cyst into 4 daughter-cells, 1000/1 (After Zumstein). *C–F*. *Euglena sanguinea* (After G. Haase), 1690/1. *C* and *D* two gametes. *E*. Young zygote with 2 nuclei and 4 chromatophores. *F*. Zygote after fusion of nuclei.

animals. It is not necessary to discuss the question to which kingdom they may be more conveniently relegated, as they probably constitute the starting point from which on the one hand the main groups of Thallophyta, on the other the Protozoa, have been derived.

Each cell (Fig. 3) is bounded by a protoplasmic membrane, in which amoeboid changes of form may occur, but a true cell-wall is absent. They are motile by means of one or more apical cilia each one being called a ***flagellum****. Green chloroplasts in the form of bands, plates or discs may or may not be present, and therefore the nutrition of the plants may be that typical of either the algae or the fungi. Reproduction takes place only by simple division in the longitudinal plane†. Each individual is however capable of forming ***resting cysts*** (see Fig. 3). The figure shows different forms and stages of one of the commonest fresh-water forms called *Euglena*, also illustrated on Plate 2.

Attention should be called to the peculiar vacuoles met with in these plants, which alternately expand and collapse. They are found just behind the flagella and are known as ***contractile vacuoles***.

V. CHLOROPHYCEAE.

The Green Algae.

The Chlorophyceae present the greatest diversity of form and structure, ranging from minute, unicellular, motile forms to such plants as the "sea-grasses" and *Caulerpas* (Fig. 4), the latter closely resembling in their external

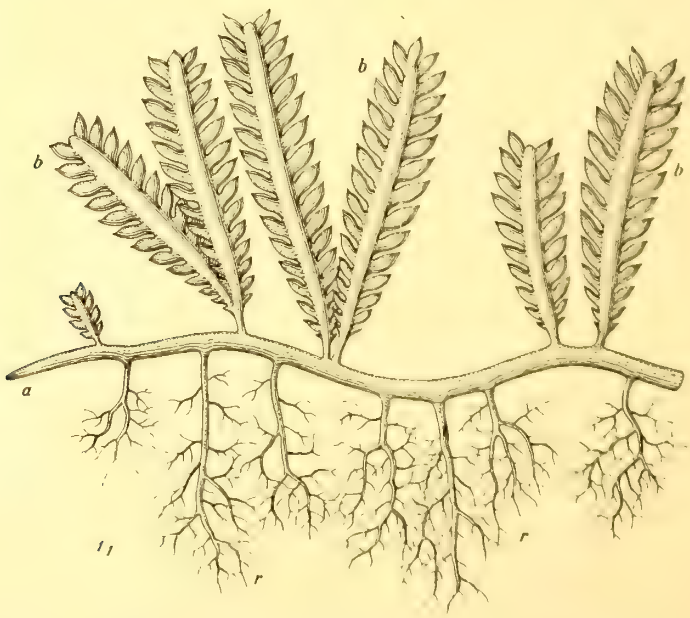


Fig. 4. *Caulerpa crassifolia* J. G. Agardh. Plant (a single cell), nat. size. *a*, dorsiventral apex of stem; *r*, roots; *bb*, branches with distichous leaves. (After J. Sachs.)

form some of the higher plants, but consisting of a single although much branched cell.

* *Cilium :* a hair ; *flagellum :* a whip.

† Reproduction by means of ***gametes*** forming ***zygotes*** also occurs in this group. The process resembles in essentials that described on p. 9 under *Sphaerella*. See Fig. 3 *C–F*.

The South African Chlorophyceae do not differ materially from the Green Algae met with in other parts of the world, these plants being as a rule cosmopolitan in their distribution. One of the very simplest forms, ranking indeed amongst the most primitive organisms in the plant kingdom, is that which causes, in some parts of the world, the phenomenon known as "red rain." This is the genus *Sphaerella* (*Haematococcus*). It is a very minute unicellular alga, which in its ordinary condition is freely motile by means of two fine cilia at the forward end of the cell. These propel the plant in somewhat the same manner as oars propel a boat.

As shown in Plate 2, Fig. A, the cell-wall of this plant stands out from the protoplasm and the latter contains a nucleus and a single basin-shaped chloroplast. *Sphaerella* readily passes, however, into a dormant condition, in which its colour becomes bright red, and it is this stage which causes the "red rain." This is called the ***palmella*** condition (Fig. A, 2).

Two methods of reproduction are met with in the genus :

(*a*) Formation of two or four smaller motile cells, destitute of a cell-wall, by division of the contents of a single mother-cell. These are called ***zoospores*** ; after a time they form a cell-wall and acquire the characters of the parent plant.

(*b*) Formation of several still smaller motile, naked cells, called ***gametes***, within a single mother-cell. These, on escaping, fuse together in pairs to form cells which remain round and motionless for a time (the ***zygotes***), but resume the motile condition subsequently.

As an example of one of the larger green algae, *Enteromorpha* may be mentioned*. The prevalent Cape species, *E. intestinalis*, is usually found growing in dense tufts, on the rocks about high water, much like a tuft of grass. The plants are more or less cylindrical, but narrower towards the base and somewhat constricted at fairly regular intervals. The cylinder is hollow and bounded by a single layer of small regularly shaped cells. Near the base the axis gives off a number of similar branches. (See Plate 2, Fig. E.) Reproduction may be either by means of minute, motile sexual cells (***gametes***), which fuse together in pairs to form a ***zygote***, the zygote subsequently growing into a new plant ; or, by means of small zoospores, which, after coming to rest, at once grow to form new plants, attached to the rocks by means of a slender, branched, root-like basal part.

Although the large majority of the Green Algae are really bright green in colour, yet there are isolated instances of plants with quite different colouring, which, however, are obviously so closely related to green forms that it would be inconvenient to separate them from the family in which they are included, on the ground of colour alone. An example of such an alga is figured in Plate 2, Fig. N. This is named *Trentepohlia* and is frequently found growing on the under side of overhanging rocks in sheltered situations of the

* This alga is one of the principal constituents of the so-called "grass" which fouls the bottom of ships, hence its universal distribution.

south-western mountains. It has the capacity of growing in a drier situation than most algae, the thallus being aerial. The plant consists of dense tufts of branched filaments of a bright colour. A few cells of a filament are shown separately in Plate 2, Fig. N 2. Reproduction is by means of **zoospores**, produced in nearly spherical sporangia, which are borne here and there, either terminally or laterally, on the filaments.

Two other green algae may be referred to, one fresh-water, the other marine, as remarkable instances of peculiar development of cells.

The fresh-water alga, called the "water net" (*Hydrodictyon reticulatum*), is found in vleis in the spring. A small part of one of these nets is shown, natural size, in Plate 2, Fig. I. Each of the green, nearly spherical segments of the net, consists of a single cell*. The most usual method of reproduction is by the formation of large numbers of zoospores within some of the old cells of the net. These swarm about within the mother-cell and then come to rest with their ends adjoining in such a manner as to form a new net within the cell. On the subsequent rupture of the mother-cell, the young net is set free, and, by growth of the cells, gradually attains its full size.

There is also a somewhat complex method of sexual reproduction, which is less commonly met with, and need not be considered here.

The marine example is *Codium tomentosum*, a dark green sea-weed with a soft cylindrical and repeatedly forked thallus several inches in length. The remarkable feature of this plant is that the whole individual is made up of a single much-branched tube, which is developed from a single cell; the ends of all the branches enlarge and become club-shaped, and being closely packed together at the surface of the thallus they form a kind of pseudo-cortex for the plant. One of these club-shaped tips is shown, considerably magnified, in Plate 2, Fig. G. Growing out from it, laterally, is one of the reproductive organs (***gametangium***). In this a large number of minute, motile sexual cells (gametes) are produced, which fuse together in pairs, the resulting zygotes growing out to form new plants.

VI. CONJUGATAE.

Quite a number of these are found in our streams, vleis and pools; they consist of unbranched filaments, each filament being made up of a single row of cells, all exactly alike. Among the commonest of these are species of the genus *Spirogyra* (Fig. 5). Each cell of *Spirogyra* is bounded by a cell-wall, and contains a central nucleus and a lining layer of protoplasm. Embedded in the latter are one or more conspicuous, spirally wound chloroplasts, from which the plant takes its name.

The plant has two methods of reproduction. One is by the repeated division and growth of the cells, accompanied by the breaking up of the

* More accurately a *coenocyte* (*i.e.* a multinucleate "cell"). The same remark applies to the cell of *Codium*.

filament into shorter lengths. The second method is by the sexual formation of spores, which are called ***zygospores*** or ***zygotes***. In order that this may take place it is necessary for two filaments to lie parallel to one another and not very far apart. Then short protuberances are put out from adjacent cells of each, which meet together between the filaments. At the point of junction the adjacent walls break down, and through the opening the contents of one cell pass over into the other cell; the united mass then surrounds itself with a fairly thick wall, thus constituting the zygospore, which generally remains dormant for some time before germinating to form a new Spirogyra plant. The whole process is known as ***conjugation***; hence the name of the class.

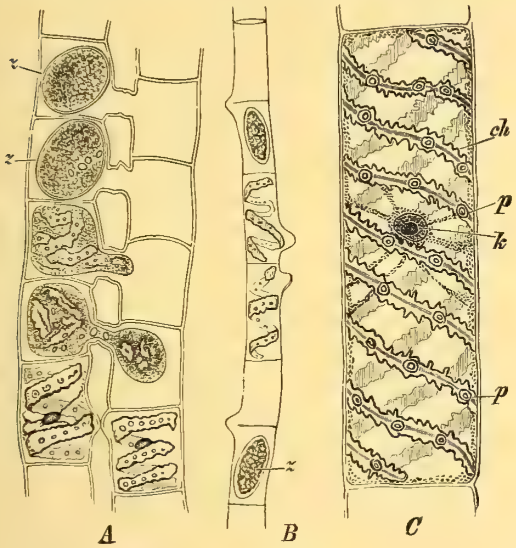


Fig. 5. *Spirogyra*. *A*. Copulation of *Sp. quinina*; z, zygospore, 240/1. *B*. *Sp. longata*, 150/1. *C*. *Sp. jugalis*; *k*, nucleus; *ch*, chromatophore; *p*, pyrenoids. 250/1. (From Strasburger, Textbook.)

Closely related to *Spirogyra* are the beautiful unicellular algae called Desmids, one of which (*Staurastrum*) is illustrated in Plate 2, Fig. H.

Desmids are chiefly remarkable for their diversity of form and their wonderful symmetry. All are microscopic, some large enough to be, although with difficulty, visible to the naked eye. The cells are often beautifully

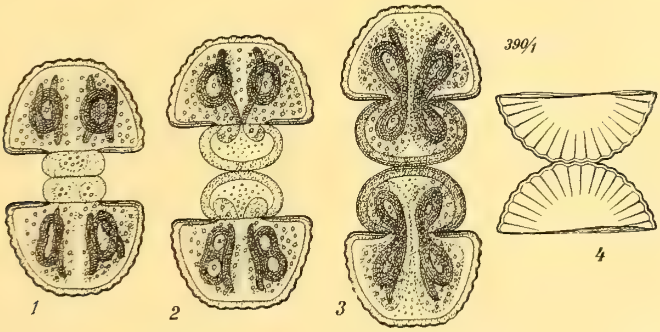


Fig. 6. *Cosmarium Botrytis* Menegh. 1–3, stages of division; 4, temporary membranes of two sister-cells shed during the formation of the final cell-wall. (After De Bary)

ornamented with spines, ridges, etc., and are usually symmetrical about three planes. In one of these planes, called the equatorial plane, there is a median constriction known as the ***isthmus***. Each cell contains a central nucleus in the isthmus, and each semi-cell contains one, or sometimes more than one, bright green chloroplast, usually in the form of a thick axile band, with radiating ridges.

Their methods of reproduction are somewhat similar to those of *Spirogyra*. In multiplying by division of the cells, each part of the mother-cell-wall becomes the corresponding half of the daughter-cell-wall, the second half being formed *de novo* (see Fig. 6). Conjugation takes place either by the formation of a canal, as in *Spirogyra*, the zygote, however, being formed in the canal and not in either of the conjugating cells; or the contents of the conjugating cells are liberated from the cells before fusion takes place.

VII. CHARALES.

The Stone-Worts*.

The Characeae (Plate 2, Fig. D), both in their vegetative structure and in their reproductive organs, are decidedly more complex than any other green algae, and in some respects may be regarded as intermediate between these and the mosses, although the relationship of the class is rather obscure. The plant consists of a main axis with long internodes and short nodes; from the latter whorls of lateral branches are given off. These lateral branches may be either simple or themselves branched in the same manner as the main axis. In the axil of one branch of each node another branch arises which repeats the characters of the main axis. Attachment to the substratum is by means of branching, root-like outgrowths from the lowest nodes, called ***rhizoids***. The growth of each axis is controlled by an apical cell, from which other cells are successively cut off by means of transverse walls. Each of these is again divided transversely into a lower, which develops into the long internodal cell, and an upper, from which, by further divisions, a disc of nodal cells is produced, as well as the lateral branches.

The reproductive organs of the Characeae are peculiar to the family and have received special names, the female organ being called the ***nucule*** and the male the ***globule***. The globule (Fig. 7 *a*) is spherical and consists of eight shield-like structures (called ***shields***) dovetailing into one another at their edges. From the inner face of each a stalk projects nearly to the centre terminating in a single cell, to this cell six others are attached, and, from each of the six, four long filaments grow out, each composed of a row of about two hundred cells. A single motile male cell, the ***spermatozoid***, is developed in each of the two hundred cells of the filament. Hence the total number of spermatozoids in a globule will be about $8 \times 6 \times 4 \times 200$ = nearly 40,000. The filaments, as shown in Fig. 7 *c*, are closely packed and twisted so as completely to fill the available space inside the globule. The nucule (Fig. 7 *b*) is ovoid and made up of a large central cell, the egg-cell, densely packed with starch (Fig. 7 *d*), surrounded by five spirally wound

* Several species are enumerated or described in a paper by Messrs H. and J. Groves: "On Characeae from the Cape Peninsula collected by Major A. H. Wolley-Dod," Journ. Linn. Soc. Bot. Vol. 37, July 1906.

Nitella tricuspis var. *macilenta*, *N. Dregeana* and *Lamprothamnus alopecuroides* occur near Stellenbosch. M.

filaments, the outer cell-walls of which are thickened, while their tips unite at the apex to form the crown. After fertilisation has been brought about by the entrance of a spermatozoid through the cells of the crown, the nucule remains in a dormant condition for some months. After this resting period it germinates, putting out a slender filament known as the ***pro-embryo***, which suggests a comparison with the protonema of the mosses, and from which, as in the mosses, the new plant arises as a lateral bud. The pro-embryo is shown in Fig. 8.

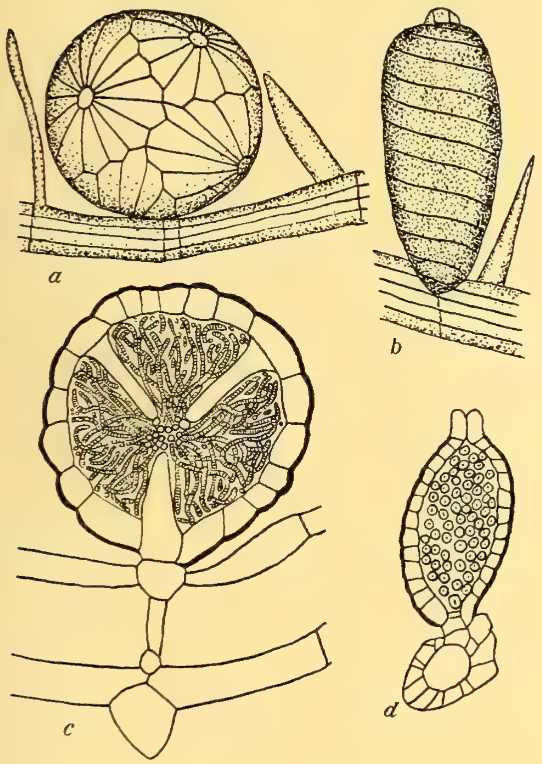


Fig. 7. *Chara polystachya* Gant. *a*, globule (♂), 60/1; *c*, the same in section, 70/1; *b*, nucule (♀), 40/1; *d*, the same in section, 30/1. W. T. S.

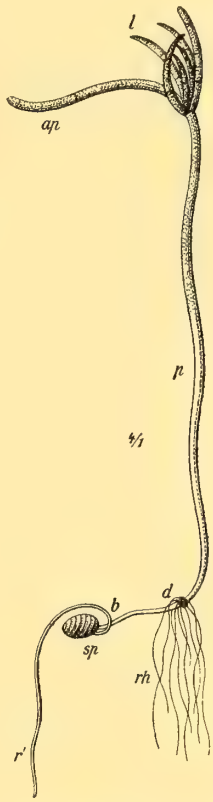


Fig. 8. *Chara fragilis* Desv. Protonema. *sp*, germinating oospore; *b*, *d*, *p*, *ap*, form together the protonema; from *d* originate the rhizoids *rh*; *r'*, the so-called principal root; *l*, the first leaves of the foliage plant; *ap*, apex of the protonema. (After Pringsheim)

VIII. DIATOMACEAE.

The diatoms are all microscopic, but they frequently occur in vast numbers, and their cell-walls are so impregnated with silica as to be almost indestructible. Fossil diatoms, for this reason, are often exceedingly well preserved, some strata formed almost exclusively of their remains being known as ***infusorial earth*** or ***kieselguhr***. Some of these are of economic importance, being used in the manufacture of dynamite, and for other purposes. All diatoms are unicellular, though some are united by the mucilage they secrete into colonies or filaments. They occur both in fresh and salt water, and are more abundant in the colder parts of the world. Hence diatoms, although common, are not so frequent in South Africa as they are in colder countries.

The structure of a diatom is somewhat remarkable. Each individual is known as a ***frustule***. The cell-wall consists essentially of two ***valves*** which fit closely together, like a pill box and its lid. In the commonest genus of diatoms, *Navicula*, each valve has the shape of a boat, one, turned upside down, fitting closely into the other, there being just sufficient difference in size between the two to make this possible. Further, that part of each valve which overlaps the other seems to have a different structure from, and to be rather attached to than continuous with, the rest of the valve. This part is known as the ***girdle***.

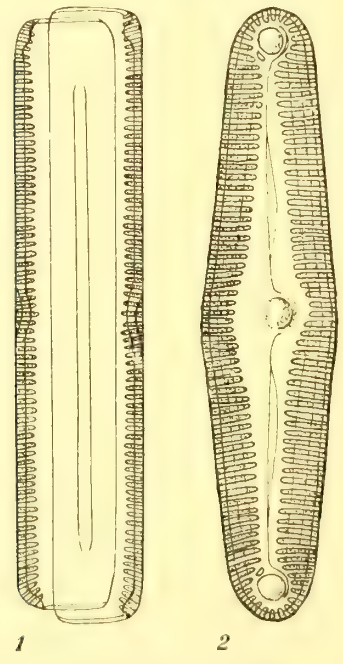


Fig. 9. *Navicula viridis* (Nitzsch) Kütz. 1. Face-view. 2. Lateral view (girdle). 1000/1. (After Pfitzer)

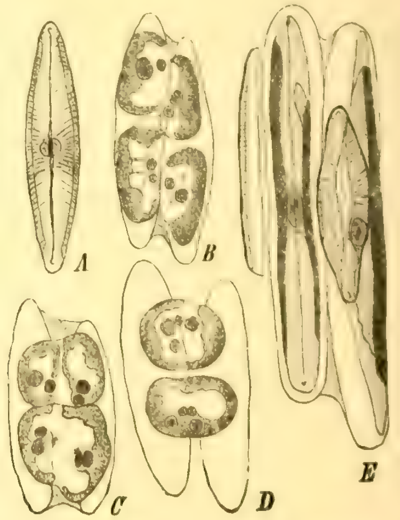


Fig. 10. Formation of auxospores of *Navicula viridula* Kütz. *A*. Face-view of cell. *B*. Two cells, their contents dividing each into two daughter-cells. *C*, *D*. Copulation of corresponding couples, each one forming one auxospore with 4 nuclei. *E*. The two adult auxospores, 700/1. (After Karsten)

It follows from what has been said that there are three points of view from which a diatom may be examined :

I. Looking down on one of the valves, known as the ***valve view*** (Fig. 9, 1).

II. Looking down on the girdle (*i.e.* with the two valves in profile) known as the ***girdle view*** (Fig. 9, 2).

III. Looking at the end of the diatom, known as the ***end view***.

On looking at a number of diatoms under the microscope, it generally happens that practically all are lying so as to exhibit either the "valve" or the "girdle" view, whereas it is a more difficult matter to see them in "end view." The two valves are exactly alike, except for a trifling difference in size, so the frustule is symmetrical about three planes at right angles to one another. The valves are often ornamented with numerous fine transverse markings, and in many cases a longitudinal opening (visible as a line) is found running nearly the whole length of each valve. This is known as the ***raphe***. Immediately within this are found three swollen ***nodules***, one in the centre, the central nodule, and one at each end of the raphe, the terminal nodules. Diatoms possessing a raphe exhibit peculiar movements, the exact cause of which is not fully understood, though it appears to be connected with the extrusion of mucilage from the nodules, through which run very fine pores called ***canaliculi***. Each frustule has a central nucleus, and one or more chloroplasts embedded in its lining layer of protoplasm, the green colour of which is however quite masked by the golden brown colouring matter, ***diatomin*** (Plate 2, Fig. F), which is always present.

Reproduction occurs (1) by division of the cells, and (2) by the formation of special spores called ***auxospores***. In the first named method a swelling of the contents of a frustule pushes the valves apart. The contents then divide into two parts, each part retaining one valve of the original frustule. Then each daughter-cell forms a new valve to fit inside the old one. Since the valves are incapable of growth in most cases, one of the daughter-cells formed at each division will be smaller than the mother-cell. This reduction in size of the frustules does not, however, proceed indefinitely, but when a certain minimum size has been attained, auxospore formation restores the original size.

As the name implies the auxospore is a much larger body than the cells from which it is formed, rapid growth taking place during its formation. It may be formed in various ways, either sexually or non-sexually. The method in *Navicula* may serve as an example of one of the more complex ways (Fig. 10). In this case two frustules come to lie side by side, the contents of each swell, cast off the valves and divide, and the nucleus of each daughter-cell divides again to form one large and one smaller nucleus; then each daughter-cell fuses with one of the daughter-cells of the other frustule, the larger nuclei uniting, the smaller disintegrating: each of the two resulting cells is an auxospore. Gradually the auxospore assumes the form of the ordinary frustule.

IX. PHAEOPHYCEAE.

The Brown Algae.

The Phaeophyceae include some of the largest known plants, the length of the largest species being three times that of the tallest forest trees. They range in size from these marine giants to forms scarcely visible to the naked eye.

They show a similar diversity both in external form and internal structure, the larger kinds often rivalling the higher plants in both respects while the smaller ones are among the simplest of algae.

It is plants of this family*, almost exclusively marine, which form the main portion of the "sea-weeds" on our shores, especially that part growing on the rocks between high and low water, and the same may be said of the sea coast all over the world. "Kelp," from which iodine can be obtained, is made up of a few common species of brown algae†.

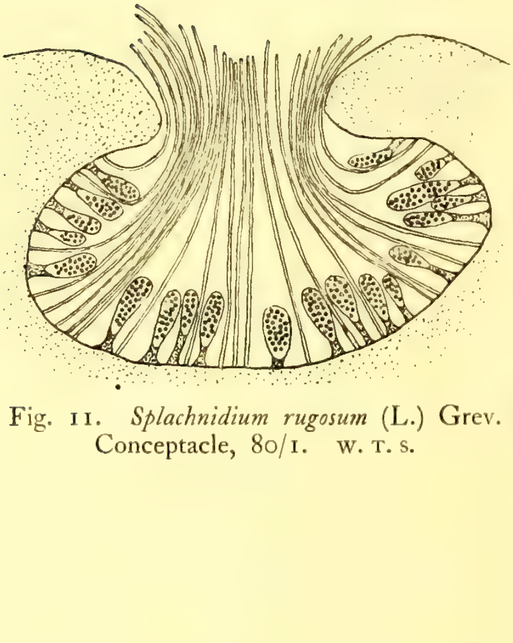


Fig. 11. *Splachnidium rugosum* (L.) Grev. Conceptacle, 80/1. W. T. S.

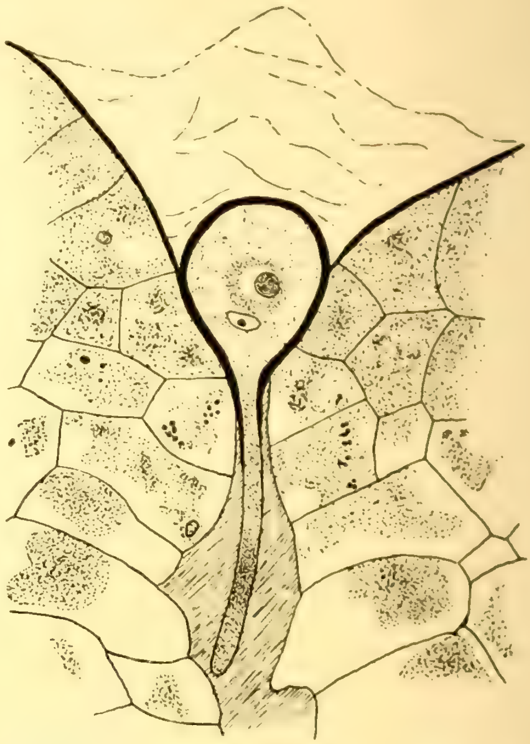


Fig. 12. *Splachnidium rugosum.* Apical cell in long. section, 1000/1. W. T. S.

While the majority of the genera of the Green and Blue-green Algae occurring in South Africa are more or less cosmopolitan in their distribution, we find, on turning to the brown and red forms, that the geographical range is more restricted, and that, as a consequence, there are several genera which do not occur in the Northern hemisphere.

* See W. H. Harvey, Nereis australis, 1847.

† All sea-weeds contain iodine in the form of iodides. Although there is only an infinitesimal amount of these compounds in the water the sea-weeds are able to store them in their tissue, hence the ashes of sea-weeds form one of the principal raw materials for the manufacture of iodine. Its presence in any of these algae can be easily demonstrated under the microscope. Place a thin section of a *Fucus* or *Laminaria* or *Ecklonia*, etc. on a slide in a little water, add a few starch grains, cover and allow a drop of a strong solution of ferric chloride to enter from the edge of the coverglass. Iodine is liberated and stains the starch grains blue. R. M.

Among the Brown Algae an example of this kind is the genus *Splachnidium* (Plate 2, Fig. B) which is not only confined to the rocky coasts of the southern seas, but is also the only known representative of its family. The general appearance of the plant is well shown in the figure, a characteristic feature being the very slender base of the axis and its branches. The dots on the surface mark the position of flask-shaped cavities called ***conceptacles***. Each of these is lined by a number of hairs, most of which project through the apex of the cavity; among them are several club-shaped bodies called ***sporangia***, each of which contains numerous zoospores. These are set free, come to rest, and grow into new *Splachnidium* plants. The growth of the axis is controlled by means of a very remarkable apical cell, quite unlike any other apical cell known in the plant kingdom. It is found in the centre of a small depression in the somewhat flattened apex (Fig. 12). The central part of the plant is made up of branched filaments embedded in mucilage.

Another characteristic Cape sea-weed is the large *Ecklonia buccinalis** or sea-bamboo, from the basal part of which fish horns† are often made. This basal part is cylindrical and hollow, often three or four feet long, very tough, and attached to the rocks by means of irregularly-branched hold-fasts. It terminates above in a large frond, split almost to the base into a number of linear segments. At the junction of stalk and frond a few smaller segments occur, on the smooth surface of which certain slightly raised areas are found. These mark the position of the reproductive organs, which cover the raised portion of the thallus and consist of club-shaped sporangia very similar to those already met with in *Splachnidium*.

X. RHODOPHYCEAE.

The Red Algae.

While the Brown Algae are conspicuous for their size the red forms are remarkable for their beauty. They are all fairly small, although the thallus may show considerable complexity, and nearly all are marine, growing at or below low water. A very few of the simplest red algae, however, grow in fresh water.

Amongst the Red Algae one of the most characteristic South African genera is *Cheilosporum*. This is a small, fan-shaped, pale strawberry-coloured plant, generally growing in rather dense tufts on the rocks, at or just above low water mark. The plant is illustrated in Plate 2, Fig. L. Like other members of the family, Coral Algae, is is somewhat thickly incrusted

* Named after Christian Friedrich Ecklon, an apothecary, who came to the Cape in 1823. Fired with enthusiasm for botany, he gave up his profession and made large collections of plants in various parts of South Africa.

† The drivers of carts offering fish for sale in the streets of Capetown and other ports blow these horns in order to make their presence known.

with lime. The branches are all made up of more or less V-shaped segments, the cells connecting one segment to the next being thicker and stronger than the rest as shown in Fig. 13. The most frequent method of reproduction is by means of spores which are formed in rows of four, and are therefore known as ***tetraspores***. This is one of the characteristic methods of reproduction in the Red Algae, though the tetraspores are often arranged in a tetrad instead of in a row.

In *Cheilosporum*, the tetraspores are formed in flask-shaped cavities in the thallus, called ***conceptacles***, the position of which is shown in Fig. 13, and the structure more clearly in Fig. 14.

Besides the tetraspores, which constitute a non-sexual means of reproduction, there is a characteristic method of sexual reproduction in the Red Algae, unique in the plant kingdom. It has been shown that, in some forms at least, a regular alternation of generations exists in these plants, quite comparable to that met with in the Mosses and Ferns. Although this has not been definitely proved in the case of *Cheilosporum*, it may be assumed that sexual

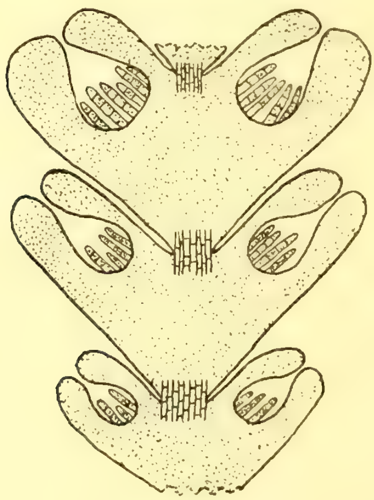


Fig. 13. *Cheilosporum cultratum* (Harv.) Aresch. Portion of thallus, 40/1. W. T. S.

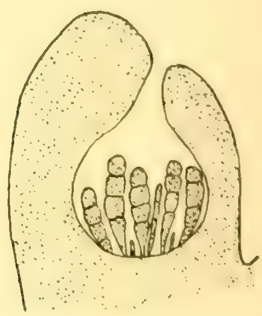


Fig. 14. *Cheilosporum cultratum.* Conceptacle, 75/1. W. T. S.

organs are produced by the plants which are formed on germination of the tetraspores, and that tetraspores are produced by the plants which result from germination of the sexually produced spores. It is known that male, female, and tetraspore-bearing plants are distinct from one another. Male and female reproductive cells are each produced in conceptacles similar to those in which the tetraspores are found. The male cells are very small, motionless, spherical bodies, called ***pollinoids***, formed in enormous numbers in each conceptacle. The female reproductive organ is called a ***carpogonium***, and is the terminal cell of a short row of cells called the procarp or carpogonial branch. The carpogonium ends in a long hair-like projection called the ***trichogyne***, and to the latter the pollinoids become attached. Fertilisation then takes place, but the fertilised carpogonium, instead of itself developing into the fruit body, puts out a tube through which the embryonic cells are conveyed to a neighbouring cell, called an ***auxiliary cell***, in which the further development is completed. The auxiliary cell then forms a number of short tubes each of which produces one or more spores, the ***carpospores***, the whole structure produced by the auxiliary cell being called the ***cystocarp***. Several groups of cells, each containing one fertile carpogonial branch and one auxiliary cell, are found in each conceptacle, which therefore subsequently contains a corresponding number of cystocarps*.

As a second example of the Red Algae the genus *Gelidium* may be mentioned (Plate 2, Fig. K). This represents the commonest type of plant body (thallus) met with among Red Algae, namely one which is freely branched, the branches being rather slender and somewhat leathery in texture. The tetraspores of *Gelidium* are arranged in cruciate form. The sexual reproductive organs are similar to those of *Cheilosporum*, but are not sunk in special conceptacles as they are in that genus. The carpogonium is found just below the surface of the thallus, surrounded by a number of auxiliary cells, the trichogyne projecting on the outside through a small opening in the surface of the thallus. After fertilisation the embryonic cells, unlike those of *Cheilosporum*, develop in the carpogonium; but when the spore-bearing tubes are produced, each becomes joined to an auxiliary cell before producing a spore. The cystocarp is shown in Fig. 15.

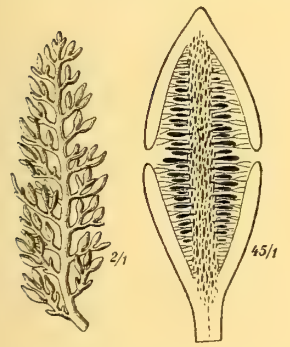


Fig. 15. *Gelidium cartilagineum.* (L.) Gaill. 1. Habit of a pinnule. 2/1. 2. Longitudinal section through a bilateral, terminal cystocarp. 45/1. (After Schmitz)

* In such cases the whole conceptacle with its contents is generally called the cystocarp.

XI. EUMYCETES.

The Fungi.

The Fungi fall naturally into four classes :

I. Phycomycetes (*Algal Fungi*), which exhibit reasonably clear affinities with the Algae. An example of this class is the common white mould.

II. Ascomycetes, including such forms as the edible morels and truffles.

III. Basidiomycetes, to which the edible mushrooms, the poisonous Amanitas, and all the "toadstools" and "puff-balls" belong.

IV. Uredineae (*Rust Fungi*), which include many of the worst disease-causing fungi, such as the rust fungi of cereals, the coffee disease, etc.

These classes differ widely from one another in many respects, but all agree in the fact that the vegetative part of the plant consists of a number of slender, branched filaments, called individually the ***hyphae*** and collectively the ***mycelium*** of the fungus. All fungi agree also in the entire absence of chlorophyll, and hence are obliged to obtain their food from organic materials. If they obtain this food from other living organisms they are known as ***parasites*** (*e.g.* rust of wheat) ; if from non-living organic substances they are called ***saprophytes*** (*e.g.* mushrooms).

Class I. Phycomycetes.

There are two well marked families of this class, and both are of some importance. The first is the Oomycetes, including a number of parasites, most of which destroy seedlings. The disease caused by them is known as the "damping off" of seedlings. Perhaps the best known member of the family, however, is that which causes the potato disease, *Phytophthora infestans*. The spores of this fungus germinate in wet weather on the leaves of the potato plant, and produce a mycelium which grows first in the tissues of the leaf, and from there spreads to the stem and finally to the tubers. After growing in the leaf for a few days, some of the hyphae begin to grow out of the stomata. These are stouter than the ordinary vegetative hyphae and branch a few times after leaving the stoma. At the end of every branch a single pear-shaped sporangium (Fig. 16 B) is formed, and then immediately below it a branch is given off, which soon grows in such a way as to appear merely a continuation of the original branch, and at its end a second sporangium is formed, after which the process is repeated. This successive formation of lateral branches, which become straightened, gives a very characteristic beady appearance to the ***sporangiophore***, sometimes

(*continued on* p. 24)

CLASS EUMYCETES

Pezizaceae (A) Uredineae (B) Agaricaceae (C) Phallineae (D) Lycoperdaceae (E. F.)

Plate 3.

A: Bulgaria spec. B: Aecidium resinicolum *(Rud.) Wint.*
C: Amanita phalloides *(Fries) Quélet* D: Anthurus Mac Owani *Marl.*
E: Lycoperdon pratense *Pers.* F: Geaster velutinus *Morgan*

Plate 3.

A. *Bulgaria* spec. (Discomycetes). From Table Mountain. 2400 feet. September.

B. *Aecidium resinicolum* (Rud.) Wint. (Uredineae). On a twig of *Rafnia angulata.* From the neighbourhood of Capetown. September.

C. *Amanita phalloides* (Fries) Quélet (Agaricaceae). The ***death-cup.*** Very poisonous. From pine woods near Stellenbosch. May. ***Paddestoel*** (vergiftig), ***Slang-kost.***

D. *Anthurus MacOwani*, sp. nov. (Phalloideae). From Somerset West. 2. Transverse section through a segment, 3/2, showing the air-chambers. The diagnosis is given below.

E. *Lycoperdon pratense* Pers. (Gasteromycetes-Lycoperdaceae).
"Meadow puff-ball." Neighbourhood of Capetown. May. 2. Long. section through nearly ripe fungus. (Somewhat diagrammatic.) The dark portion is the gleba in a pulpy condition, which on drying is transformed into the powder of the puff-ball.

F. *Geaster velutinus* Morgan (Lycoperdaceae). 1. Young plant. 2. Adult plant, the outer peridium split. From Eastern Cape Colony. The common *G. hygrometricus* is of universal occurrence; the rarer *G. pectinatus* and several others are found occasionally.

Description.

A. The genus *Bulgaria* is nearly allied to *Peziza*; the plants generally occur in damp localities, especially where cattle are grazing. Several S. A. species of these genera are undescribed. (See page 28.)

B. This fungus is not known as yet in the uredospore or teleutospore form. (See page 34.)

C. The "death-cup." This contains two poisonous principles, viz. an alkaloid somewhat resembling that of the fly-mushroom, which is ***muscarine***, and a haemolytic substance (toxalbumin) called ***phalline*** (Kobert). Numerous cases of poisoning have been caused by this plant, as it is occasionally, especially by strangers, mistaken for the ordinary eatable mushroom. It appears (in the Western Province) during April and May, mostly in oak- or pine-woods, rarely on open ground. With a little care it can be easily distinguished from the common field mushroom by the colour of its gills, for these are white, even on adult plants, and joined to the stalk. The cap generally, not always, bears a few bits of the annulus on its upper side, and the bulbous base of the stalk is surrounded by a split membrane. The colour varies from a light drab to brown, mostly with a greenish tinge.

How dangerous this mushroom is may be gathered from the fact that some years ago a cook at Elsenburg College, an Indian who had come from Natal, was thrown into terrible agony for 36 hours merely by having eaten some rice that had been boiled in a pot, which his mate had just used for stewing some of the *Amanita.* The mate died the same day.

D. *Anthurus MacOwani**. This handsome fungus appears in May in oak-woods near Somerset West, whence it was brought to us by Mr N. S. Pillans. It is of a very spongy texture, the strands of hyphae of which it is constructed being separated by large air chambers. The dark red patches on the inner side of the segments shown in the figure are particles of the slimy gleba (masses of spores) left there on the separation of the segments.

This species somewhat resembles a plant from Natal, described by Kalchbrenner and MacOwan as *Anthurus Woodii*†, but it differs from it by the shorter stipes and the much longer lanceolate acuminate segments, which are 6 to 8 times as long as wide. The black spores are very minute.

E. *Lycoperdon*. There are a number of species of puff-balls in South Africa, most of them probably introduced and spread by sheep or cattle. One of the most common species is *L. pratense* in several varieties, appearing especially on grazing lands at the beginning of winter. (See page 30.)

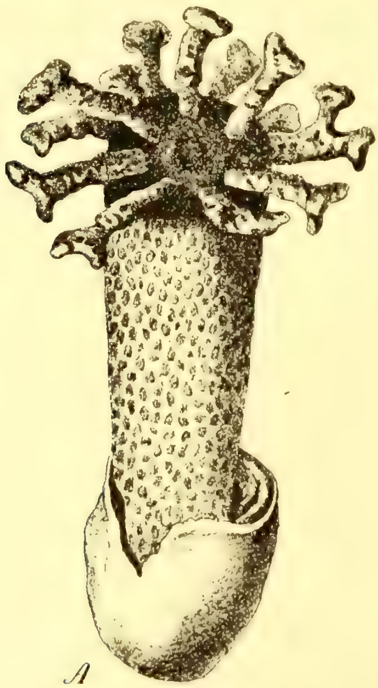


Fig. 15 *a*. *Kalchbrennera corallocephala* (Welw. & Curr.) Ed. Fisch. 2/3 nat. size. The stipes is yellowish, the short branches are carmine. Said to be phosphorescent. (After Kalchbrenner ex Engler & Prantl)

* *Anthurus MacOwani*, sp. nov. Peridium ovoideum, albidum, irregulariter rumpens; pedunculus brevis, cylindraceus, albidus, in 5—6 lacinias divisus. Laciniae simplices, elongatae, acuminatae, recurvae, pedunculo 3plo longiores. (For the diagnosis of the genus *Anthurus* Kalchbr. & MacOw. see K. Kalchbrenner, Phalloidei Novi vel minus cogniti. Budapest 1880.) Named in honour of Dr P. MacOwan, for many years the only botanist in South Africa who paid any attention to fungi.

† C. G. Lloyd, who examined the dried specimens of the plant originally sent to Kew by Dr Medley Wood of Durban, declares it to be a *Lysurus* and not an *Anthurus*, Kalchbrenner's figure being an incorrect representation. The name would consequently be *Lysurus Woodii* (Kalchbr. & MacOw.) Lloyd. See Lloyd, Synopsis of the known phalloids. Cincinnati 1909. Other phalloids from South Africa represented in European collections are *Dictyophora phalloidea* (Fig. 24, facing p. 30) and *Kalchbrennera corallocephala*, the latter being fairly frequent in the East and South East.

CLASS EUMYCETES

Helvellaceae (A) Agaricaceae (B. C) Polyporaceae (D)

Plate 4.

A: Morchella conica *Persoon* B: Psalliota campestris *(L.) Fries*

C: Amanita muscaria *(L.) Persoon* D: Boletus edulis *Bulliard*

Plate 4.

A. *Morchella conica* Persoon (Discomycetes). The edible morel.

B. *Psalliota campestris* (L.) Fries (*Agaricus campestris* (Basidiomycetes-Agaricaceae). The common field mushroom (edible). *Champignon*, ***Kampernoelie.***

C. *Amanita muscaria* (L.) Persoon (Agaricaceae). The fly-mushroom or fly-agaric. A young specimen. Very poisonous. Vergiftige ***Paddestoel.***

D. *Boletus edulis* Bulliard (Basidiomycetes-Polyporaceae). The stone-mushroom. Edible. ***Eetbarezwam.***

All from the Cape Peninsula.

Description.

Morchella conica. The pointed morel, which is one of the most highly esteemed mushrooms in Central Europe, occurs here in oak-woods or among shrubs of the Western Province in spring (September, October). About 25 years ago the author found only a few specimens among the oaks at the Round House near Capetown, but gradually the plant has spread and occurs now in various localities on the Cape Peninsula and probably elsewhere. It imparts a delicious flavour to roast meat, but may be also prepared like the common field mushroom or the boletus.

Psalliota campestris (Champignon, locally pronounced "zampion"). The common field mushroom appears in autumn in meadows and on grassy slopes, especially where cattle graze. It can always be distinguished from the deadly *Amanita phalloides* [See Plate 3] by its gills, which are pink or salmon coloured on young plants, turning dark brown or even black on older ones. The gills are free from the stalk, and the base of the stalk is not surrounded by a membrane.

Amanita muscaria. This is a very young plant of the fly-agaric, adult specimens having an expanded cap 3—5 inches in diam. It appears in autumn, especially in pine and poplar woods. In some countries, *e.g.* Siberia, it is eaten in order to produce a state of intoxication.

The name fly-mushroom or fly-agaric has been given to it because it is or was employed for preparing fly-poison by boiling some slices of it with milk.

Boletus edulis. This is one of the most common mushrooms used in Northern and Central Europe, growing often in profusion in pine- and fir-forests at the end of summer. Twenty years ago it was a great rarity in South Africa, occurring only under some oaks on the Orangezicht estate, but now it is found in almost all the oak woods around Table Mountain as well as at the Paarl, Stellenbosch and Wellington, appearing in April and May according to the autumnal rains. It attains much larger dimensions here than in Europe, weighing not rarely two and occasionally three pounds, the cap being 8 or 10 and even 12 inches in diameter, and yet quite firm and sound.

The squirrels (introduced from Canada) are also fond of it, but do not touch the *Amanita phalloides*, although both kinds of fungus grow often intermingled.

A near ally, *Boletus bovinus*, also edible although not quite so tasty, is somewhat moist and shining on the upper side, while the lower side of the cap is yellow or greenish yellow. This occurs more frequently in pine woods. Any one not well acquainted with mushrooms is advised to use none but the common field mushroom and that only in the fresh state.

*called ***conidiophore***, of *Phytophthora* (Fig. 17), the main branches showing a series of contractions which mark the bases of successive lateral branches.

The sporangia fall off when ripe, and the contents of each then divide up to form about eight motile zoospores (Fig. 17 C and D). These are as a rule only liberated when plenty of moisture is present, swimming about in drops of dew or rain on the plant, finally coming to rest and starting the disease afresh.

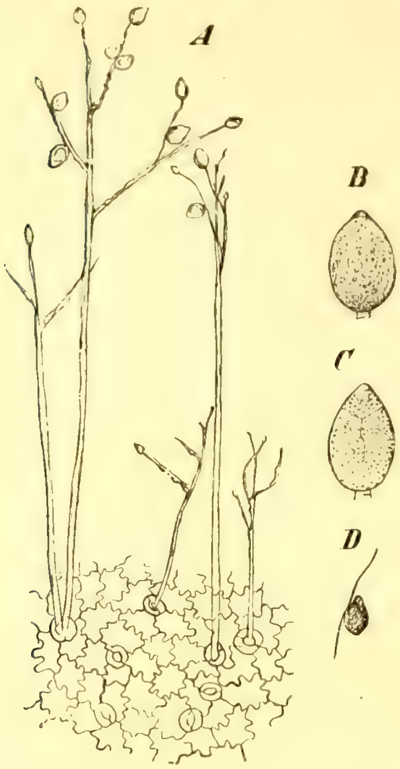


Fig. 16. *Phytophthora infestans*. *A*. Lower surface of potato leaf, showing the sporangiophores protruding from the stomata. 90/1. *B*. Mature sporangium. *C*. The same, its contents aggregated. *D*. Motile spore (zoospore). *B–D* 540/1.
(After H. Schenck)

Sexual reproduction is also met with in the family. The sexual organs are ***oogonia*** (female) and ***antheridia*** (male). The former are large, terminal, spherical cells at the ends of some of the hyphae; the latter are smaller and more or less club-shaped, growing close to the oogonia, but usually arising from separate hyphae (Fig. 18). When both are mature the antheridium puts out a very slender ***fertilising tube*** which penetrates the wall of the oogonium; through this some of the contents of the antheridium pass into and fertilise the single egg-cell. The latter then surrounds itself with a thick cell-wall and becomes an ***oospore***; this remains dormant until it is eventually set free by the decay of the surrounding tissues of the diseased host-plant. Only the oogonia and oospores of *Ph. infestans* are known at present, the antheridia still remaining to be discovered. (See Kew Bulletin 1913, p. 192.)

Closely allied to the potato disease is the "False Mildew" of the vine, caused by the fungus *Plasmopara viticola*. Here the conidiophores arise in tufts from the stomata of the leaf, and each is very much branched, the ultimate branches being very small and short and arranged in groups of three (see Fig. 19). In other respects it closely resembles *Phytophthora*.

The second family of the Algal Fungi are the Zygomycetes, the only well-known member of which is the common white mould, *Mucor*. This is described in so many botanical text-books that the reader is referred elsewhere for an account of its life history.

Related apparently to both these families is the "locust-fungus," *Empusa Grylli*. This is entirely parasitic on the bodies of locusts, quickly killing the

* Continuation from page 20.

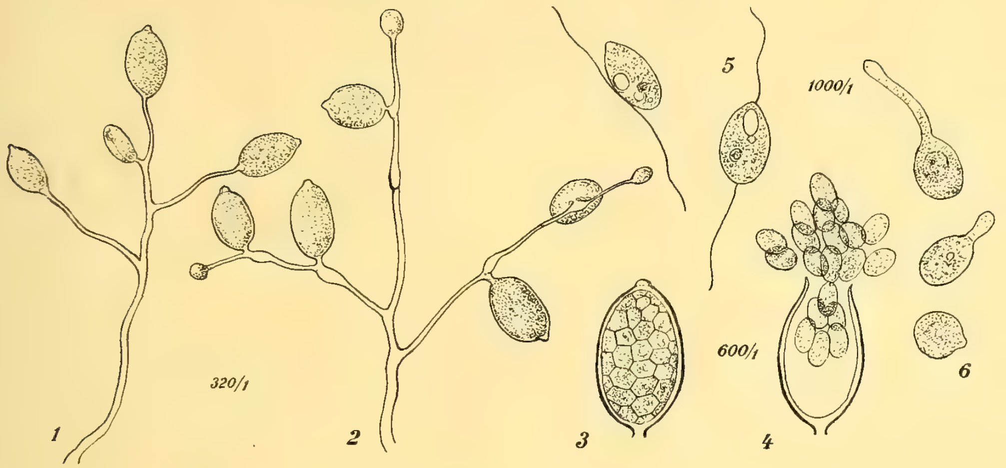


Fig. 17. *Phytophthora infestans* (Montagne) De Bary 1. Conidiophore with conidia. 2. Later stage, the older conidia being pushed aside. 3–6. Zoospores. 3. Enclosed in the conidium. 4. The discharging of the zoospores. 5. Liberated zoospores. 6. Germination. (After De Bary)

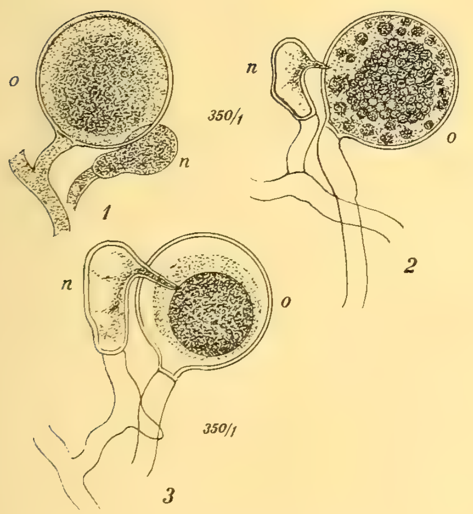


Fig. 18. *Peronospora alsinearum* Casp. Formation of oospore. 1. Young stage. 2. Formation of oosphere and fecundation-tube. 3. After fecundation. *n*, antheridium; *o*, oogonium. 350/1. (After De Bary)

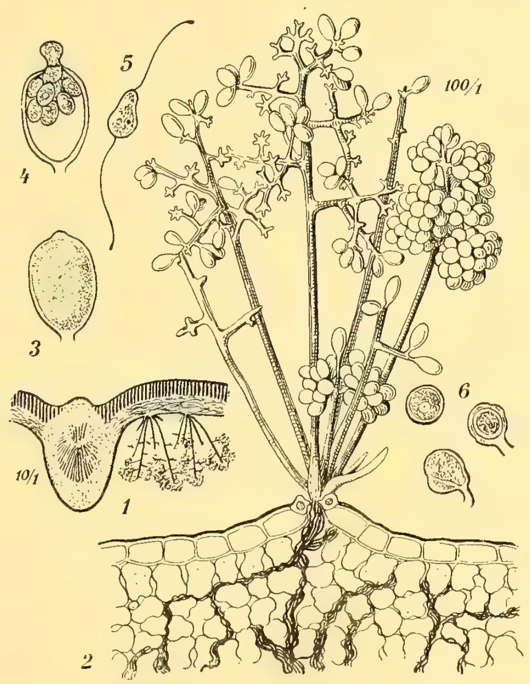


Fig. 19. *Plasmopara viticola*. 1. Portion of diseased vine-leaf (section), with conidiophores. 2. A smaller piece. Conidiophores with conidia. 3. Conidium (Sporangium). 4 and 5. Formation of zoospores. 6. Oospore. (After Millardet)

infected insects. A spore which finds its way to a suitable insect germinates, putting out a hypha which penetrates into the body of the victim, and there sprouts in a yeast-like manner, producing a large number of separate cells. Death soon follows, and then each yeast-like cell produces a hypha which grows out through the skin of the insect, and then forms, at its apex, a single conidium. It has been attempted to use this fungus as a means of destroying locusts ; but so far this has not been generally practicable, mainly owing to the fact that the fungus cannot be cultivated as a saprophyte on any of the ordinary media.

Class II. Ascomycetes.

This class is primarily characterised by the formation of a special reproductive organ, the ***ascus***, in which almost invariably eight ascospores are produced. Other methods of reproduction are often met with in addition.

Three sub-classes may be conveniently recognised, based on the structure of that part on or in which the asci are found :

A. Perisporiales. Asci completely enclosed in a ***cleistocarp***.

B. Pyrenomycetes. Asci in a flask-shaped cavity, open only at the apex, the ***perithecium***.

C. Discomycetes. Asci on the concave, upper surface of a saucer or cup-shaped structure, the ***apothecium***.

In addition there are a few forms in which the asci either do not contain the typical, definite number of spores, or are borne directly on the mycelium. The yeast plant is the most important of these.

Sub-class A. Perisporiales. To this sub-class belong some of the blue-green moulds (mostly saprophytic), some parasites of plants, viz. the mildews of the vine, tobacco and vegetable marrow, and lastly the edible truffles (*Tuber brumale* and *T. aestivum* of Central Europe), the fruit bodies of which occur underground.

Two indigenous species of truffles, belonging to the genus *Terfezia*, are found in the Kalahari, occurring near shrubs of *Acacia hebeclada*, generally 3—4

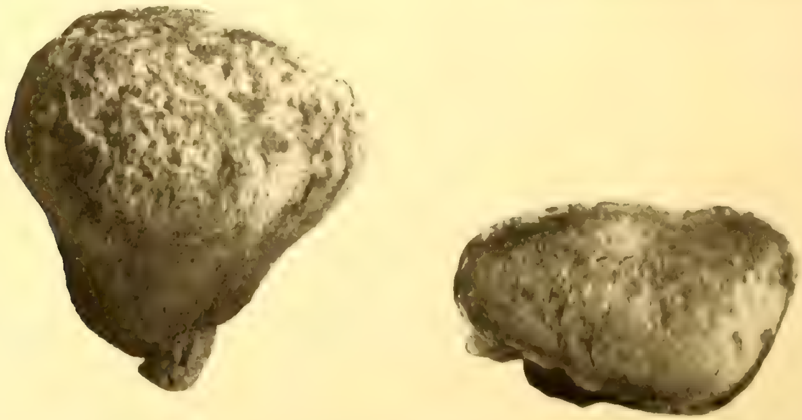


Fig. 19*a*. *Terfezia Claveryi* Chatin. From neighbourhood of Windhuk. Side view and transverse section. 2/3 nat. size. Photo. by Frau C. Bohr

inches below the surface of the ground. They are much esteemed as an article of diet when in season (March—June)*.

The fungus causing the mildew of the vine is known botanically as *Uncinula spiralis*†. The mycelium of the fungus, unlike that of *Phytophthora* and most other parasites, does not penetrate the tissues of the host-plant, but forms a web on the outside only, attached to the leaf or berry by means of very minute outgrowths from the hyphae called ***haustoria***, which penetrate the outer cells and extract nourishment from them. Here and there, on the mycelium, short upright hyphae occur, on which chains of conidia develop (Fig. 20 A), each conidium being capable of immediate germination if carried by the wind to another leaf. It is the presence of these conidia which gives the characteristic appearance of a "mildewed" leaf, as though flour had been dusted on the surface. In South Africa no other method of reproduction is met with, but in North America the ascus-bearing fruit-body (***cleistocarp***) is sometimes found (Fig. 20 C). This is nearly spherical and consists of a somewhat thick wall, bearing a number of long, simple hairs coiled near the apex, and enclosing a small number of oval asci, each containing four or eight ***ascospores***. The cleistocarp, owing to its thick hard wall, can withstand long periods of drought.

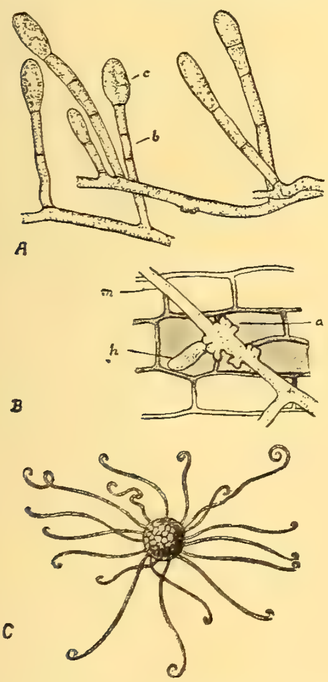


Fig. 20. *Uncinula necator* (*U. spiralis*). *A.* Conidiophores, *c*, conidia. *B.* Mycelium on surface of leaf of vine. *h*, haustorium. *C.* Cleistocarp (perithecium). (After Sorauer and Lindau, Pflanzenkrankheiten)

Sub-class B. Pyrenomycetes. A good South African representative of this order is a fungus, parasitic on yellow-wood trees (*Podocarpus*), called *Corynelia* (see Fig. 21, also Plate 17, Fig. A, 4). In the same figure is illustrated another very closely related fungus, also occurring on *Podocarpus* at the Cape, and only differing in the shape of the spores. The ***perithecia*** are about a millimetre in length as shown in Fig. 21, 1. Fig. 21, 9 represents a section of one of the perithecia. From the base of this are borne a considerable number of asci (2), each with eight brown spores. Other smaller flask-shaped cavities are also met with, called ***pycnidia*** (4), each lined with hyphae bearing exceedingly small ***pycnospores*** (5). Some trees in damp situations suffer considerably from the attacks of this fungus.

The "Ergot" of grasses, especially of the rye, also belongs to this order.

* *Terfezia Claveryi* and *T. Boudieri*, both known from North Africa and used there under the name "terfaz."

† The "true mildew" of the vine, more generally known as *Oidium Tuckeri*; but this name applies only to the conidial stage.

Sub-class C. Discomycetes.

[See *Bulgaria* (Plate 3, Fig. A) and *Morchella* (Plate 4, Fig. A).]

The apothecia of the species of *Bulgaria* and *Peziza* occurring at the Cape are usually urn-shaped, and have a basal stalk embedded in the ground. They are about an inch high, and of the same breadth. The apothecium is more or less hairy on the outside, but very smooth and often brightly coloured on the concave side, where the ***hymenium*** (made up of the closely packed asci) is found. The asci (Fig. 22) are long and cylindrical, but somewhat narrowed to the base, and contain eight ovoid spores in a row at the apical end, which are eventually discharged through an apical pore (Fig. 22). The figure also shows two of the sterile hairs (***paraphyses***) which always occur among the asci. In some species of *Peziza* other reproductive spores (***conidia***) are met with, but these are not known to occur in the South African forms.

Morchella conica (Plate 4, Fig. A) is one of the edible morels and resembles to some extent an ordinary mushroom, but its structure is entirely different. It consists of a stalk, surmounted by a cap, on the outer surface of which are a number of saucer-shaped depressions, each similar to a shallow apothecium of *Peziza*. On the concave surface of each are found the asci, which are similar to those of *Peziza*, like them containing eight spores but somewhat broadened at the apex.

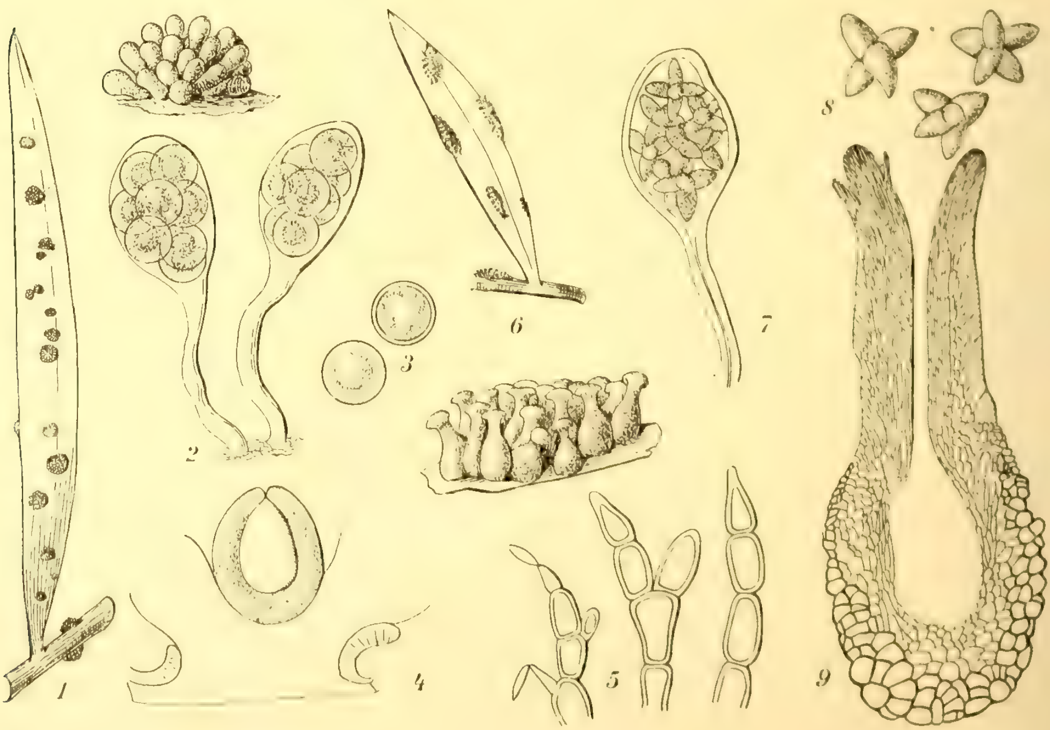


Fig. 21. 1–5. *Corynelia clavata* (L.) Sacc. 1. Leaf of *Podocarpus* with carpophores. 2. Asci, 500/1. 3. Spores, 1000/1. 4. Long. section of pycnid, 90/1. 5. Sterigmata and spores of the pycnid, 600/1. (After Lindau & Wille) 6–9. *Tripospora tripos.* 6. Leaf with carpophores. 7. Ascus. 8. Spores, 600/1. 9. Section through wall of carpophore, 100/1. (From Engler and Prantl)

Class III. Basidiomycetes.

These include by far the greater number of those plants which are popularly known as "fungi," *i.e.* all the mushrooms, toadstools, puff-balls, stinkhorns, "bird's nest fungi," and "bracket fungi" (on tree-trunks), etc. The class is characterised by the formation of a special type of spore, called the ***basidiospore***. These are produced in definite numbers (generally four, rarely two or three) on the outside of a stout hypha called the ***basidium***. The basidia, except in one or two of the very simplest forms, are grouped closely together in a ***hymenium***, and the families are based to a large extent on the position and extent of the hymenium.

The two main sub-divisions* are the Hymenomycetes, in which the hymenium is freely exposed before the spores are mature, and the Gasteromycetes, in which the hymenium is completely enclosed until (or after) the spores are ripe. Of the Hymenomycetes the best known and largest family is the Agaricaceae, to which the ordinary edible mushroom belongs as well as some very poisonous species.

Fig. 22. *Peziza* spec. Ascus and paraphyses, 300/1. W.T.S.

Agaricaceae. Examples of this family are shown in Plate 4, Fig. B (the edible mushroom), Plate 3, Fig. C (the "death cup"), and Plate 4, Fig. C (the fly-mushroom). The two latter are exceedingly poisonous, nearly all the cases of mushroom-poisoning being caused by the "death cup."

The main points in the structure and development of the common mushroom, *Psalliota campestris*, are: The vegetative part, the ***spawn***, consists of rather thick strands of hyphae which spread in the soil. On these the mushrooms first appear as little swellings. The mature ***sporophore*** consists of a stalk and an umbrella-shaped cap, called the ***pileus*** Half-way up the stalk are the remains of a thin white membrane, forming a ring round the stalk, called the ***annulus***. On the lower side of the pileus are a number of radiating lamellae or ***gills***. On the outer surface of the gills (forming the hymenium) are the basidia, each of which bears from two to four small basidiospores. Mixed with these are the ***paraphyses***, which resemble the basidia but are sterile. Figure 23 shows a small part of the hymenium in a related plant. These mushrooms are rarely reproduced by

* Some of the smaller groups, *e.g.* the smut diseases and the quivering fungi, have been omitted in order to simplify the classification here given.

means of the spores, the "spawn" being invariably used for this purpose in cultivation, and probably acting in a similar way in nature also.

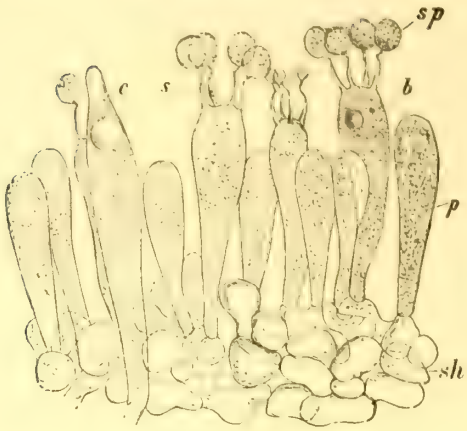


Fig. 23. *Russula rubra.* Portion of hymenium. *sh*, sub-hymenial layer; *b*, basidia; *s*, sterigmata; *sp*, spores; *p*, paraphyses; *c*, cystid, 540/1. (From Strasburger, Textbook)

The above description of the common edible mushroom will apply to a large number of related fungi.

Polyporaceae. Plate 4, Fig. D. The fruit-body consists of a stalk and a pileus, but the hymenium, instead of occurring on gills, lines the inner surface of a large number of slender, closely packed tubes (***pores***), lying at right angles to, and opening upon, the under surface of the pileus. The hymenium itself is very similar to that of *Psalliota*. The layer of pores in *Boletus* is rather thick and is easily detached from the rest of the pileus.

Gasteromycetes. Of these, two families are of interest, viz. Lycoperdaceae and Phalloideae.

Lycoperdaceae. The puff-balls (Plate 3, Figs. E and F). When young the whole of the dark brown (fertile) part in Figure E is made up of a number of irregularly-shaped cavities in a mass of mycelium. Each cavity is lined with hymenium (similar to that of *Psalliota*), and as the spores ripen all the rest of the fertile part of the fruit-body breaks down to form a watery fluid, with the exception of some thick-walled, branched hyphae called ***capillitia***. The fluid gradually dries up, leaving the spores and capillitia as a dry powdery mass, forming a cloud of brown dust if the fruit-body is accidentally broken. (Hence the name "Puff-ball.")

Plate 3, Figure F, 1 and 2, represent respectively young and mature fruit-bodies of one of the "earth stars." It differs from *Lycoperdon* chiefly in the fact that the outer covering of the fruit-body (the ***outer peridium***), splits regularly from the apex outwards, and becomes bent out or reflexed, giving the whole plant, looked at from above, its characteristic star-like appearance. In other respects the structure of *Geaster* is very similar to that of *Lycoperdon*.

Phalloideae. One of the most striking of South African fungi is the rather rare plant shown in Plate 3, Fig. D, viz. *Anthurus MacOwani*. When young the fruit-bodies of all phalloids look just like white eggs peeping half out of the ground. Our example, in this stage, is about the size of a hen's egg. Later the "egg" splits irregularly at the apex, and the enclosed structure rapidly grows out. Without going into detail it may be mentioned that a small portion of the centre of the young fruit-body has a similar structure to the fertile part of *Lycoperdon*, but before the "egg" bursts, this part disintegrates and forms a dark liquid in which the spores are suspended.

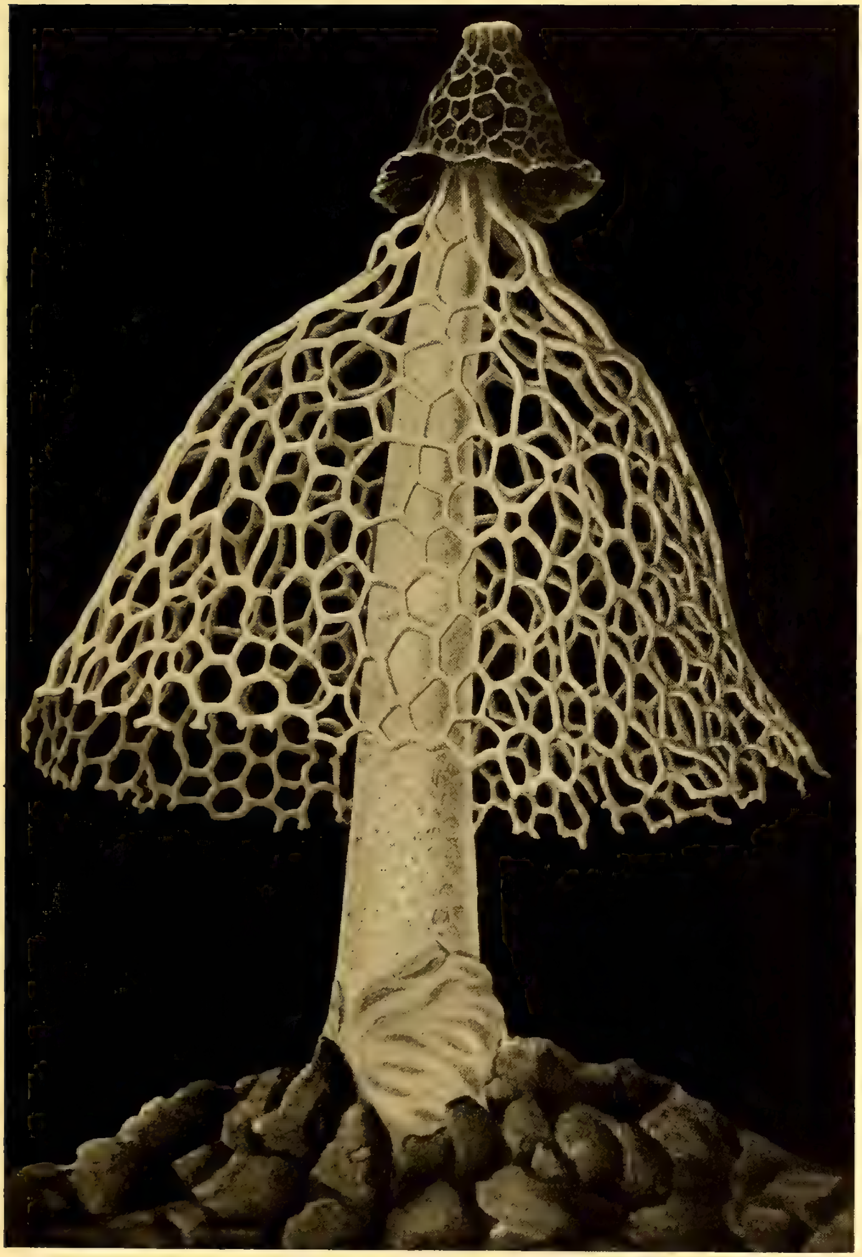


Fig. 24. *Dictyophora phalloidea* Desv. (From ALFR. MÖLLER, Brasilian. Pilzblumen.) This fungus, which has the odour of Limburg cheese, is used as food in China. See letter of Prof. S. Karvamura (Tokio) in *Mycological Notes*, No. 37 (April 1911) by C. G. LLOYD.

Nor are these plants less interesting from the purely scientific point of view. The majority of the rusts have developed the curious faculty of living partly on one host-plant and partly on another. Such a fungus is said to be ***heteroecious***. No case of this kind is yet known in South Africa, but there can be little doubt that some do occur here as well. As the two stages of these fungi are very different, they were for a long time thought to represent wholly different diseases.

Taking one of the commonest of the wheat rusts, *Puccinia graminis*, as a type of the Uredineae (Fig. 25), we find that the disease caused by it on the wheat plant has two distinct phases. At first, while the host-plant is still young and green, the disease appears as orange-coloured streaks and patches, called ***sori***, on the stem and leaves; later, when the plant becomes old and straw-coloured, the sori rapidly assume a dark rust colour

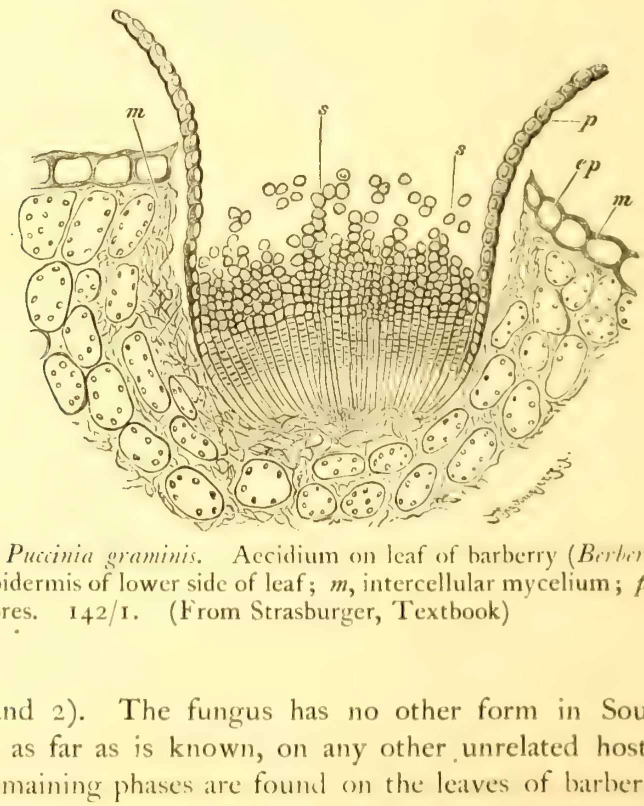


Fig. 27. *Puccinia graminis.* Aecidium on leaf of barberry (*Berberis vulgaris*). *ep*, epidermis of lower side of leaf; *m*, intercellular mycelium; *p*, peridium; *s*, spores. 142/1. (From Strasburger, Textbook)

(Fig. 25, 1 and 2). The fungus has no other form in South Africa, nor does it occur, as far as is known, on any other unrelated host-plant; but in Europe the remaining phases are found on the leaves of barberry plants. On the under surface of these leaves the fungus appears as little cup-shaped structures, quite visible to the naked eye, while on the upper surface minute brown dots, only with difficulty visible to the eye, are to be seen. Turning to the microscopic structure of the fungus in these different stages, we find that the orange-coloured sori on the wheat plant contain large numbers of thin-walled spores, called ***uredospores*** (Fig. 25, 5, on right), on short stalks. These are capable of germinating at once on the same or other cereal, and in a week a single spore may develop to form a mycelium in the tissues, and a new uredospore sorus. Towards the end of the season the same mycelium (sometimes in the same sorus) produces larger, dark brown, thick-walled, two-celled ***teleutospores*** (Fig. 25, 5, on left, and 6). The latter may remain dormant for a long time after falling off, and then germinate to form, from each cell, a four-celled basidium (Fig. 26, 8). Each cell of the basidium (or ***promycelium***) as shown in the figure, puts out a very slender hypha (***sterigma***) ending in a minute spore, the ***sporidium***. The sporidia are distributed by the wind, and if one falls on a barberry leaf it will germinate there, producing a mycelium in the tissues, and the cups on the lower surface, as mentioned above. These cups are known as ***aecidia*** (Fig. 27). Each aecidium is bounded by a wall called the ***peridium***, and arising from its base are a number of closely packed and regularly arranged hyphae, each

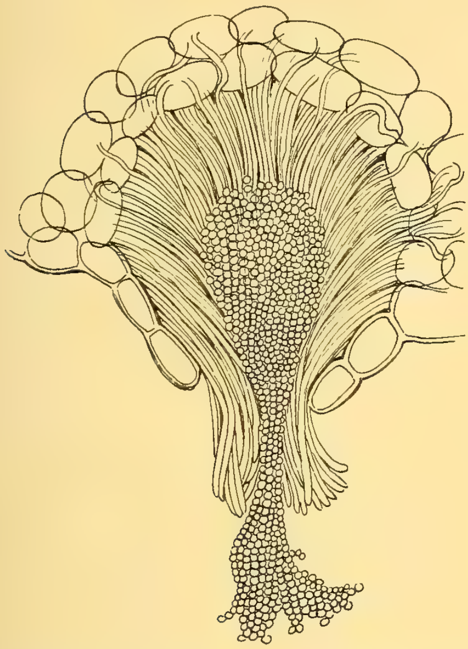


Fig. 28. *Aecidium Euphorbiae* Pers. Section of spermogonium. 200/1. (After De Bary)

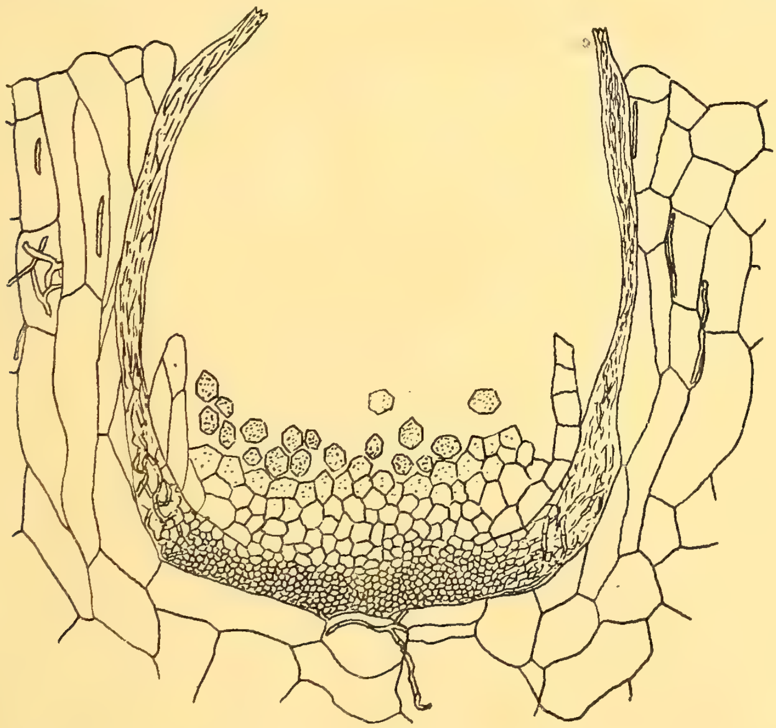


Fig. 29. Aecidium from leaf of *Rafnia angulata*. 200/1. W. T. S.

terminating in a chain of spores, the ***aecidiospores***. It is these which are able to infect the young wheat plant at the beginning of the season, but after that the same function is carried out by successive generations of uredospores. On the upper surface of the barberry leaf are a number of small flask-shaped openings, appearing externally as the brown dots mentioned before, called ***pycnidia***. These, as shown in the figure, produce vast numbers of exceedingly small cells which have been variously regarded as spores and as male gametes. In any event these cells are functionless now, so far as we know. It is probable that in South Africa uredospore infection is quite sufficient to account for the disease, without an alternative host-plant being necessary. Even in Europe, with a long cold winter, uredospore sori sometimes survive on winter wheats and wild grasses ; and the conditions permitting such survival are much more favourable here.

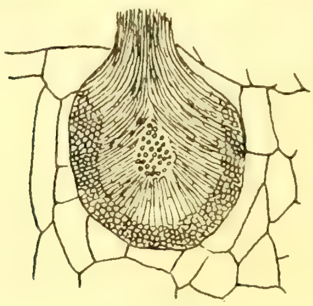


Fig. 30. Pycnidium from leaf of *Rafnia angulata*. 200/1. W. T. S.

As a South African example of the aecidium-stage, *Aecidium resinicolum* [Plate 3, Fig. B] has been chosen. This causes large galls on the stem and leaves of *Rafnia angulata* ; each gall is covered with numerous aecidium cups, which differ from those of *Puccinia* in having a long peridium projecting from the surface of the gall. In early stages of the development of the galls the aecidia (Fig. 29) are found on both surfaces of the leaf, and interspersed with them are pycnidia (Fig. 30), hardly distinguishable from those already described and figured.

LICHENES*.

It is probable that most people recognise a lichen when they see one, but few are aware of the peculiarities which enable a lichen to live where no other plant can. The reason for this lies in the fact that every lichen consists not of a single organism but of two, quite different in function and structure, and mutually dependent upon each other for existence in those dry and barren spots where lichens are often found.

One of these organisms is an alga belonging to either the Schizophyceae or the Chlorophyceae, and the other is a fungus, mostly of the Discomycetes. Usually the algal constituent is also known in the free state in more congenial habitats ; but the fungal constituent is only rarely able to exist except in the lichen form. Hence the name of the lichen is used either for the whole plant or for the fungal constituent, but not for the alga, which has its own name. A further reason for this is that it is only the fungus which forms the typical reproductive cells of its class (***ascospores***), while the alga remains in the vegetative condition.

The lichen-forming algae are often such as possess more or less mucilaginous

* Numerous lichens occurring in South Africa are described or enumerated by MASSALONGO, STIRTON and STIZENBERGER. See literature, page 246.

sheaths to their cells, and these sheaths have a considerable capacity for retaining water brought to them by the fungus-hyphae. In return they supply the fungus with the greater part of its food, manufactured with the aid of chlorophyll from the carbon dioxide of the air. This mutually dependent existence of the constituents of a lichen is usually regarded as a good example of ***symbiosis*** (*i.e.* living together with mutual advantage), though it has also been suggested that the advantage is wholly on the side of the fungus which, on this view, is simply regarded as a parasite on the alga.

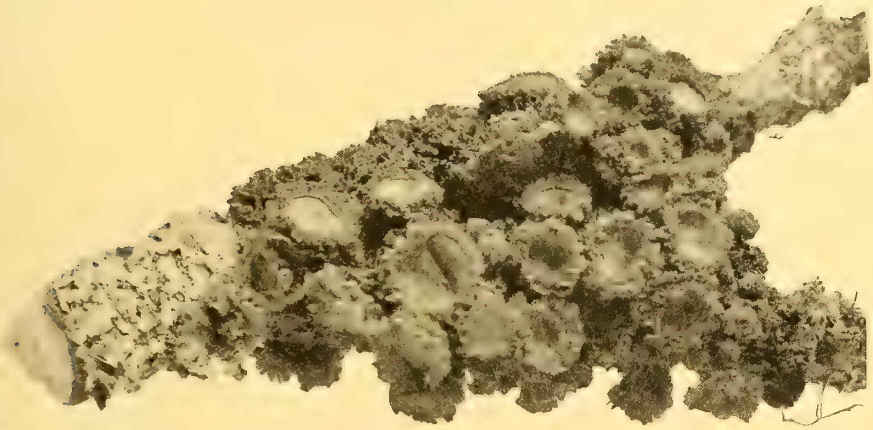


Fig. 31. *Leptogium tremelloides* (L. f.) Wainio On the branch of a tree. Nat. size.

For convenience it is customary to classify the lichens according to the form and structure of the thallus. In some the two constituents are evenly distributed through the thallus, which is then said to be homoiomerous, while in others the alga forms a definite layer (or layers) in the thallus, known as the ***gonidial layer.*** These are known as Heteromerous Lichens. The latter are much commoner and are either Crustaceous (forming a firm crust closely attached to the substratum), Foliaceous (flattened and leaf-like, but only loosely attached to the substratum) or Fruticose (filamentous or band-like, and branched in a shrub-like manner).

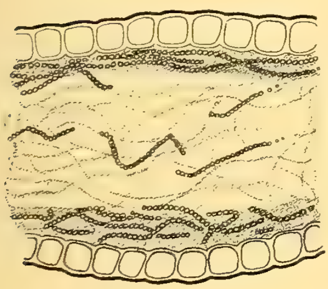


Fig. 32. *Leptogium tremelloides* (L.f.) Wainio Section through thallus. (After Zahlbruckner in E. P.) Much enlarged.

The most widely distributed homoiomerous lichens are gelatinous in texture, a common South African species being *Leptogium tremelloides**. Here the alga is a species of *Nostoc*, while the fungus is a discomycete.

* This plant often occurs on the bark of trees in ravines and other sheltered localities as a flat lump one or more inches in diameter. It is a very pretty thing, the greenish black colour of the frilled thallus forming a strong contrast to the saucer-shaped, rust-coloured apothecia, which are $\frac{1}{4}$–$\frac{1}{2}$ inch in diameter. The plant fructifies in the neighbourhood of Capetown (Table Mountain) in spring (Fig. 31). M.

In the heteromerous lichens a special and characteristic method of reproduction is often met with, by means of small structures known as ***soredia***. Each of these consists of a few algal cells, about which some fungus hyphae are entwined, and they are set free in large numbers from the thallus, appearing to the naked eye as a powder on the surface (Figs. 34 and 37).

Of foliaceous forms we have in South Africa a considerable number of species of *Parmelia*, which possesses a leathery, leaf-like thallus, forming both small apothecia and the much smaller ***spermogonia***. Fig. 33 shows the general structure of the thallus and apothecium of a species of *Parmelia*. It can be seen that the alga consists of isolated cells, and these belong to the genus *Pleurococcus*. Soredia are frequently formed on the upper surface of the thallus (Fig. 34).

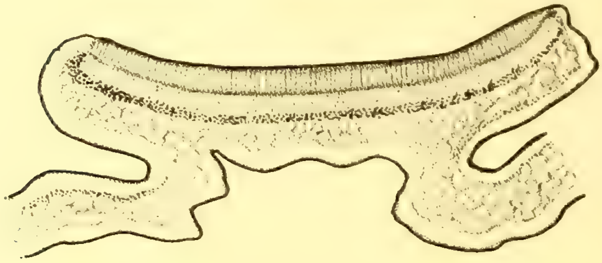


Fig. 33. *Parmelia arizonica* (Tuck) Nyl. Section through apothecium. (After Reinke) Enlarged.

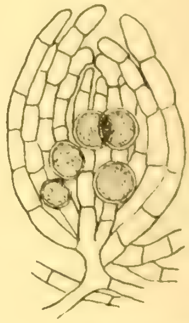


Fig. 34. Soredium of *Parmelia*. Section. 1000/1. W. T. S.

The apothecia have a slightly concave, smooth upper surface, in which a large number of sterile hairs or ***paraphyses*** occur as well as the ***asci***. The latter contain (usually) eight two-celled ascospores (Fig. 35).

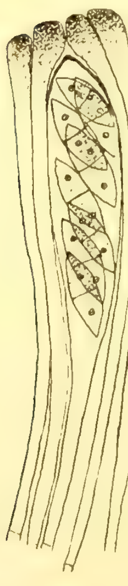


Fig. 35. Asci and paraphyses of *Parmelia*. 700/1. W. T. S.

The spermogonia or pycnidia are very small and appear as minute black dots on the surface of the thallus. In section they are spherical or egg-shaped and contain large numbers of ***spermatia*** (***pycnospores***). While it has been shown that in certain lichens the spermatia probably act as male cells, it is very doubtful whether they have such a function in other cases, and practically certain that as a rule they have not. It is likely, however, that they had their origin as male cells, and on this view it is customary to speak of them as spermatia, and of the cavities within which they are borne as spermogonia, though the alternative names mentioned above are also in use.

Of the fruticose lichens an example known from South Africa is *Usnea florida*, shown in Fig. 36. Here the structure of the thallus is similar to that of *Parmelia*, the chief difference being in the external form. The structure of the apothecia and spermogonia (pycnidia) is indicated in the figure. Asci and paraphyses are both found in the apothecia, and eight one-celled ascospores are contained in each ascus. The soredia of a species of *Usnea* are shown in Fig. 37.

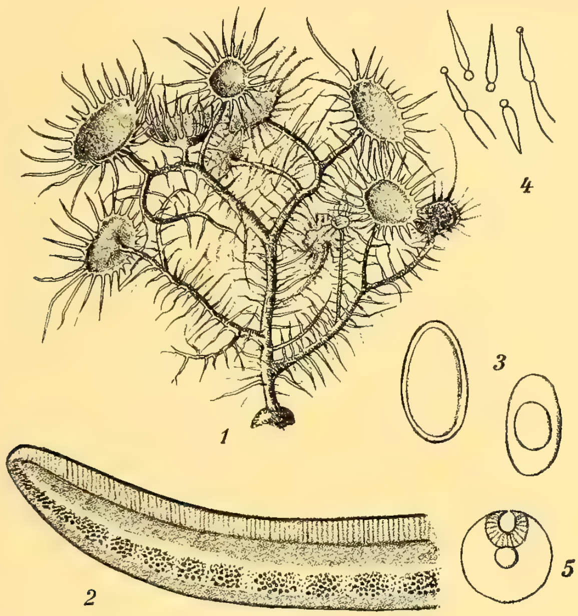


Fig. 36. *Usnea florida* (L.) Hoffm. 1. Plant. 2. Section through apothecium, slightly enlarged. 3. Spores. 4. Fulcra and pycnoconidia. 5. Transverse section of receptacle of pycnoconidia. (After Crombie) 3–5 much enlarged. (3–4 after Reinke)

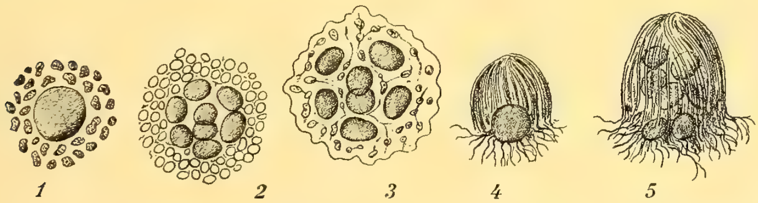


Fig. 37. *Usnea barbata* Fries Soredia. 1. A single conidium, surrounded by hyphae. 2. Soredium with its conidia sub-divided several times. 3. Group of simple soredia, which have been forced apart by the growth of the intervening hyphae. 4, 5. Growing soredia, the hyphae having formed an apical thallus. × 500. (After Schwendener)

INDEX OF THALLOPHYTES.

Synonyms are printed in italics.

CORMOPHYTA. The Higher Plants.

Whether all the higher plants are derived from one original type, or whether they have originated from different classes of thallophytes need not be discussed here. With the exception of a few of the lowest forms, *e.g.* liverworts and mosses, and, of course, of those which, owing to a special mode of life like the parasites, have lost certain organs and developed others, all cormophytes possess true roots, stems and leaves, and consequently vascular tissue. They are provided with chlorophyll, hence also able to assimilate the carbon dioxide of the atmosphere. They reproduce themselves by a sexual process, often also by vegetative means; but the mode of sexual reproduction and the organs serving it are so widely different in the four main groups of cormophytes, that their relationship, as far as it may exist or may have existed, is not yet sufficiently understood.

A. Archegoniatae.

Division XII. **Bryophyta.** Liverworts and mosses.
XIII. **Pteridophyta.** Ferns and fern-allies.

B. Anthophyta. *Flowering Plants.*

Division XIV. **Gymnospermae.** Plants with naked ovules and seeds.
XV. **Angiospermae.** Plants with pistils and seeds, the latter enclosed in various ways by the wall of the fruit.

The fundamental differences between the four main groups are briefly represented in the following table:

Division	Sexual Generation (The Gametophyte)	♀ Sexual Organ	♂ Sexual Organ
I. **Bryophyta**	Liverwort and Moss-plant.	Archegonia; in the mosses at the apex of the branches.	Antheridia, producing motile spermatozoids.
II. **Pteridophyta** 1. Isosporous (Fern)	Prothallium ⚥	Archegonia, borne on under side of prothallium.	Antheridia, borne on under side of prothallium, producing motile spermatozoids.
2. Heterosporous Ex. *Selaginella*	♀* Rudimentary prothallium, partly within the macrospore.	Archegonia, embedded in the rudimentary prothallium.	Antheridium, formed within germinating microspore and producing motile spermatozoids.
III. **Gymnospermae**	♀* Prothallial tissue (colourless), developed within the ovule and subsequently transformed into endosperm.	Archegonia, (2 or more), embedded in the prothallial (nucellar) tissue of an ovule. Ovules exposed.	Microspore (pollen grain), carried by outside agency to the ovule, entering it as a whole. 1. *Cycadaceae* and *Gingkoales*. Pollen grain producing motile spermatozoids. 2. *Coniferae*, *Gnetaceae*. Pollen grain developing a pollen tube.
IV. **Angiospermae**	♀* Rudimentary tissue in the nucellus, mostly disappearing completely.	Embryo-sac, enclosed in the nucellus, finally often filling it. Ovule (1 or ∞) enclosed in a carpel.	Pollen grain, germinating on the stigma; pollen tube carrying the generative nucleus passively to the embryo-sac.

* For ♂ organ see column 4.

Product of sexual amalgamation : The sporophyte		The sporophyte develops :	Further stage
Sporogonium (Seta and capsule or capsule only)		Spores ‖	*a.* A green protonema; *b.* The plant
Fern-plant		Numerous sporangia and spores. ‖	Prothallium, ⚥, mostly green and expanded.
Plant		Two kinds of sporangia, arranged in one spike, producing microspores and macrospores. ‖	Rudimentary prothallium.
Embryo with 2 or more cotyledons.	‖ Plant	Mostly two kinds of cones (exc. *Cycas*), one with pollen bags and one with naked ovules.	♂: Pollen grain. ♀: Prothallial tissue within the nucellus of the ovule.
Embryo with 1 or 2 cotyledons.	‖ Plant	Flowers with stamens and one or more ovules enclosed in a pistil. Both organs either in the same flower or separate.	♂: Pollen grain. ♀: Nucellus with embryo-sac.

The vertical double line indicates the break in the cycle, viz. the period of rest and dissemination.

PART II

ARCHEGONIATAE.

Plants consisting either of a thallus only, as some liverworts and primitive mosses, or provided with stems and leaves. The latter are either constructed of cells only, as in the bryophytes, or provided with true vessels and vascular tissues, as in the pteridophytes.

The distinction of this group as a whole from the thallophytes is in the mode of reproduction. There are two regularly alternating generations, viz. a sexual and an asexual one. The sexual generation, termed the ***gametophyte***, originates from the spore and produces two kinds of sexual organs, viz. ***antheridia*** (♂) and ***archegonia*** (♀) [Fig. 46]. The archegonium contains the ***oosphere*** (egg-cell), which after fertilisation develops into the ***embryo*** (the asexual generation). This is of a very different form in the two sections of the group, but in both it produces the spores by an asexual process, hence it is termed the ***sporophyte***. With the germination of the spore recommences the cycle of life.

While in the structure of their vegetative parts the bryophytes resemble the thallophytes to some extent, the pteridophytes do not materially differ from the flowering plants in this respect. On the other hand their mode of reproduction, while showing the two classes to be nearly allied, separates them well from the lower plants on the one hand and from the flowering plants on the other, although there exist a few connecting links in both directions.

Division XII. **Bryophyta.** The gametophyte (the moss-plant) mostly with stems and leaves, but without vascular tissue; the sporophyte, a mostly stalked, capsule-like body (moss capsule).

Division XIII. **Pteridophyta.** The gametophyte small, thalloid; the sporophyte (the fern etc.) with true roots, stems and leaves, all possessing vascular tissue.

Plate 5.

Cliff with Liverworts. Table Mountain, 3000 feet.

Plate 5.

Moist Cliff with liverworts. Table Mountain, 3000 feet. Dec.
Upper part: *Plagiochila natalensis* Pears., with plants of *Disa longicornu.*
Lower part: *Marchantia polymorpha* L. (♀), with *Crassula margaritifera* (in front).

Division XII. BRYOPHYTA.

Plant consisting either of a thallus only or provided with stems and leaves; no true roots but merely rhizoids and no real vascular tissue; the nerves of the leaves, where present, formed of strands of elongated cells.

The spore on germination produces a simple or branched thread of cells, called the ***protonema.*** On this appear lateral buds, from which originate the adult plants. Each plant bears two kinds of sexual organs, viz. antheridia and archegonia. The ***antheridium*** produces ***spermatozoids*** and the ***archegonium*** an ***oosphere*** (egg-cell). The spermatozoids are liberated only in water, hence in drier localities usually after rain or heavy dew. Being provided with two cilia and attracted by some substance secreted by the archegonium (*e.g.* sugar) they propel themselves towards its mouth and finally enter it. The product of the fertilised egg-cell, the ***embryo***, develops into the ***sporogonium***, the so-called moss capsule, which remains permanently connected with the gametophyte, being nourished by it in the same manner as a semi-parasite.

The sporogonium develops a vast number of spores, and when ripe opens in various ways, the spores then recommencing the cycle of life.

The bryophytes form two natural classes, viz. the Hepaticae (liverworts) and the Musci (mosses), which, apart from other characters, principally differ in the mode of development of the sporogonium.

Class I. HEPATICAE.

Protonema much reduced, generally consisting of a short and simple thread only. Plants either thallus-like (frondose) or consisting of stem and leaves (foliose). Stem bilateral, in the foliose groups often with two rows of upper leaves and one row of ventral leaves (***amphigastria***) (Figs. 40 and 41 F). The leaves generally consist of one layer of cells only, but the fronds of *Marchantia* and some others are fleshy and provided with stomata and intercellular spaces.

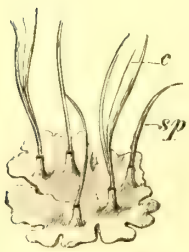


Fig. 38.

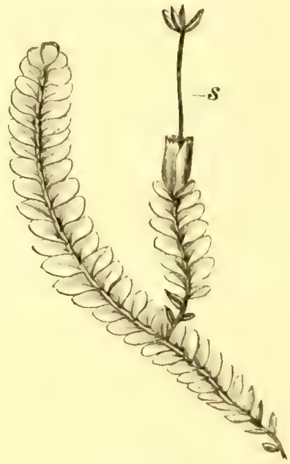


Fig. 39.

Fig. 40.

Fig. 38. *Anthoceros laevis* L. *sp.* Sporogone. *c.* Columella. Nat. size.

Fig. 39. *Plagiochila asplenioides* (Vaill.) Dum. *s.* Sporogone.

Fig. 40. *Frullania Tamarisci* (L.) Dum. 36/1. Seen from below. *r.* Lateral leaf. *ws.* Modified lower lobe of leaf (water storing). *a.* Amphigastrium. (From Strasburger, Textbook)

The archegonia are either terminal at the end of the stem or the branches, or dorsal, while the antheridia are rarely terminal. The sporogone remains enclosed in the archegonium until nearly fully developed, when, in most cases, it perforates the apex of the archegonial wall, being raised by the rapid lengthening of its stalk, while the archegonial wall remains at its base as a sheath (Fig. 39). The inner portion of the sporogone produces spores as well as, in most cases, sterile cells, termed ***elaters***, which assist in the distribution of the spores. The capsule opens generally by splitting into 4 or (*Anthoceros*) 2 valves (Fig. 38), rarely merely by decay or by means of a lid.

Some species propagate themselves also in a vegetative way by the agency of buds (*bulbils*), which are produced in special receptacles. (Fig. 41.)

The liverworts occur only in damp or moist and mostly well shaded localities, hence they are specially numerous in rainy regions. There are over 6000 species known, but about 100 only from South Africa*. Some of the largest genera are:

	Total number of species	Recorded from South Africa
Lejeunea	1760	15
Plagiochila	780	7
Frullania	690	10
Mastigobryum	340	1

Order I. JUNGERMANIALES.

Plant either with stem and leaves, or flat and thalloid. The sexual organs not borne on special receptacles. The sporogonium (capsule) stalked, opening by four valves and containing spores as well as elaters.

Order II. MARCHANTIALES.

Plant thalloid (frondose). The sexual organs mostly borne on special receptacles. The sporogonium sessile or very shortly pedunculate, opening either by decay or by a circular fissure, or by teeth, and containing spores, either alone or mixed with elaters or other sterile cells.

Order III. ANTHOCEROTALES.

Plant thalloid (frondose). The sporogonium nearly sessile, thinly cylindrical, not unlike a siliqua. The centre of the sporogone is sterile and forms the ***columella***, the sporogonial tissue being derived from the outer layer of the embryo. Sporogonium opening by two valves and containing spores as well as elaters.

* It is highly probable that there are many more species of liverworts in South Africa, for the Rev. A. E. Eaton collected in Aug. and Sept. 1874, merely on the northern side of Table Mountain 40 species, of which 6 were new to science. See literature, page 246.

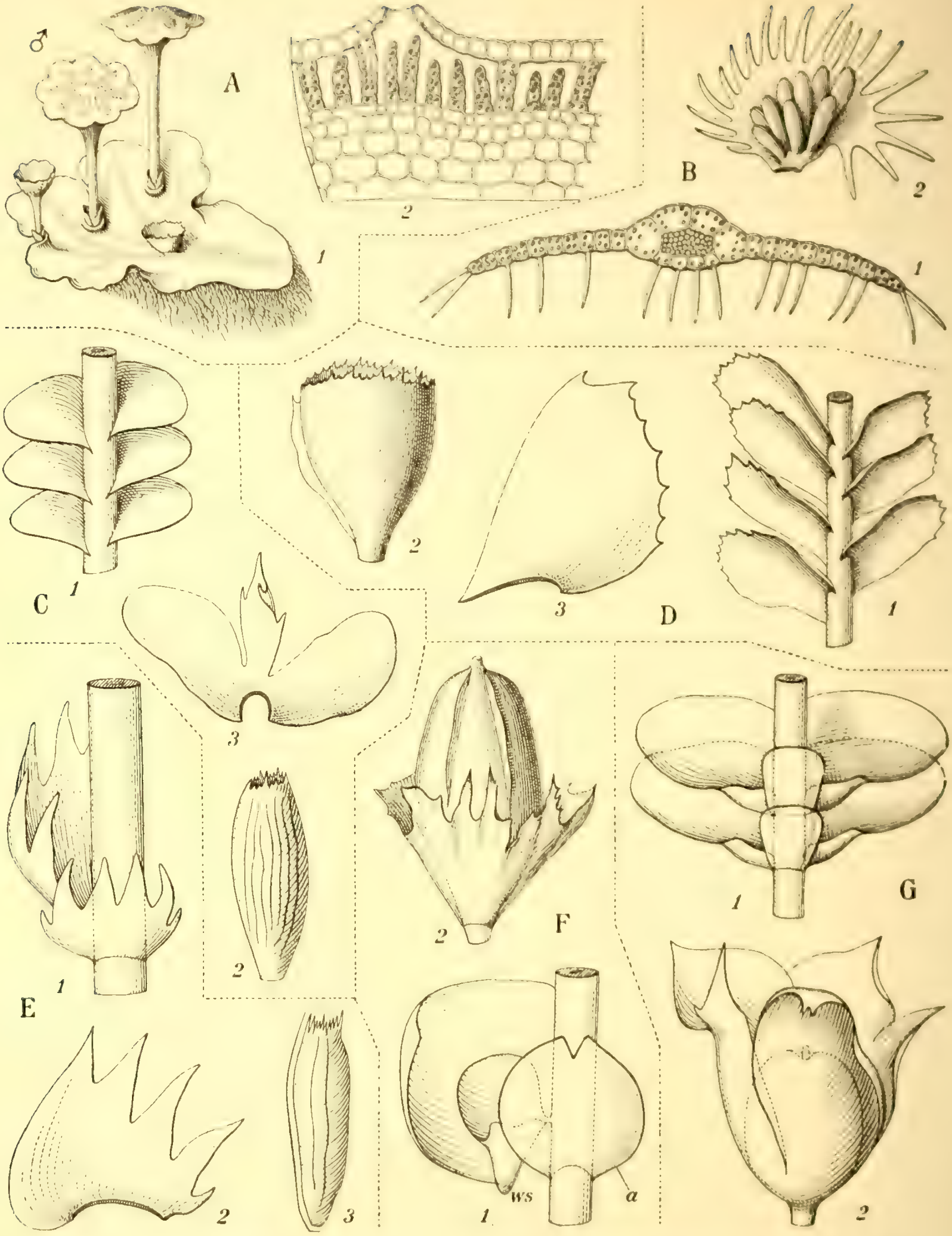


Fig. 41. A. *Marchantia polymorpha* L. 1. Male plant with empty cup (bulbils removed). 2. Section through thallus, showing air chambers. B. *Metzgeria*. 1. Section of thallus. 2. Female twig. C. *Jungermania*. 1. Portion of stem. 2. Perianth. 3. Involucre. D. *Plagiochila*. 1. Portion of stem. 2. Perianth. 3. Leaf. E. *Lepidozia*. 1. Piece of plant. 2. Leaf. 3. Perianth. F. *Frullania*. 1. Piece of plant, seen from below. *a*. Amphigastrium. *ws*. Water reservoir. 2. Perianthium. G. *Lejeunea*. 1. Piece of plant. 2. Perianthium, the sporogone shining through. All figures variously enlarged, from sketches by F. Stephani.

SYNOPSIS OF GENERA*.

Order I. JUNGERMANIALES.

A. **Acrogynae.**

Plant leafy. Archegonia terminal, *i.e.* produced from the apical cell of the stem or branches. Sporogone consequently terminal at the end of the stem (acrogenous), or of short lateral branchlets (cladogenous).

a. Capsule 4-valved to the base. Elaters 2-coiled.

I. Leaves† entire or bipartite, rarely 3—5 lobed, never incubous; inflorescence mostly acrogenous.

1. Perianth present.

× ♀ *inflorescence acrogenous.*

o *Perianth terete.*

§ *Leaves entire.*

! *Leaves of the involucre as long as the cauline leaves.* (Fig. 41, C.)

(1)‡ 1. **Jungermánia**

!! *Leaves of the involucre shorter and smaller than the cauline leaves.*

(2) 2. **Jamesoniélla**

§§ *Leaves 2- or multipartite.*

(1) 3. **Anastrophýllum**

oo *Perianth flattened, its mouth wide, bilabiate.*

§ *Stem without rhizoids.* (Plate 5 and Figs. 39 and 41, D.)

(7) 4. **Plagiochíla**

§§ *Stem creeping, with rhizoids.*

(2) 5. **Leioscýphus**

ooo *Perianth triangular, its mouth trilabiate with laciniate lips.*

(5) 6. **Lophocólea**

× × ♀ *inflorescence cladogenous, leaves mostly entire.*

(2) 7. **Chiloscýphus**

2. Perianth none.

× *Sporogone not enclosed in a bag.*

(2) 8. **Notoscýphus**

* By L. Diels (Marburg); the numbers of the S. A. species of the genera by F. Stephani (Leipzig).

† The leaves of liverworts are said to be "incubous" if the lower leaves overlap the upper on the dorsal side of the stem: when the upper overlap the lower they are said to be "succubous."

‡ The figure in brackets denotes the number of species known from South Africa.

× × *Sporogone enclosed in a bag.*

o *Leaves entire.*

§ *Leaves opposite.*

(2) 9. **Gongylánthus**

§§ *Leaves alternate.*

(2) 10. **Calypogéia**

oo *Leaves bipartite or pluripartite.*

(1) 11. **Tylimánthus**

II. Leaves often incubous, dentate, bifid or multifid. ♀ inflorescence cladogenous on a very short ventral branch. Perianth mostly narrow, triangular.

1. Leaves bipartite.

(2) 12. **Cephalózia**

2. Leaves 3—5 partite.

× *Leaves incubous.* (Fig. 41, E.)

(3) 13. **Lepidózia**

× × *Leaves succubous.*

(1) 14. **Psilóclada**

3. Leaves entire or dentate.

× *Leaves incubous.*

(1) 15. **Mastigobrýum**

× × *Leaves succubous.*

o *Stem ascending, not rooting.*

(1) 16. **Adelánthus**

oo *Stem creeping, rooting.*

(1) 17. **Alobiélla**

III. Leaves bipartite. ♀ inflorescence acrogenous or cladogenous on lateral branch. Perianth folded at the mouth into 3—10 plaits.

1. ♀ inflorescence acrogenous.

× *Leaves appressed to the stem.*

(1) 18. **Anthélia**

× × *Leaves spreading.*

(1) 19. **Herbérta**

2. ♀ inflorescence cladogenous.

(1) 20. **Lepicólea**

IV. Leaves folded into two lobes. ♂ inflorescence acrogenous.

1. Perianth connate with the calyptra into a fleshy indumentum.

(1) 21. **Schistochíla**

2. Perianth flattened.

(4) 22. **Rádula**

b. Capsule 4-valved to the middle or a little beyond only.

I. Elaters deciduous, 2—3-coiled.

(3) 23. **Madothéca**

II. Elaters persistent on the valves, 1-coiled.

1. Perianth obtuse, not ciliate. (Figs. 40 and 41.)

(10) 24. **Frullánia**

2. Perianth 3—4-lobed, ciliate. (Fig. 41.)

(15) 25. **Lejeúnea**

B. **Anacrogynae.**

Plant thalloid (exc. *Fossombronia*). Archegonia dorsal or lateral; sporogonia consequently dorsal or lateral.

a. Plant thalloid.

I. Elaters persistent on the top of the valves.

1. Thallus fleshy, lobed, without a rib.

(2) 26. **Aneúra**

2. Thallus thin, furcate, with a definite midrib. (Fig. 41.)

(1) 27. **Metzgéria**

II. Elaters persistent at the base of the capsule, or deciduous.

1. Involucre of capsule double, the inner one long and tubular.

(1) 28. **Pallavicínia**

2. Involucre simple.

(2) 29. **Symphyógyna**

b. Plant leafy.

(4) 30. **Fossombrónia**

Order II. MARCHANTIALES.

A. Epidermal pores (stomata) wanting or rudimentary. Sexual organs embedded in open cavities upon the dorsal surface. Sporogonium sessile, when ripe without wall, remaining permanently within the wall of the archegonium. Elaters none.

(8) 31. **Ríccia**

B. Epidermal pores fully developed. Sexual organs not embedded. Sporogone with a wall. Elaters present.

a. Sporogone single on the ventral side of the lobes of the thallus.

(1) 32. **Targiónia**

b. Sporogones in groups on special, long stalked receptacles.

I. Stomata stellate.

(1) 33. **Plagiochásma**

II. Stomata simple.

1. Sporogone opening by a circular slit.

× *Receptacle slightly lobed at the edge.*

o *Perianth finally deeply cleft, multipartite.*

(4) 34. **Fimbriária**

oo *Perianth none.*

(1) 35. **Grimáldia**

× × *Receptacle cleft to the middle. Perianth none.*

(1) 36. **Reboúlia**

2. Sporogone longitudinally split into valves. Frond areolate on the upper side.

× *Bulbilliferous receptacles crescent-shaped. Antheridia in clusters sessile on upper side of frond. Frond bifurcate, small.*

(1) 37. **Lunulária**

One cosmopolitan species (*L. cruciata*) frequent in conservatories and sheltered places.

× × *Bulbilliferous receptacles cup-shaped, with dentate margin. Antheridia in clusters on a stipitate stellate capitulum.*

(3) 38. **Marchántia**

Three S. A. species. *M. polymorpha* ubiquitous in damp places. (Plate 5; Fig. 41.)

Order III. ANTHOCEROTALES.

The only genus. (Fig. 38.)

(2) 39. **Anthóceros**

Plate 6.

A. *Sphagnum capense* Hornsch. 1. Plant. 2. Leaf. 3. Margin of leaf. 4. Transverse section of leaf. 5. *Sphagnum squarrosum* Hornsch. the perichaetium with pseudopodium and ripe capsule.

B. *Andreaea subulata* Harv. 1. Plant. 2. Leaf. 3. *Andreaea petrophila* Ehrh. Dehiscing capsule, the calyptra removed.

C. *Archidium capense* Hornsch. 1. Plant. 2. Same, enlarged. 3. Apex of leaf. 4. Basis of leaf. 5. Capsule in long. section.

D. *Leucoloma Zeyheri* C. Muell. 1. Plant. 2. Leaf. 3. Apex of leaf. 4. Basis of leaf.

E. *Fissidens fasciculatus* Hornsch. 1. Plant. 2. Leaf. 3. Apex of leaf. 4. Peristome.

F. *Syrrhopodon pomiformis* (Hook.) Hampe. 1. Plant. 2. Leaf. 3. Cells from middle portion of leaf.

G. *Astomum tetragonum* (Harv.) Broth. 1. Plant. 2. Plant, enlarged. 3. Leaf. 4. One half of apex of leaf. 5. Isolated cells from central portion of leaf, showing the annular papillae.

H. *Glyphomitrium* (*Brachysteleum*) *crispatum* Hook. & Grev. 1. Plant. 2. Leaf. 3. Apex of leaf. 4. Capsule with calyptra. 5. Peristome.

Figs. A 5, B 1–3, F 1–3, G 1–5, from Engler & Prantl, the others from nature.

A: SPHAGNUM CAPENSE Hornsch. B: ANDREAEA SUBULATA Harv.
C: ARCHIDIUM CAPENSE Hornsch. D: LEUCOLOMA ZEYHERI C. Muell.
E: FISSIDENS FASCICULATUS Hornsch. F: SYRRHOPODON POMIFORMIS (Hook.)
G: ASTOMUM TETRAGONUM (Harv.) H: GLYPHOMITRIUM CRISPATUM (Hook. et Grev.)

A: MACROMITRIUM PULCHELLUM Brid. B: GONIOMITRIUM AFRICANUM (C. Muell.)
C: BARTRAMIDULA COMOSA (Hamp. et C. Muell.)
D: RHACOCARPUS ECKLONIANUS (C. Muell.) E: LEPTODON SMITHII (Dicks.)
F: HYPOPTERYGIUM LARICINUM Brid.

Class II. MUSCI. Mosses.

Protonema mostly consisting of branching threads, provided with rhizoids and producing buds which develop into moss-plants (the sexual generation). Antheridia and archegonia at the apex of the plant or branch, often surrounded by an involucre of leaves (*perichaetium*) in such a way that the whole arrangement resembles a flower. Usually the sporogonium detaches in its growth the wall of the surrounding archegonium and carries it on its apex as the *calyptra*.

In most orders of mosses the lower portion of the sporogonium is transformed into a stalk called the *seta*. When ripe the capsule opens either by slits or by means of a lid, the mouth being often provided with beautifully ornamented teeth (*peristome*), which yield, by their number and shape, valuable characters for taxonomy.

Plate 7.

A. *Macromitrium* (*Macrocoma*) *pulchellum* Brid. 1. Plant. 2. Leaf. 3. Apex of leaf. 4. Basis of leaf. 5. Capsule with calyptra. 6. Peristome.

B. *Goniomitrium africanum* (C. Muell.) Broth. 1. Plant. 2. Same, enlarged. 3. Leaf.

C. *Bartramidula comosa* (Hamp. & C. Muell.) Broth. 1. Plant. 2. Twig, enlarged. 3. Leaf. 4, 5. Apex of leaf. 6. Capsule.

D. *Rhacocarpus Ecklonianus* (C. Muell.) Broth. 1. Plant. 2. Branch, enlarged. 3. Leaf. 4, 5. Apex of leaf. 6. Cells from apex. 7. Basis of leaf.

E. *Leptodon Smithii* (Dicks.) Mohr. 1. Plant. 2. Plant, shrivelled. 3. Apex of leaf. 4. Perichaetial branch with capsule and calyptra. 5. Peristome.

F. *Hypopterygium laricinum* Brid. 1. Plant. 2. Twig, enlarged. 3. Apex of leaf. 4. Peristome.

Fig. E from Bryologia Europaea, the others from nature.

Although the study of mosses has been much neglected in South Africa the number of known species is already considerable. Our list shows 32 families with 103 genera, none of them, however, endemic here. The number of species, as far as known, amounts to 335, but there is no doubt that a good many more will be found, especially in the forests and on the mountains.

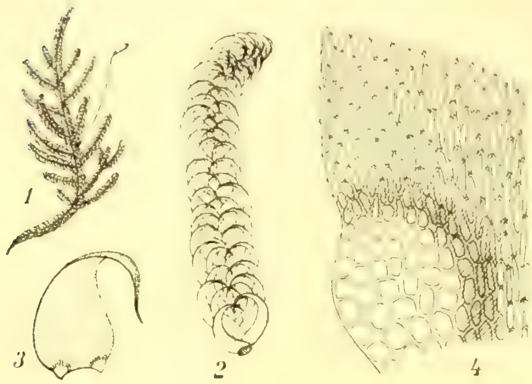


Fig. 42 *a*. *Stereodon cupressiformis* (L.) Brid. 1. Plant. 2. Twig, enlarged. 3. Leaf, 10/1. 4. Basis of leaf, 150/1. (From nature)

Fig. 42 *b*. *Campylopus atroluteus* C. Mueller A viviparous moss from the summit of Table Mountain, propagating itself principally or perhaps exclusively by leafy buds* (bulbillae). Nat. size.

Until some day a Bryologia Capensis appears the student who wishes to learn more about our mosses will have to resort to K. Mueller's Synopsis Muscorum and his account of the collection of 200 species of mosses made by A. Rehmann (Literature, page 246).

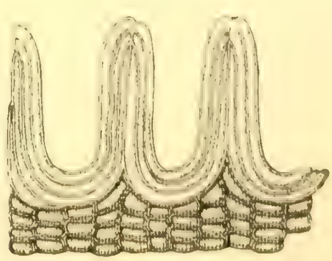


Fig. 43. *Polytrichum commune* L. Very young peristome. (After Lantzius-Beninga)

* From R. Marloth, Das Kapland. (Jena, 1908.)

THE FAMILIES AND GENERA OF THE S. A. MOSSES*.

Order I. SPHAGNALES.

Wall of archegonium splitting during the development of the sporogonium and remaining at its base as a ***vaginula*** : sporogone (capsule) supported by a ***pseudopodium*** which does not originate from the archegonium, but from the twig that carried it. Calyptra absent or rudimentary. Capsule opening with a lid. No peristome. Fam. 1.

Order II. ANDREAEALES.

Sporogonium with vaginula, pseudopodium and calyptra. Capsule opening by means of 4—8 longitudinal slits. Fam. 2.

Order III. BRYALES.

Sporogonium provided with vaginula and calyptra and generally borne on a true seta. Capsule opening by means of a lid, its mouth mostly with a peristome.

I. Subord. EUBRYINEAE.

Teeth of peristome formed of the thickened walls of cells, transversely articulated.

Series 1. Haplolepideae.

Peristome simple (rarely quite absent). The dorsal (outer) layer of the teeth formed of one row of cell-walls, the ventral (inner) layer of two rows. Fam. 3—9.

Series 2. Diplolepideae.

Peristome double, rarely apparently simple or rudimentary. Dorsal layer of exostome formed of two rows of walls, ventral layer of one row. Fam. 10—31.

II. Subord. POLYTRICHINEAE.

Teeth of peristome consisting of entire, more or less elongated, horseshoe-shaped cells, which are slantingly articulated. Fam. 32.

* By V. F. BROTHERUS (Helsingfors).

SYNOPSIS OF FAMILIES.

Order I. SPHAGNALES.

(Plate 6, A.) *Gen.* 1. 1. **Sphagnaceae**

Order II. ANDREAEALES.

(Plate 6, B.) *Gen.* 2. 2. **Andreaeaceae**

Order III. BRYALES.

I. Subord. Eubryineae.

Series 1. Haplolepideae.

A. Seta absent. The sessile capsule not opening by a lid, but breaking irregularly or merely decaying. Calyptra finally splitting in an irregular way, leaving some portions at the base of the capsule. Spores very large. (Plate 6, C.)
Gen. 3. 3. **Archidiaceae**

B. Seta present. Calyptra borne on the apex of the capsule.

a. Leaves distichous, amplexicaul, with dorsal wings. (Plate 6, E.)
Gen. 4. 4. **Fissidentaceae**

b. Leaves pluriseriate, without dorsal wings.

I. Plants whitish. Midrib of leaves broad, consisting of several layers of large, empty cells and one inner layer of smaller, green cells.
Gen. 5. 5. **Leucobryaceae**

II. Plants green. Cells of midrib of leaves all with chlorophyll.

1. Teeth of peristome split into two (rarely 3) segments.

× *Cells of leaves smooth.* (Plate 6, D.)
Gen. 6—16. 6. **Dicranaceae**

× × *Cells papillose.* (Plate 6, G.)
Gen. 17—29. 7. **Pottiaceae**

2. Teeth of peristome mostly entire.

× *Leaves vaginate; inner cells of vagina delicate and empty.* (Plate 6, F.)
Gen. 30. 8. **Calymperaceae**

× × *Leaves not vaginate; inner cells of the basal portion similar to the others.* (Plate 6, H.)
Gen. 31—33. 9. **Grimmiaceae**

Series 2. Diplolepideae.

A. Capsule usually terminal on the main axis or its principal branches.

a. Leaves distichous.
Gen. 34. 10. **Eustichiaceae**

b. Leaves pluriseriate.

I. Cells of leaves papillose; cells of lamina small, parenchymatous. (Plate 7, A.)
Gen. 35—40. 11. **Orthotrichiaceae**

II. Leaves smooth.

1. Cells of leaves large.

× *Teeth of exostome opposite the divisions of the inner peristome, not lamellate.* (Plate 7, B.)
Gen. 41—43. 12. **Funariaceae**

× × *Teeth of exostome alternate with the divisions of the inner peristome, lamellate.*

o *Cells near apex of leaves prosenchymatous.*
Gen. 44—51. 13. **Bryaceae**

oo *Cells near apex of leaves parenchymatous.*
Gen. 52. 14. **Mniaceae**

2. Cells of leaves small, parenchymatous. Sexual organs radical or lateral.
Gen. 53. 15. **Rhizogoniaceae**

III. Cells of lamina small, mostly parenchymatous, mammillate on both sides of the leaf. Capsule nearly globose, longitudinally striate. Teeth of inner peristome split down to their base into two spreading lobes. (Plate 7, C.)
Gen. 54—57. 16. **Bartramiaceae**

B. Capsules borne on lateral branchlets, which are mostly very short, rarely somewhat elongated.

a. Peristome absent.

I. Foliage of stem flattened out.
Gen. 58. 17. **Erpodiaceae**

II. Foliage arranged evenly around the stem. (Plate 7, D.)
Gen. 59—62. 18. **Hedwigiaceae**

b. Peristome present.

I. Perichaetial branch more or less elongated. Aquatic plants.
Gen. 63. 19. **Fontinalaceae**

II. Perichaetial branch very short. Mostly terrestrial plants.

1. Cells near margin of base of leaves modified, *i.e.* several rows of cells are smaller, square or rounded or even broader than long, and specially thickened.

× *Main axis stoloniform. Leaves smooth.*
Gen. 64—66. 20. **Leucodontaceae**

× × *Main axis rhizome-like. Cells of leaf papillate.*
Gen. 67. 21. **Prionodontaceae**

2. Cells at base of leaf normal or merely alate.

× *Cells of stem not thickened.*

o *Amphigastria absent.*

§ *Calyptra hood-shaped.*
Gen. 81—83. 24. **Fabroniaceae**

§§ *Calyptra conical.*
Gen. 84—86. 25. **Hookeriaceae**

oo *Amphigastria present.* (Plate 7, F.)
Gen. 87. 26. **Hypopterygiaceae**

× × *Marginal cells of stem thickened, lumen small.*

o *Dorsal leaves not different from the others.*

§ *Plants not shining. Cells of lamina parenchymatous, mostly papillose.*
Gen. 88—91. 27. **Leskeaceae**

§§ *Plants more or less shining. Cells of lamina prosenchymatous, mostly smooth.*

† *Capsule mostly erect, regular.*

! *Alar cells not or only slightly modified.* (Plate 7, E.)
Gen. 68—78. 22. **Neckeraceae**

!! *Alar cells differentiated, numerous, square or broader than long.*
Gen. 79, 80. 23. **Entodontaceae**

†† *Capsule more or less inclined, irregular, often quite curved.*

! *One row of the alar cells inflated, elongated, thin-walled; midrib short and double or absent. Lid with a needle-shaped beak.*
Gen. 94. 29. **Sematophyllaceae**

!! *Alar cells all alike, or in some layers square or elongate-six-sided, thickened.*

Δ *Midrib mostly very short and double or absent.*
Gen. 92, 93. 28. **Hypnaceae**

ΔΔ *Midrib simple, mostly reaching nearly to the apex of the leaf.*
Gen. 95—99. 30. **Brachytheciaceae**

oo *Dorsal leaves much smaller than the others, distichous.*
Gen. 100. 31. **Rhacopilaceae**

II. Suborder Polytrichineae.

Gen. 101—103. (Fig. 43.) 32. **Polytrichaceae**

SYNOPSIS OF GENERA.

[The figures in brackets indicate the number of species known from South Africa.]

Fam. 1. Sphagnaceae.
(Plate 6, A and Vol. IV. plate 60.) (14) 1. **Sphágnum**

Fam. 2. Andreaeaceae.
(Plate 6, B.) (1) 2. **Andreáea**

Fam. 3. Archidiaceae.
(Plate 6, C.) (7) 3. **Archídium**

Fam. 4. Fissidentaceae.
(Plate 6, E.) (38) 4. **Físsidens**

Fam. 5. Leucobryaceae.
(2) 5. **Leucobrýum**

Fam. 6. Dicranaceae.

A. Alar cells not modified.
- *a.* Lid not distinct.
  - I. Calyptra hood-shaped. (3) 6. **Pleurídium**
  - II. Calyptra cap-shaped. (3) 7. **Brúchia**
- *b.* Lid distinct, deciduous.
  - I. Capsule with an elongated neck. (2) 8. **Trematodon**
  - II. Capsule devoid of neck, or with a short neck.
    - 1. Outer layer of teeth of peristome papillate or crosswise striate.
      - × *Capsule smooth.* (1) 9. **Dítrichum**
      - × × *Capsule striate and grooved.* (1) 10. **Cerátodon**
    - 2. Outer layer of teeth of peristome punctate or longitudinally striate.
      - × *Antheridia arranged on a disc.* (2) 11. **Aongstrœmia**
      - × × *Antheridia aggregated into a bud-like body.* (3) 12. **Dicranélla**

B. Alar cells much larger, colourless and transparent or brownish.
- *a.* Leaves not marginate. Midrib very broad.
  - I. Teeth of peristome divided halfway down.
    (Fig. 42 A.) (17) 13. **Campýlopus**
  - II. Teeth of peristome divided to the base. (2) 14. **Dicranodóntium**

b. Leaves with a hyaline margin.

I. Margin faint. Capsule irregular with a distinct gizzard.
(1) 15. **Dicranolóma**

II. Margin distinct. Capsule erect, regular.
(Plate 6, D.) (4) 16. **Leucolóma**

Fam. 7. Pottiaceae.

A. Leaves mostly narrow; cells of lamina small.

a. Lid not distinct.
(Plate 6, G.) (1) 17. **Astomum**

b. Lid distinct, deciduous.

I. Peristome absent.

1. Orifice of capsule closed with a membrane after the dropping of the lid.
18. **Hymenóstomum**

2. Orifice of capsule open when lid falls off.
(1) 19. **Hymenostýlium**

II. Peristome present.

1. Outer layer of peristome thicker than the inner one, with conspicuous transverse ridges.
(1) 20. **Weísia**

2. Both layers of peristome similar, without transverse ridges.

× *Leaves triseriate.*
(2) 21. **Triquetrélla**

× × *Leaves pluriseriate.*

o *Leaves with flat or slightly recurved margins.*

§ *Teeth of peristome or its divisions erect and straight.*
(1) 22. **Trichóstomum**

§§ *Teeth of peristome or its divisions spirally twisted to the left.*
(6) 23. **Tortélla**

oo *Margin of leaves recurved distinctly, at least at the base.*

§ *Teeth of peristome erect or slightly inclined to the right.*
(1) 24. **Didýmodon**

§§ *Teeth of peristome spirally twisted to the left.*
(8) 25. **Bárbula**

B. Leaves broad. Cells of lamina large.

a. Lid not distinct.

I. Capsule globular, without a mucro.
(1) 26. **Acaúlon**

II. Capsule globular or ovate, mucronate.
(2) 27. **Pháscum**

b. Lid distinct.

I. Lid remaining on capsule. (1) 28. **Póttia** (*Subgenus* **Pottiélla**)

II. Lid deciduous. (10) 29. **Tórtula**

Fam. 8. Calymperaceae.
(Plate 6, F.) (2) 30. **Syrrhópodon**

Fam. 9. Grimmiaceae.

A. Calyptra bell-shaped.
(Plate 6, H.) (6) 31. **Glyphomítrium**

B. Calyptra cap-shaped.

a. Teeth of peristome entire, or split at the apex only, or fenestrate. (6) 32. **Grímmia**

b. Teeth divided completely into two threads. (5) 33. **Rhacomítrium**

Fam. 10. Eustichiaceae. (1) 34. **Eustíchia**

Fam. 11. Orthotrichaceae.

A. Seta lateral. (1) 35. **Anoectángium**

B. Seta terminal.

a. Calyptra cap-shaped. (5) 36. ***Zýgodon***

b. Calyptra bell-shaped, plicate.

I. Stem erect. (3) 37. **Orthótrichum**

II. Stem creeping.
(Plate 7, A.) (6) 38. **Macromítrium**

c. Calyptra bell-shaped, not plicate.

I. Capsule oval or cylindrical. Lid awl-shaped. (7) 39. **Schlothéimia**

II. Capsule club- or pear-shaped. (2) 40. **Leiomítrium**

Fam. 12. Funariaceae.

A. Calyptra covering the capsule nearly completely, provided with 8 longitudinal ridges.
(Plate 7, B.) (1) 41. **Goniomítrium**

B. Calyptra not ribbed, not reaching below middle of capsule.

a. Calyptra cap-shaped. (2) 42. **Physcomítrium**

b. Calyptra inflated, hood-shaped. (12) 43. **Funária**

Fam. 13. Bryaceae.

A. Sexual organs on lateral, rooting branchlets, mostly near the base of the stem.

a. Outer peristome absent. (4) 44. **Mielichhoféria**

b. Inner peristome absent. (1) 45. **Haplodóntium**

B. Archegonia inserted at the apex of the main shoot or on the principal branches.

a. Membrane of inner peristome not protruding or very little only. (1) 46. **Orthodóntium**

b. Membrane of inner peristome much protruding.

I. Inner peristome shorter than the outer one. Appendages rudimentary. (7) 47. **Brachyménium**

II. The two peristomes equal.

1. Cells of leaves narrow, in the apical portion narrow-rhomboid to linear.

× *Foliage on stem bushy.* (7) 48. **Póhlia**

× × *Leafy shoots catkin like.* (1) 49. **Anomobrýum**

2. Cells of leaves towards the apex rhombical to hexagonal.

× *Stem without offsets. Sporogone solitary.* (13) 50. **Brýum**

× × *Stem with offsets. Sporogones several altogether.* (2) 51. **Rhodobrýum**

Fam. 14. Mniaceae. (1) 52. **Mníum**

Fam. 15. Rhizogoniaceae. (1) 53. **Rhizogónium**

Fam. 16. Bartramiaceae.

A. Stem without verticillate branchlets below the fertile apex. (5) 54. **Bartrámia**

B. Stem with verticillate branchlets.

a. Peristome absent. (Plate 7, C.) (1) 55. **Bartramídula**

b. Peristome present.

I. Cells at base of leaf rounded. (6) 56. **Philonótis**

II. All cells of leaf linear. (3) 57. **Breutélia**

Fam. 17. Erpodiaceae. (2) 58. **Aulacopílum**

Fam. 18. Hedwigiaceae.

A. Leaves without a distinct margin.

a. Capsule embedded between the apical leaves.

I. Lamina of leaves papillate, each papilla with 2 or more points. Capsule smooth.
(1) 59. **Hedwígia**

II. Papillae with a simple point. Capsule in the dry state grooved.
(1) 60. **Hedwigídium**

b. Capsule stalked.
(1) 61. **Braúnia**

B. Leaves marginate.
(Plate 7, D.) 62. **Rhacocárpus**

Fam. 19. Fontinalaceae.
(1) 63. **Wárdia**

Fam. 20. Leucodontaceae.

A. Midrib of leaf double or absent.

a. Lamina of leaf smooth.
(1) 64. **Leúcodon**

b. Cells papillose.
(1) 65. **Pterogónium**

B. Midrib single.
(1) 66. **Forsstroémia**

Fam. 21. Prionodontaceae.
(1) 67. **Priónodon**

Fam. 22. Neckeraceae.

A. Dorsal layer of the teeth of the peristome irregularly thickened, but smooth.

a. Midrib wanting or very short and double.
(1) 68. **Renaúldia**

b. Midrib simple.
(1) 69. **Pterobryópsis**

B. Dorsal layer of teeth normal, mostly papillate, sometimes striate, rarely smooth.

a. Secondary branchlets mostly cylindrical, more or less pendulous. Leaves symmetrical.

I. Alar cells forming a sharply defined group of square cells.
(1) 70. **Squamídium**

II. Alar cells not well defined.

1. Midrib double but very short, or absent. Cells of leaf smooth.
(3) 71. **Pilotrichélla**

2. Midrib simple. Cells of leaf papillose.

× *Branches not flattened.*
(1) 72. **Papillária**

× × *Branches flattened.*
(1) 73. **Aërobryópsis**

b. Secondary branchlets flattened, ascending or pendulous. Leaves not symmetrical.

I. Leaves cordate and eared at base. (1) 74. **Calyptothécium**

II. Leaves neither cordate nor eared at base.

1. Plants not shining; paraphyllia numerous. (Plate 7, E.) (1) 75. **Léptodon**

2. Plants shining; paraphyllia absent. (1) 76. **Néckera**

c. Secondary branchlets erect and branched, the plants resembling miniature trees. Leaves not quite symmetrical.

I. Teeth of outer peristome provided with transverse striae nearly to the apex. (1) 77. **Thámnium**

II. Teeth of outer peristome papillate or transversely striate at their base only. (1) 78. **Porótrichum**

Fam. 23. Entodontaceae.

A. Midrib double but short, or absent. (1) 79. **Éntodon**

B. Midrib simple. (1) 80. **Stereophýllum**

Fam. 24. Fabroniaceae.

A. Plants glossy like silk.

a. Plants very slender. Teeth of outer peristome broad and blunt. (7) 81. **Fabrónia**

b. Plants more or less stout. Teeth of outer peristome acuminate. (1) 82. **Ischýrodon**

B. Plants not glossy, slender. (2) 83. **Dimerodóntium**

Fam. 25. Hookeriaceae.

A. Leaves not marginate.

a. Lamina smooth. (1) 84. **Hookeriópsis**

b. Lamina papillate; each cell mammillate. (1) 85. **Callicostélla**

B. Leaves marginate. (1) 86. **Cyclodíctyon**

Fam. 26. Hypopterygiaceae. (Plate 7, F.) (1) 87. **Hypopterýgium**

Fam. 27. Leskeaceae.

A. Capsule erect, regular. (1) 88. **Haplohyménium**

B. Capsule inclined, irregular.

a. Paraphyllia absent. (1) 89. **Pseudoléskea**

b. Paraphyllia present.

I. Leaves all alike. (3) 90. **Haplocládium**

II. Leaves dimorphous. (3) 91. **Thuídium**

Fam. 28. Hypnaceae.

A. Leaves arranged symmetrically around the stem, sickle-shaped, one-sided. Alar cells modified. (Fig. 42.) (1) 92. **Stereódon**

B. Foliage flattened; leaves unsymmetrically squarrose. Alar cells not or hardly modified. (3) 93. **Plagiothécium**

Fam. 29. Sematophyllaceae. (7) 94. **Rhaphidostégium**

Fam. 30. Brachytheciaceae.

A. Capsule erect and regular. (1) 95. **Pleúropus**

B. Capsule inclined or horizontal, irregular.

a. Lid conical. (9) 96. **Brachythécium**

b. Lid with a long beak.

I. Leaves broadly ovate or elongate-oval, with a short and broad apex. (1) 97. **Oxyrrhýnchium**

II. Leaves ovate to ovate-lanceolate.

1. Plant stout. Midrib not continued as a stiff mucro. (5) 98. **Rhynchostégium**

2. Plant slender. (5) 99. **Rhynchostegiélla** *Sect.* **Leptorhynchostégium**

Fam. 31. Rhacopilaceae. (1) 100. **Rhacopílum**

Fam. 32. Polytrichaceae.

A. Leaves not vaginate, but strongly marginate. Calyptra bare but rough towards the apex. (1) 101. **Catharináea**

B. Leaves vaginate, not marginate. Calyptra felt-like.

a. Capsule cylindrical. (2) 102. **Pogónatum**

b. Capsule 4-angled. (Fig. 43.) (4) 103. **Polýtrichum**

Division XIII. PTERIDOPHYTA.

Ferns and fern-allies.

Plants with true roots; the stems and leaves with fibro-vascular strands. The spore of the true ferns (Order Filices), on germinating, produces a small, thalloid body,

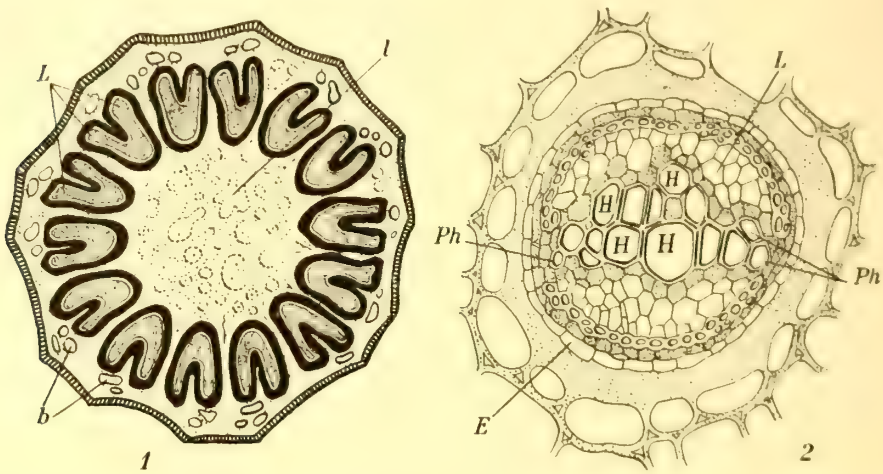


Fig. 44. 1. Transverse section of the stem of a species of *Alsophila*. *L*, Fibrovascular bundles of the main woody cylinder; *l*, accessory bundles, *b*, bundles which are passing into the leaves. (From Wettstein, Handbuch) 2. Transverse section of the bundle of the rhizome of *Polypodium glaucophyllum* Kunze *H*, xylem; *L*, phloëm; *Ph*, proto-xylem; *E*, endodermis. (From Engler and Prantl)

the ***prothallium*** (Fig. 45), which is provided with rhizoids and bears both kinds of sexual organs, viz. antheridia and archegonia, on its under side. In the other groups of the pteridophytes the prothallium is generally much reduced, sometimes not emerging from the spore. The ***spermatozoids*** (Fig. 46) swarm in water until they reach the mouth of the archegonium, being attracted thither by traces of malic or citric acid, as the case may be, secreted by the female organ.

The fertilised oosphere develops into a minute embryo, from which originates the asexual generation (the sporophyte), which is the adult plant. The adult plant produces ***sporangia*** (receptacles filled with spores) either directly on the leaves (fronds) or on specially modified

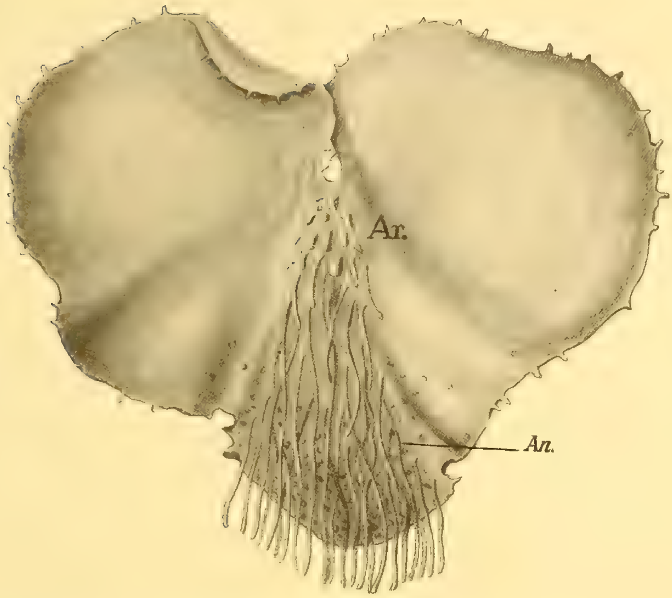


Fig. 45. Prothallium of *Dryopteris*, with rhizoids. The under side. *Ar.* Archegonia. *An.* Antheridia. 20/1. (From Wettstein, Handb.)

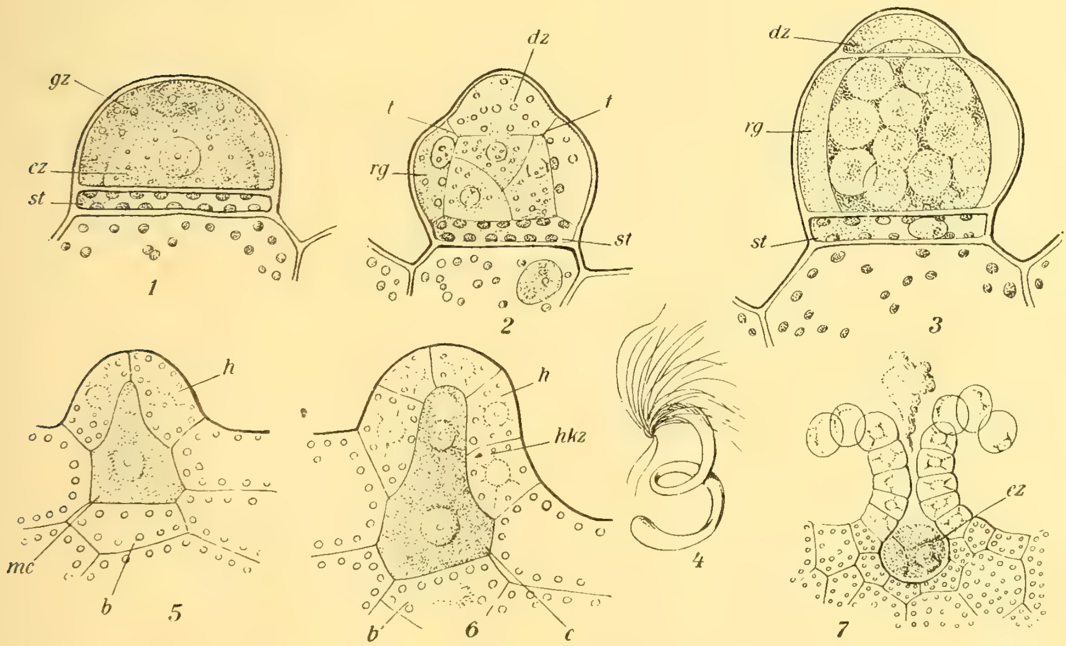


Fig. 46. Antheridia and archegonia of ferns. 1–3. Successive stages of an antheridium. *gz*, cup cell; *cz*, central cell; *st*, stalk cell; *t*, cleavage wall; *rg*, ring cell; *dz*, cup cell. 4. Spermatozoid. 5–7. Successive stages of an archegonium. *h*, neck cell; *b*, basal cell; *mc*, mother cell of the central row; *hkz*, neck canal cell; *ez*, egg cell. (From Engler and Prantl)

sporophylls, the spores being either all of one kind (isosporous pteridophytes) or of two kinds, viz. microspores and macrospores (heterosporous pteridophytes), *e.g.* *Selaginella*.

With the germination of the spore recommences the cycle of life, as in the bryophytes.

One of our indigenous ferns, found in Natal and adjoining districts, viz. *Dryopteris athamantica* *, a species nearly allied to the European Male fern (*D. filix mas*), is, like that plant, employed as a vermifuge, and the rhizomes are occasionally exported under the name of *Radix pannae*. Its native name is *Inkomokomo*.

THE CLASSES OF THE PTERIDOPHYTES.

Class I. FILICINAE.

Stems usually small in proportion to the leaves, mostly underground, sometimes creeping; in a few S. A. species upright. Leaves mostly large and much divided, rarely entire. Sporangia as a rule grouped in ***sori***, which are either naked or partly covered by a membranous ***indusium***, or completely enclosed in a capsule-like indusium.

Class II. EQUISETINAE.

Stems simple or branched. Leaves much reduced, whorled, mostly membranous. Sporangia on peltate sporophylls, which are arranged in a terminal spike.
The only S. A. Fam.: Equisetaceae (page 76).

Class III. LYCOPODIINAE.

Stems simple or branched, small. Leaves small, not whorled, mostly green. Sporangia solitary in the axils of leaves or at their base (page 78).

* Syn. *Nephrodium athamanticum*.

Class I. FILICINAE. Ferns. Varens.

Subclass I. Ophioglossales.

Sporangia with thick walls, borne on a spike-like appendage of the fertile frond.

Only 1 S. A. genus: *Ophioglossum*.

Subclass II. Filices Eusporangiatae.

Isosporous. Sporangia with thick walls, formed of several layers of cells. Leaves large, with two basal appendages resembling stipules.

Only 1 S. A. genus: *Marattia*.

Subclass III. Filices Leptosporangiatae.

Sporangia originating from single cells; the walls of the adult sporangium consisting of a single layer of cells.

1. Order Filices. True Ferns.

Isosporous. Sporangia mostly with annulus. Vernation mostly circinate.

2. Order Hydropterides. Water-ferns.

Heterosporous.

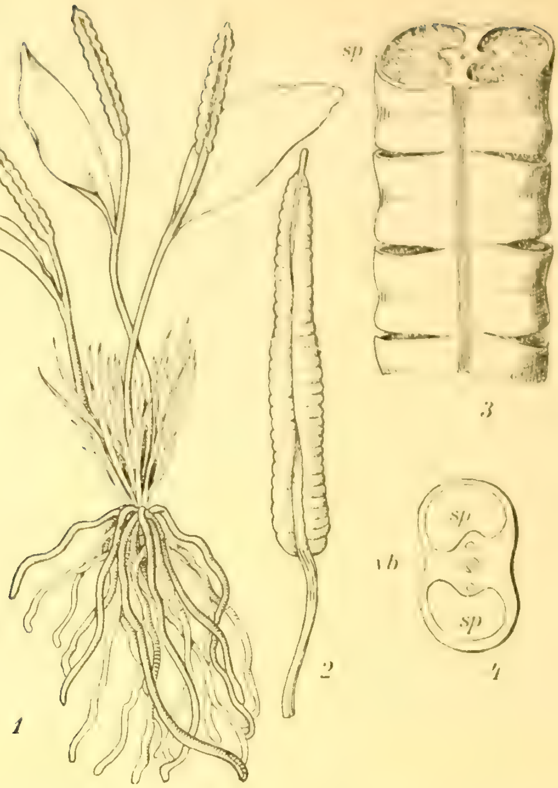


Fig. 47. *Ophioglossum.* 1. *O. capense* Sw. 2–3. *O. palmatum* L. 2. Spike. 3. Portion of spike, splitting. 8/1. 4. *O. vulgatum* L. Diagr. section of spike. (1 from Engler, Afrika; 2–4 from Engler and Prantl)

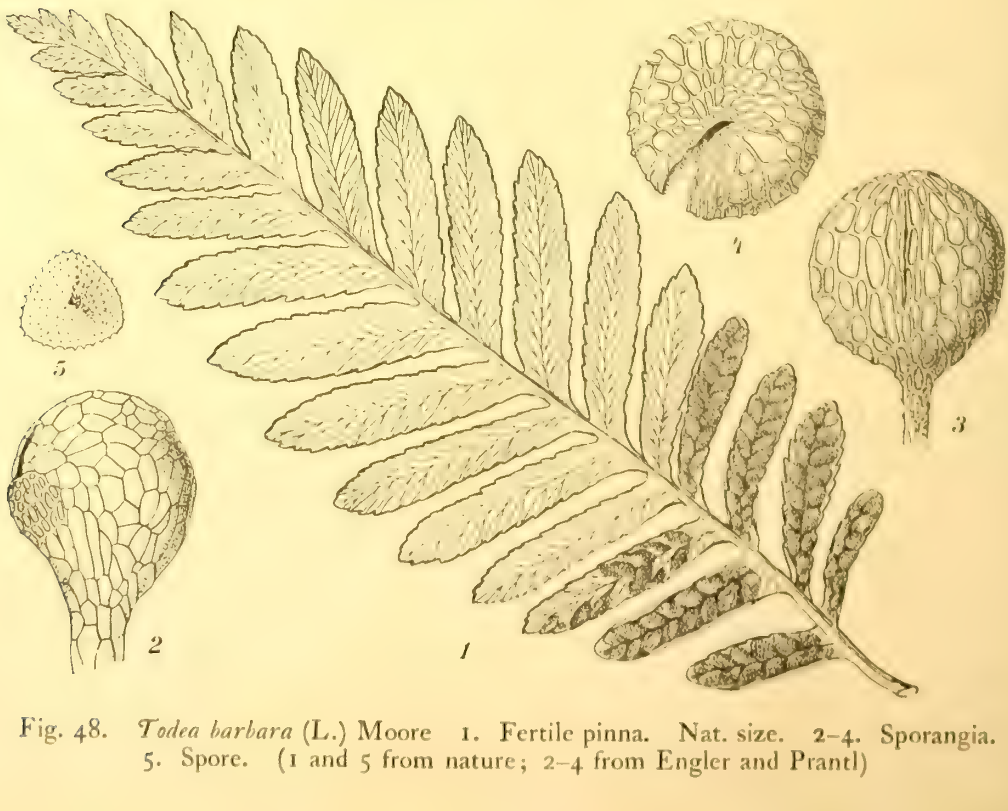


Fig. 48. *Todea barbara* (L.) Moore 1. Fertile pinna. Nat. size. 2–4. Sporangia. 5. Spore. (1 and 5 from nature; 2–4 from Engler and Prantl)

Werner & Winter Frankfort a/M

FERNS ON A CLIFF IN THE DISA GORGE

GLEICHENIA POLYPODIOIDES (L.) Smith. TODEA BARBARA (L.) Moore.
HYMENOPHYLLUM TUNBRIDGENSE (L.) Smith.
The young tree in the foreground is CUNONIA CAPENSIS L.
Table Mountain, 2000 feet

Plate 9

A: Hymenophyllum tunbridgense *(L.) Smith*
B: Polypodium lanceolatum *L.* C: Notochlaena Eckloniana *Kunze*
D: Vittaria lineata *(L.) Smith* E: Elaphoglossum conforme *(Sw.) Schott*

Plate 9. Class Filices.

A. *Hymenophyllum tunbridgense* (L.) Smith From ravine on Table Mountain.
B. *Polypodium lanceolatum* L., epiphytic on a branch of *Ilex capensis.*
C. *Notochlaena Eckloniana* Kunze From the Karoo.
1. In the fresh state after rain.
2. Dormant. In dry weather. Both figures are from the same plant.
D. *Vittaria lineata* (L.) Smith A small plant, from the Knysna forest.
E. *Elaphoglossum conforme* Schott From a moist cliff on Table Mountain. One younger and one old frond showing the under side covered with sporangia.

Hymenophyllum. There are several species of "filmy ferns" in South Africa, all living in damp and sheltered parts of forests or mountain-ravines. The species figured here has a very wide range of distribution, the name indicating that it was originally found in England near the town of Tonbridge.

An even prettier species is *H. Marlothii* (Fig. 56), which requires still more shelter than the others, occurring in the forests of the South (fide T. R. Sim) and at two localities on Table Mountain, viz. in Skeleton ravine and in the Disa gorge a little below the spot known as the Lover's Leap, also at Jonkershoek. Until quite recently this rare plant was considered to be identical with *H. obtusum* Hook. & Arn., otherwise known only from the Sandwich Islands. When examining the type of the latter species about a year ago at Kew we thought it to be different from the Table Mountain plant; Colonel Brause has now confirmed this view and described the latter under the above name.

Polypodium lanceolatum (see also Fig. 54) is the only epiphytic fern which occurs on the Cape Peninsula, while further east other epiphytic species of *Polypodium* are not unfrequent. (See *P. africanum* on Plate 16, page 100.)

Notochlaena Eckloniana possesses remarkable vitality, which enables it to grow in crevices of rocks even in the Karoo. When the atmosphere becomes too dry the fronds shrivel up, being specially protected by the closely set scales of the under side. As soon as rain falls, however, the plants revive and unfold their fronds, in readiness to continue their active live. One may keep plants for several months without soil or water and yet find them alive as soon as they are placed in water. This fern is consequently an example of a "resurrection plant," similar in this respect to some species of *Selaginella.*

Gymnogramme cordata, which much resembles it, behaves in the same way.

Vittaria lineata occurs on damp rocks or on trees of our southern forests and at first glance hardly looks like a fern, the fronds generally hanging down like blades of grass. Also known from ravines on the southern sides of Table Mountain.

Elaphoglossum conforme (*Acrostichum conforme*) has beautifully glossy fronds and grows on damp cliffs of sheltered ravines. (See Plate 8, near margin on right.)

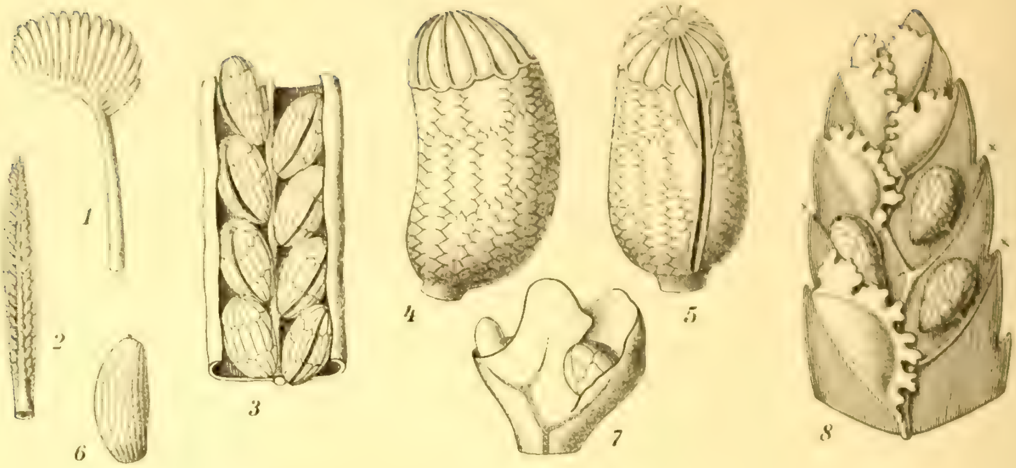


Fig. 49. Schizaeaceae. 1, 2. *Schizaea pectinata* J. Sm. 1. Fertile part of frond. Nat. size. 2. Segment of the same. 3. *Sch. dichotoma* J. Sm. Portion of a fertile segment. 10/1. 4, 5, 6. *Sch. pennula* Sw. 4, 5. Sporangium. 6. Spore. 7, 8. *Lygodium japonicum* Sw. 7. Apex of young fertile segment. 8. Fertile segment, adult. (1 and 2 from nature; 3–8 from Engler and Prantl)

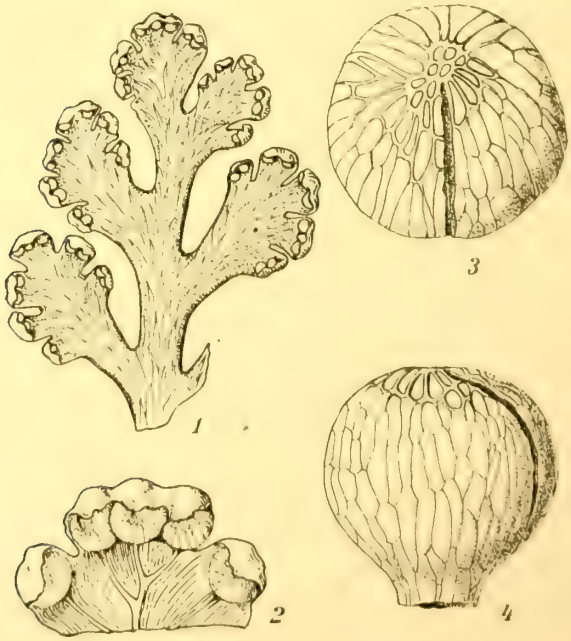


Fig. 50. *Mohria caffrorum* (L.) Desv. 1. Part of frond. Nat. size. 2. Apex of frond with sori. 2/1. 3, 4. Sporangia. (1 from nature; 2–4 from Engler and Prantl)

Photo. by E. Dyke

Werner & Winter, Frankfort a/M

THE EASTERN TREE FERN
CYATHEA DREGEI Kunze
From the midlands of Natal

SYNOPSIS OF THE FAMILIES OF FERNS.

Subclass I. OPHIOGLOSSALES.

Gen. 1. (Fig. 47.) 1. **Ophioglossaceae**

Subclass II. FILICES EUSPORANGIATAE.

Gen. 2. 2. **Marattiaceae**

Subclass III. FILICES LEPTOSPORANGIATAE.

1. Order: Filices.

A. Sporangia often crowded on special fronds or segments, sessile or with a very short and stout stalk; no real ring, but at the apex a group of thick-walled cells; opening by a longitudinal slit. (Plate 8; Fig. 48.)

Gen. 3, 4. 3. **Osmundaceae**

B. Sporangia sessile or almost so, solitary. Ring horizontal, near the apex; slit longitudinal. Fertile fronds or segments much modified. (Figs. 49, 50.)

Gen. 5—8. 4. **Schizaeaceae**

C. Fronds dichotomously branched. Sori on the back of the frond without indusium. Sporangia few in a sorus (2—8), with a large equatorial ring and opening by a longitudinal slit. (Plate 8; Fig. 51.)

Gen. 9. 5. **Gleicheniaceae**

D. Sori with or without indusium, mostly at the back of the frond, formed of numerous, generally stalked sporangia. Ring of sporangium vertical but incomplete, being interrupted near the base and opening at this spot by a horizontal slit. (Plates 9 and 24; Figs. 52, 53, 54.)

Gen. 10—34. 6. **Polypodiaceae**

E. Trunk arborescent. Ring complete, subvertical; slit transverse. (Plates 10 and 11; Fig. 55.)

Gen. 35, 36. 7. **Cyatheaceae**

F. Delicate pellucid ferns. Sori marginal on an elongated receptacle and surrounded by a cup-shaped or labiate indusium. Sporangium compressed; ring complete, oblique. (Plates 8 and 24; Fig. 56.)

Gen. 37, 38. 8. **Hymenophyllaceae**

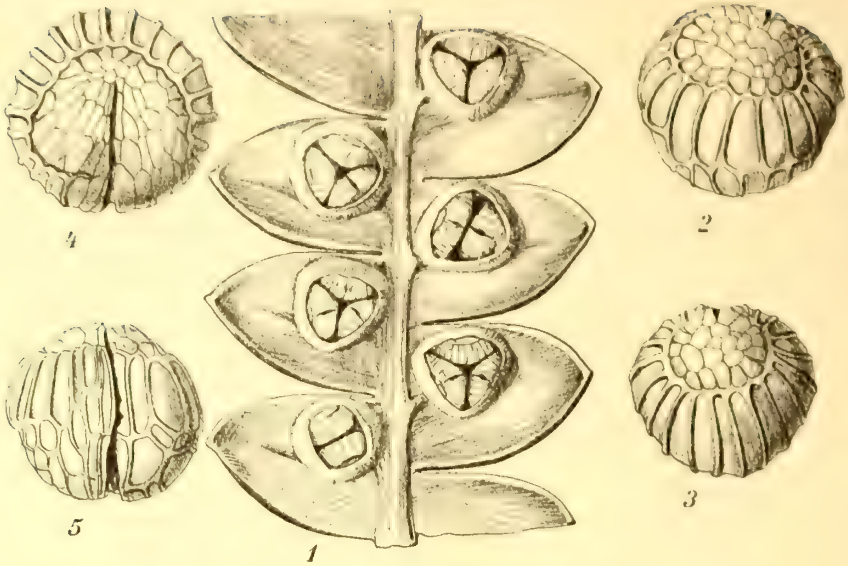


Fig. 51. *Gleichenia polypodioides* (L.) Smith 1. Portion of frond. 2–5. Different views of sporangia. (1 from nature; 2–5 from Engler and Prantl)

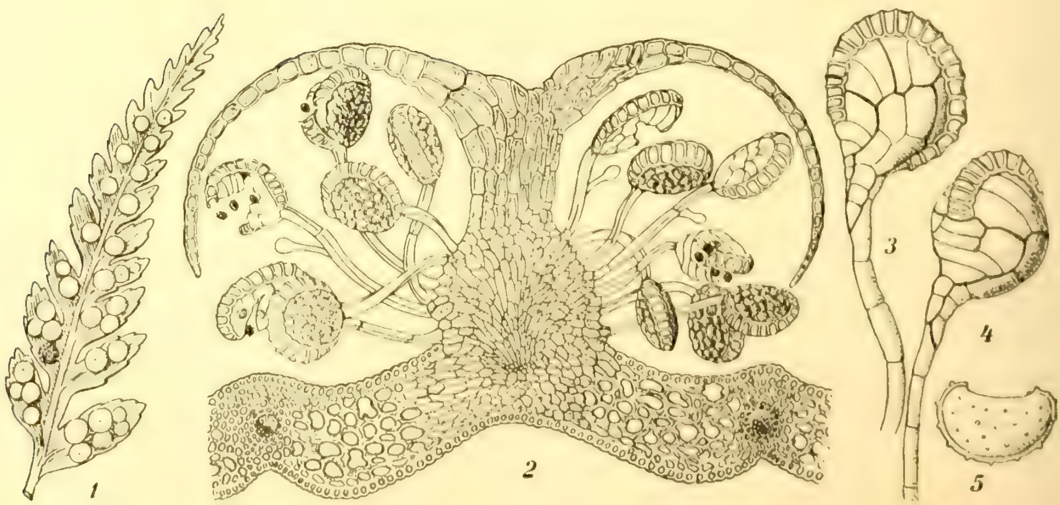


Fig. 52. *Aspidium capense* L. 1. Portion of frond. 2. Transverse section of sorus and indusium. 3, 4. Sporangia. 5. Spore. (1 and 5 from nature; 2–4 from Engler and Prantl)

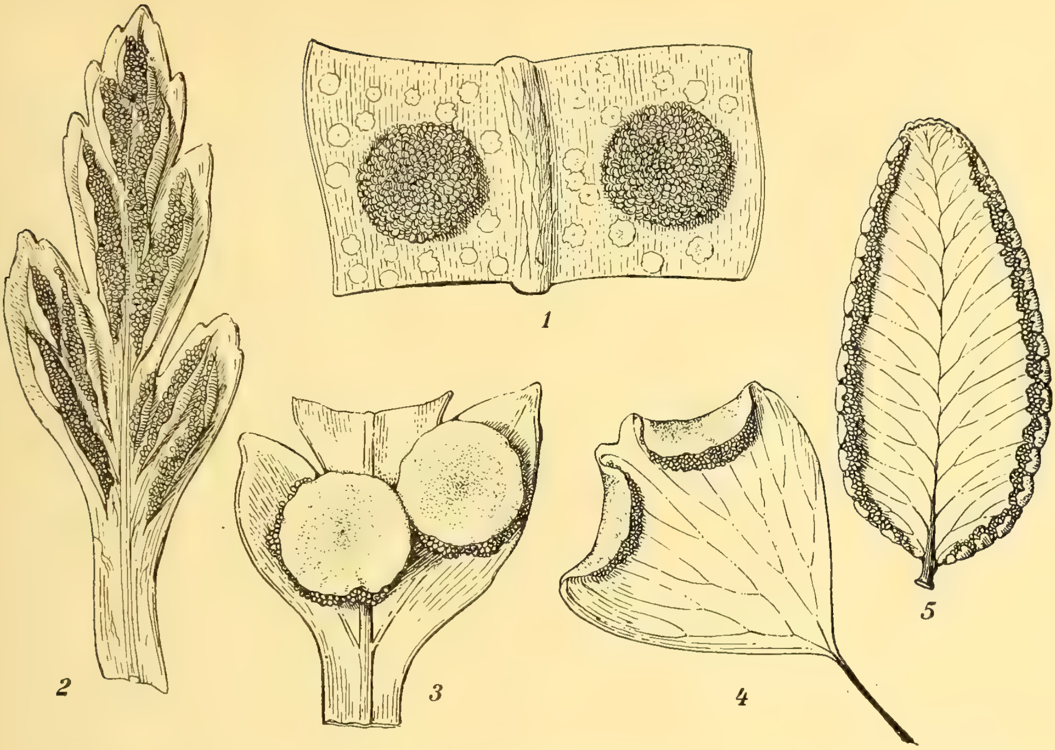


Fig. 53. Polypodiaceae. 1. *Polypodium lanceolatum* L. Two sori. 2. *Asplenium praemorsum* Sw. (*A. furcatum*). Fertile pinnules with sori and indusia. 3. *Aspidium capense* L. Two sori with indusia. 4. *Adiantum Poivetii* Wickstr. Fertile pinnule with two sori. 5. *Pellaea hastata* (Thunb.) Prantl Pinnule. (From nature)

Fig. 54. *Polypodium lanceolatum* L. 1/4 size. Epiphytic on a tree of *Halleria lucida* L., in a wooded ravine on Table Mountain, 2000 feet.

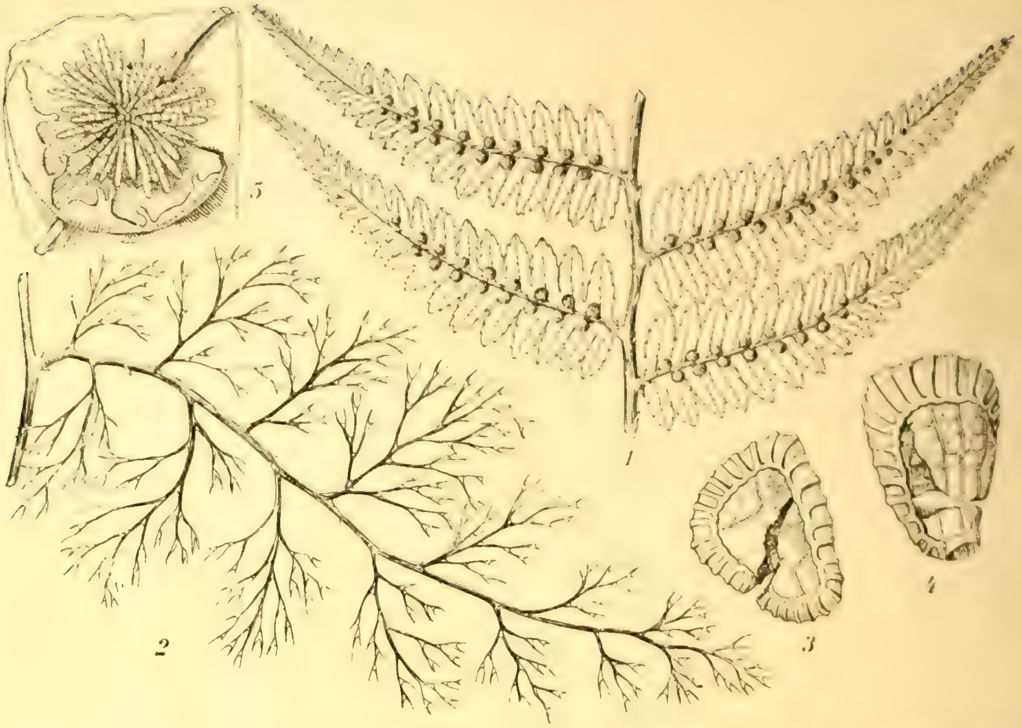


Fig. 55 A. *Hemitelia capensis* (L.) R. Br. 1. Part of a pinna. 2. Old aphlebium, from base of frond. Nat. size. 3, 4. Sporangia, dehiscing, 150/1. 5. Sorus showing the indusium, 15/1. (From nature)

Fig. 55 B. *Hemitelia capensis* R. Br. Head of stem, showing the crowded aphlebia, the fronds being cut away. ½ nat. size. The upper aphlebia are fresh and green, those below, from old and decayed fronds, dead. June.

P Marloth

Werner & Winter, Frankfort/M.

THE FOREST TREE FERN

HEMITELIA CAPENSIS (L.) R. Br.

In the foreground an entanglement of RUBUS PINNATUS Willd.

In a wooded ravine on Table Mountain, 1500 feet

The Aphlebia of Hemitelia capensis.

Hemitelia capensis (Plate 11) is one of the few living ferns, the fronds of which are provided with two peculiar basal pinnae (Fig. 55 A, 2), called ***aphlebia***. Such structures were frequent on ferns of former geological periods, but are rare now. Their function has been a cause of much speculation among botanists.

Some authors look upon them as "hydrofoliola," which absorb dew or other moisture, thus assisting in the supply of water to the plant. That, however, cannot be so in our case, for the following reasons :

1. *Hemitelia capensis* grows only in permanently wet and shaded spots of the forests or mountain ravines, where, owing to the canopy of the trees, no dew occurs, and where the plant has always an unlimited supply of water at its disposal in the soil.

2. The aphlebia are not capable of absorbing water placed upon them in the form of spray, for water does not adhere to their surface, in fact one cannot moisten them in this way.

We think that their function is simply that of the stipules of various other leaves, which, while assimilating themselves, protect the young foliage against the effect of drying winds or other injuries.

They are always fully developed before the frond to which they belong makes its appearance (beginning of winter, viz. May or June), and they become dry before the next season's aphlebia begin to show, while their fronds are still fresh and vigorous.

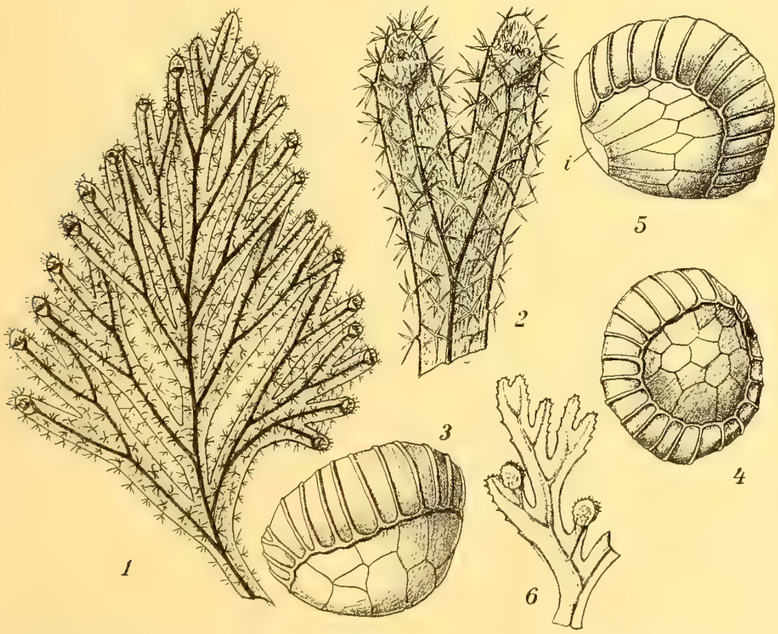


Fig. 56. *Hymenophyllum.* 1, 2. *H. Marlothii* Brause 1. Frond, without the stalk, 2/1. 2. Segment, 4/1. 3–6. *H. tunbridgense* (L.) Smith 3–5. Different views of sporangia. 6. Pinnule with two sori enclosed in the cup-shaped indusia. (From nature)

2. Order: Hydropterides.

A. Delicate floating, moss-like herbs. Sori of two kinds, containing either a number of microsporangia or a single macrosporangium.

Gen. 39. 9. **Azollaceae**

B. Rooted aquatic or marsh plants with a rhizome-like stem and alternate leaves. Fertile leaves with 4-parted lamina and basal sporocarpia. Sporocarpium bean-shaped with a tough wall, bearing numerous sori on its inner side, each one containing micro- and macrosporangia. The sporocarpium is split by the swelling of an annular layer of cells, and this gelatinous ring forces the sporangia out. The male prothallium remains enclosed in the spore and produces two antheridia. (Fig. 57.)

Gen. 40. 10. **Marsiliaceae**

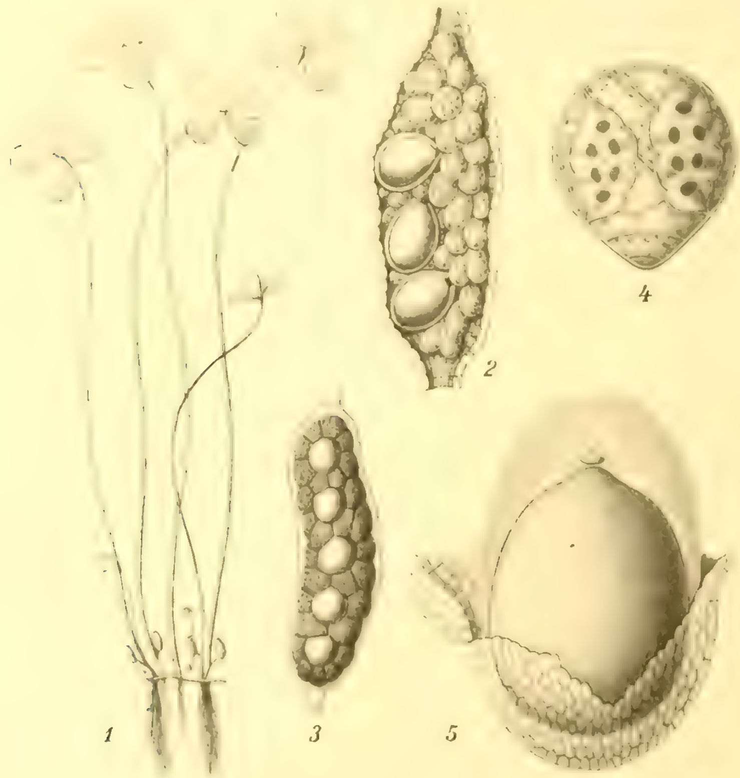


Fig. 57. *Marsilia.* 1. *M. capensis* A. Br. Plant collected near Worcester. 2, 3. *M. salvatrix* Hanst. Long. section of a sporocarpium, showing the sporangia. 10/1. 4. *M. elata* A. Br. ♂ gametophyte. 300/1. This discharges later on the spermatozoids. 5. *M. salvatrix*, macrospore. 30/1. (1 from nature, 2–5 after Belajeff)

Class II. EQUISETINAE. Horsetails. Paardestaart.

(Fig. 58.) The only family. *Gen.* 41. 11. **Equisetaceae**

The only species of this class occurring in South Africa is *Equisetum ramosissimum.* This plant is considered to be injurious to stock. Sometimes called *dronkgras* (Transvaal), like the more southerly *Melica decumbens* (Gram. Vol. IV).

Fig. 58. *Equisetum ramosissimum* Desf. 1. Plant from Natal. 2. Spike. *r.* Annulus. 3. A sporophyll. 4. The same seen from below. 5. Spore. 6. *E. palustre* L. Part of a ♂ gametophyte. *a*, *b*, *c*, *d*, stages of development of the antheridia. *sp.* Spermatozoids. 7. *E. arvense* L. Female gametophyte. *pr.* Sterile lobes. *rh.* Rhizoids. *ar.* Archegonia. (1–5 from nature, 6, 7 from Engler and Prantl)

Class III. LYCOPODIINAE. Clubmosses and Quillworts.

A. Isosporous. Leaves without ligula. (Plate 12; Fig. 59.)
Gen. 42, 43. 12. **Lycopodiaceae**

B. Heterosporous. Terrestrial. Leaves with ligula. Stems very slender. (Fig. 60.)
Gen. 44. 13. **Selaginellaceae**

C. Heterosporous. Aquatic. Stems condensed into a short caudex. Leaves grass-like, with ligula. (Fig. 61.)
Gen. 45. 14. **Isoetaceae**

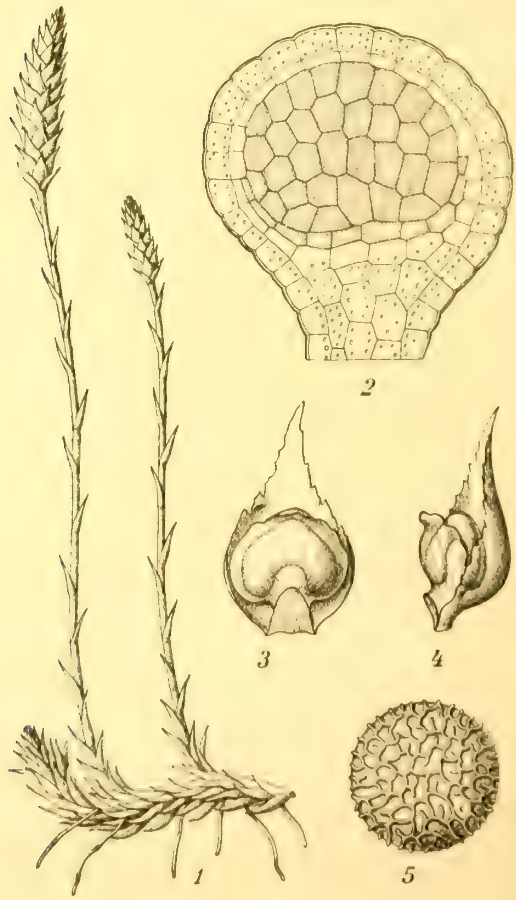


Fig. 59. *Lycopodium.* 1, 3–5. *L. carolinianum* L. 1. Plant. 3, 4. Sporophyll with sporangium. 5. Spore. 2. *L. clavatum* L. Long. section of a sporangium. (Fig. 2 from Engler and Prantl, the others from nature.)

Photogr. by R. Marloth.

Werner & Winter, Frankfort a/M

LYCOPODIUM GNIDIOIDES L.
In the background KNOWLTONIA VESICATORIA Sims.
Table Mountain, 2400 feet

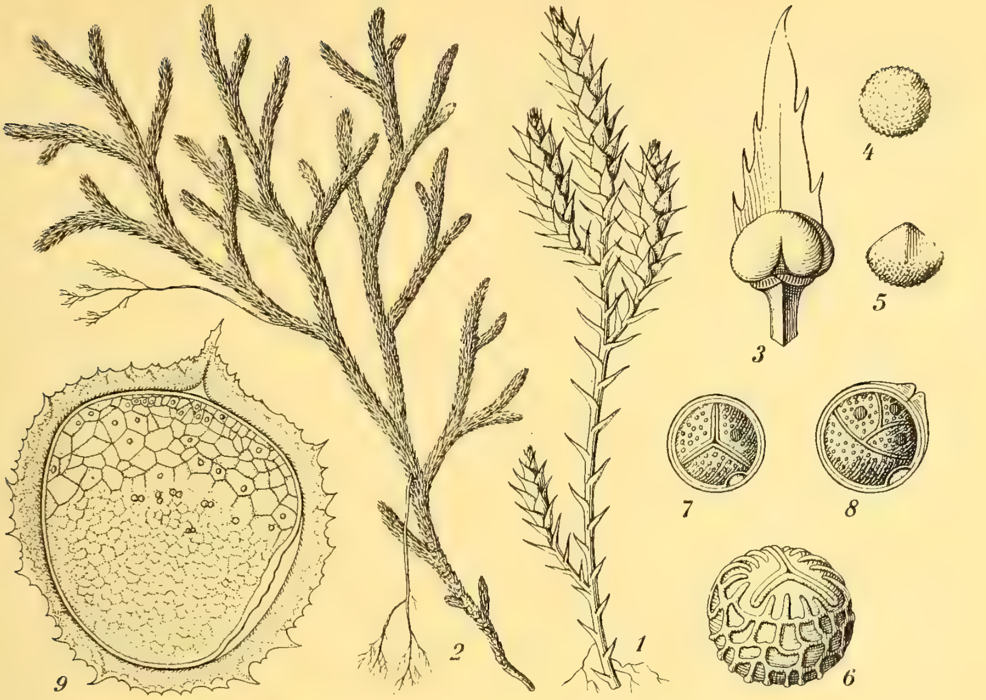


Fig. 60. *Selaginella*. 1. *S. pumila* (Schlecht.) Spring Plant from Mowbray. 2. *S. rupestris* L. Plant from Warmbad (Transvaal). 3. *S. selaginoides* (L.) Link Sporophyll with sporangium. 4–6. *S. lepidophylla* (Hook. & Grev.) Spring 4, 5. Microspores. 6. Macrospore. 7, 8. *S. Kraussiana* (Kze.) A. Br. 7. Microspore. 8. ♂ gametophyte (microspore with rudimentary prothallium). 9. *S. Martensii* Spring ♀ gametophyte, within the macrospore. (1 and 2 from nature, 3–9 from Engler and Prantl)

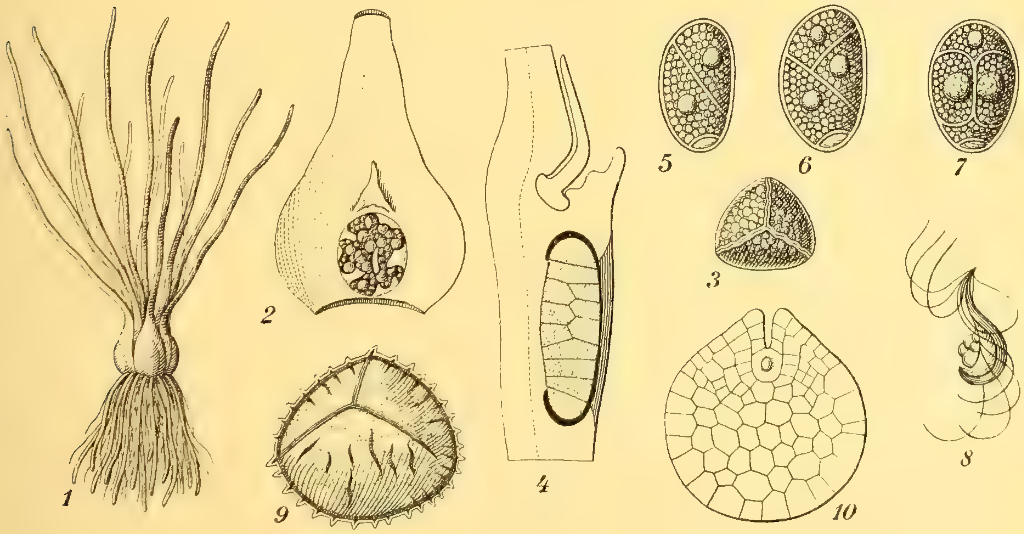


Fig. 61. *Isoetes*. 1–3. *I. natalense* Bak. Plant, the sporangia shining through the leaves. 2. Base of fertile leaf. 3. Microspore. 4. *I. lacustre* L. Long. section of a fertile (♂) leaf. 5–7. *I. setaceum* Bosc. ♂ gametophyte. 8. *I. Malinvernianum* Cesati & De Not. Spermatozoid. 9, 10. *I. lacustre* L. Macrospore and gametophyte. (1–3 from nature, 4–10 from Engler and Prantl)

SYNOPSIS OF THE GENERA OF PTERIDOPHYTES*.

[The figures in brackets indicate the number of species in S. A.]

Fam. 1. Ophioglossaceae.
(Fig. 47.) (5) 1. **Ophioglóssum**

Fam. 2. Marattiaceae.
(1) 2. **Maráttia**

Fam. 3. Osmundaceae.

A. Fertile pinnae almost devoid of lamina.
(1) 3. **Osmúnda**

B. Sori on the back of ordinary pinnae. (Plate 8 ; Fig. 48.)
(1) 4. **Tódea**

Fam. 4. Schizaeaceae.

A. Fronds without lamina, rigid and wiry, the fertile segments crowded at the apex into a comb-like body. (Fig. 49.)
(3) 5. **Schizáea**

B. Fronds pinnately divided. Fertile part of frond distinct, without lamina, much branched, rising from the base of the leafy barren frond.
(3) 6. **Aneímia**

C. Sporangia marginal or nearly so, on ordinary fronds. (Fig. 50.)
1 species only, *M. caffrorum.* 7. **Móhria**

D. Scandent. Fronds alternate, dichotomous near the base. Sporangia in spikes along the edges of ordinary or modified fronds or parts of fronds, each one separate in the axil of an almost marginal, infolded involucre. The involucre of each sporangium imbricating over that next above it. (Fig. 49.)
(2) 8. **Lygódium**

Fam. 5. Gleicheniaceae.
"The Creeping Fern." (Plate 8; Fig. 51.)
(3) 9. **Gleichénia**

Fam. 6. Polypodiaceae.

A. Sori furnished with an involucre or indusium.

a. Indusium covering the sorus (at least when young) and opening towards the margin of the frond.

I. Sorus marginal, roundish. Indusium attached at the base and at the sides, being open only at the outer edge.
(4) 10. **Davállia**

* By T. R. Sim, F.L.S.

II. Sori dorsal.

1. Involucre membranous, cup-shaped, at first enclosing the sorus, afterwards splitting at the apex into several lobes.
   1 S. A. species. Small, herbaceous. 11. **Wóodsia**

2. Involucre resembling a scale, its wider end being under the sorus and the other end turned over it like a hood.
   1 species, *C. fragilis*, cosmopolitan. 12. **Cystópteris**

III. Sori linear, marginal, covered by a linear indusium, which opens outwards.
   1 tropical species in Natal. 13. **Lindsáya**

b. Sori marginal. Indusium formed by the edge of the frond reflexed over the sorus and opening towards the midrib.

I. Indusium terminal on the pinnule, reniform or elongated, bearing the sporangia on its under surface. "Maidenhair."
   11 species in S. A., of which *A. thalictroides* is frequent.
   14. **Adiántum**

II. Sori in the sinuses between the lobes, reniform or oblong; veins anastomosing.
   (1) 15. **Lonchítis**

III. Veins free. Sori in the sinuses between the lobes or sometimes scattered. Indusia membranous, small, round, equal.
   3 species in S. A. 16. **Hypólepis**

IV. Sori abundant, often confluent round the edge of the frond excepting the sinuses. Indusia roundish, not confluent, formed of the edge of the frond, only partly inflexed.
   9 species in S. A. 17. **Cheilánthes**

V. Sporangia arranged on the frond in a broad line, the indusium sub-continuous or sometimes interrupted and then consisting of rounded portions. (Fig. 53.)
   7 species in S. A. 18. **Pelláea**

VI. Sporangia in the axil of the indusium in a narrow line. Indusium quite continuous.
   8 species in S. A. (Incl. *Pteridium.*) 19. **Ptéris**

VII. Sori occupying the whole under side of the frond except the ribs. Indusium linear, continuous. Fertile pinnae narrower than the barren.
   5 species in S. A. 20. **Lomária**

c. Sori not marginal, but covered by a linear or oblong indusium which opens towards the midrib.

I. Sori linear, parallel with the midrib.
   2 species in S. A. 21. **Bléchnum**

II. Sori linear or oblong, placed obliquely between the midrib and the margin. (Fig. 53.)
A very large genus, 28 species in S. A.
22. **Asplénium**

III. Frond flabellate, with narrow segments. Sori submarginal, linear.
1 tropical species also in Na, Tr.
23. **Actiniópteris**

d. Sori not marginal, covered by a reniform or circular, peltate indusium.

I. Sori reniform; indusium reniform or elliptical and attached to the vein for its entire length, free at the edge.
1 tropical species in Natal.
24. **Didymochláena**

II. Sori subglobose; indusium orbicular, attached in the centre, peltate. (Figs. 52 and 53.)
A large genus. 6 species in S. A.
25. **Aspídium**

III. Sori subglobose; indusium reniform, attached at the sinus. Pinnae not articulated.
16 species in S. A. 26. **Nephródium**

IV. Involucre reniform or suborbicular; pinnae simple, articulated to the rhachis.
3 species in S. A. 27. **Nephrólepis**

V. Involucre reniform; rhizome scandent. Fronds simple.
1 species reaching Natal. 28. **Oleándra**

B. Sori without involucre or indusium.

I. Sori round or nearly so, dorsal. (Figs. 53 and 54; Plates 9 and 24.)
A very large genus, 14 species in S. A.
29. **Polypódium**

II. Sori marginal, at first oblong but soon confluent into a continuous marginal line; fronds 2—3-pinnate. (Plate 9.)
4 species in S. A. 30. **Notochláena**

III. Sori oval, oblong or linear, not marginal. Fronds 2—3-pinnate.
6 species in S. A. 31. **Gymnogramme**

IV. Fronds simple, grass-like, with several veins. Sori in longitudinal lines near the margin. (Plate 9.)
1 species in S. A. 32. **Vittária**

V. Sori covering the back of the frond, not in dots or lines. (Plate 9.)
10 species in S. A. 33. **Acróstichum**

VI. Barren frond thalloid, cordate; fertile frond arising from the sinus, simple or dichotomously branched; sori in patches on the back of the bifurcations.
2 species in S. East Afr. 34. **Platycérium**

Fam. 7. Cyatheaceae.

A. Involucre at first completely enclosing the sorus, afterwards forming a cup by splitting at the apex. Sporangia surrounding the raised receptacle. Arborescent. (Plate 10.)
1 S. A. species, the largest S. A. fern.
35. **Cyáthea**

B. Involucre reduced to a scale underneath the sporangia, the latter surrounding the raised receptacle. (Plate 11; Fig. 55.)
1 species, the Forest Tree Fern.
36. **Hemitélia**

Fam. 8. Hymenophyllaceae.

A. Involucre compressed, deeply 2-labiate. (Plates 8 and 24; Fig. 56.)
7 S. A. species. 37. **Hymenophýllum**

B. Involucre cup-shaped, with an entire or only slightly 2-lipped mouth.
5 S. A. species. 38. **Trichómanes**

Fam. 9. Azollaceae.
1 species, doubtful for S. A. 39. **Azólla**

Fam. 10. Marsiliaceae.
4 species in S. A. (Fig. 57.) 40. **Marsílea**

Class II. EQUISETINAE.

Fam. 11. Equisetaceae.
1 species in S. A. (Fig. 58.) 41. **Equisétum**

Class III. LYCOPODIINAE.

Fam. 12. Lycopodiaceae.

A. Sporangia reniform, one-celled, opening lengthwise along the top. (Plate 12; Fig. 59.)
7 species in S. A. 42. **Lycopódium**

B. Sporangia 3-lobed, 3-celled, each cell splitting down its centre.
1 S. A. species. 43. **Psilótum**

Fam. 13. Selaginellaceae.
10 S. A. species. (Fig. 60.) 44. **Selaginélla**

Fam. 14. Isoetaceae.
2 S. A. species, about 60 others. (Fig. 61.) 45. **Isoétes**

GENERA AND SPECIES OF ARCHEGONIATAE.

Synonyms are printed in italics. Introduced or foreign plants are printed in black type.

PARTS III AND IV

ANTHOPHYTA

FLOWERING PLANTS

ANTHOPHYTA. Flowering Plants.

(PHANEROGAMS)

As explained in the introduction the term Flowering Plants conveys an erroneous impression if used in contrast to the cryptogams, the so-called non-flowering plants; hence various attempts have been made to introduce a more accurate designation, *e.g.* ***Spermatophyta***, ***Siphonogama***. But these names, although suitable for purposes of classification, are not sufficiently convenient for general use.

The defining of a ***flower***, as far as it relates to the angiosperms, is a simple matter; but if one attempts to do so with regard to the gymnosperms serious difficulties arise. Some authors look upon each ovuliferous scale in the cone of *Pinus* as a flower, but others consider the whole cone as one flower. In Gnetaceae, however, *e.g. Welwitschia*, the latter view cannot be accepted, neither for the male nor the female cone, for here each scale supports an individual flower.

Similarly, if the cones of *Encephalartos*, male as well as female, or the aggregation of sporophylls at the apex of a *Cycas*, be called flowers, the spikes of sporophylls of *Equisetum* or *Selaginella* are just as much flowers, and yet we cannot very well include the latter among the flowering plants. The more advanced student will find it very interesting to compare the arguments brought forward by the various writers in support of their respective views, but this is not the place to discuss them.

We shall therefore employ the term Flowering Plants in accordance with long established practice, although the term flower has, especially among the gymnosperms, a somewhat arbitrary and variable meaning.

PLATE 13 VOL. I

THE OUTENIQUA YELLOWWOOD
PODOCARPUS LATIFOLIUS (L.) R. Br.
In the wilderness near George

PART III

GYMNOSPERMAE.

The sexual organs are of two kinds. The male organs, viz. the microspores, here called *pollen grains*, are produced in pollen bags corresponding to the anthers of angiospermous plants. The pollen bags are borne on special scales called *sporophylls*, which are arranged either in cones or catkins, but in the highest gymnospermous plant known, viz. *Welwitschia*, they assume a stamen-like form.

The female organ, viz. the macrospore, is embedded in a complex body, the whole structure being called an *ovule*. The ovules are borne either on the edge of leaves as in *Cycas* (not South African) or on scales, in which case there are generally two on each scale, rarely one only. In a few genera, *e.g. Podocarpus*, these ovuliferous scales remain isolated, but generally a number of them are aggregated into a cone. The pollen grain, which consists of two or more cells, enters the ovule as a whole (not in the form of a tube), floating in the fluid which fills the micropyle and finally attaching itself to a certain part of the wall of the micropyle (*pollen chamber*). Here it produces either *spermatozoids* (*Cycas*) or a *pollen tube*, the latter penetrating the tissue of the nucellus and carrying the generative nucleus to the oosphere.

As a result of the subsequent changes in the nucellus the whole ovule is transformed into a seed. The *seed* of the gymnosperms consists of three parts, viz. the shell, which is principally derived from the integuments but may be variously modified, the *endosperm* (nutritive tissue) formed from the prothallial tissue of the nucellus (exc. *Gnetum*), and thirdly the *embryo*, the latter being the product of the union of the nucleus of the oosphere with the spermatozoid or the generative nucleus of the pollen tube. The embryo possesses two or more cotyledons.

One of the chief distinctions of this division from the two previous ones, the bryophytes and pteridophytes, is the absence of an independent sexual generation, the latter being produced directly by the sporophyte as a tissue within the ovule, without the intermediary stage of an independent spore, and remaining in organic connection with it during the sexual process. Both generations, the sexual and asexual, are consequently condensed into one, the nucellar tissue only being the equivalent of the prothallium of the ferns. The new type of plant, which is by analogy a sporophyte but by function a gametophyte, has taken over the production of the sexual cells.

The pollen is transported by the wind, but in the highest order, Gnetaceae, insect agency has been observed, viz. in *Welwitschia* by PEARSON and in *Ephedra* (Mediterranean) by PORSCH. With regard to *Encephalartos* see that genus.

All gymnosperms are woody plants.

THE GENERA OF CYCADACEAE.

(From page 96.)

A. Cones always solitary. Pinnae of leaves with a strong midrib, feather-veined. (Plate 14.)
Endemic. 1. **Stangéria** *Moore*

B. Cones mostly in a whorl. Pinnae of leaves without a midrib, with longitudinal parallel veins. (Plate 15.)
8 species in S. A., 5 in Trop. Afr.
2. **Encephalártos** *Lehm.*

Class I. Cycadales.

Stems simple or divided into a few stout branches. Leaves pinnate. ♂ flowers as well as ♀ flowers spirally arranged in cones. Pollen bags on lower side of scales (sporophylls). Seeds with a fleshy coat.

Fam. 1. **Cycadaceae**

Class II. Coniferae.

Stems branched. Leaves simple. ♂ flower resembling a catkin.

A. ♀ flowers pedunculate, solitary or in pairs, each one with 1 ovule. Pseudo-fruit globular, 1-seeded, supported (*Podocarpus*) by the swollen apex of the peduncle.

Fam. 2. **Taxaceae**

B. ♀ flower a cone, consisting of 4 or more scales, each scale with 2 ovules. Ripe cone with woody scales and dry, nut-like seeds.

Fam. 3. **Pinaceae**

Class III. Gnetales.

Stem (of *Welwitschia*) 2-lobed at the apex. Leaves 2, simple, but lacerated into shreds. Dioecious. Cones of both sexes arranged in cymes. ♂ flower formed of 6 stalked pollen bags, surrounded by 4 bracts (pseudo-perianth), in the centre an abortive ovule. ♀ flower an erect ovule, surrounded by a tubular but broadly winged perianth. The ripe seed nut-like, enclosed in the dry persistent perianth.

Fam. 4. **Gnetaceae**

Class I. CYCADALES.

Fam. 1. CYCADACEAE.

Subfam. ZAMIEAE.

(Plates 14, 15, 16.)

Plants with simple or slightly branched, woody stems and terminal tufts of pinnate leaves. Dioecious.

Male flowers cone-shaped, solitary or in a whorl of 3–5 at the apex of the stem. Each cone composed of a large number of spirally arranged scales (sporophylls), which bear numerous pollen bags on their under side. When the cone is ready for pollination the axis elongates a little, thus separating the scales to some extent and exposing the pollen bags, which open by a longitudinal slit. The pollen grains cohere in lumps to some extent.

Female flowers cone-shaped, solitary or in a whorl at the apex of the stem, about twice as thick as the ♂ cones, each one consisting of a large number of spirally arranged ovuliferous scales. Each scale consists of a winged stalk with an enlarged, more or less peltate apex, from which, on the upper side of the stalk, two ovules are suspended, the micropyle being turned towards the axis of the cone. The ovule is fully developed only when it has reached almost the size of the ripe seed; it then secretes a drop of fluid at the micropyle, by means of which the pollen grains, brought there either by the wind or through the agency of insects, are captured and transported into the pollen chamber; here they attach themselves to the walls of the chamber by means of a short tube (***haustorium***). Their further development has not been observed in any South African species as yet, but in *Cycas* each pollen grain develops two ***spermatozoids***, which are provided with several tufts of cilia, by means of which they are able to move about in the fluid of the pollen chamber. The spermatozoid attaches itself to the apex of the nucellus, when its contents, by entering the latter, finally reach the oosphere. (Fig. 62, Nos. 4 and 5.)

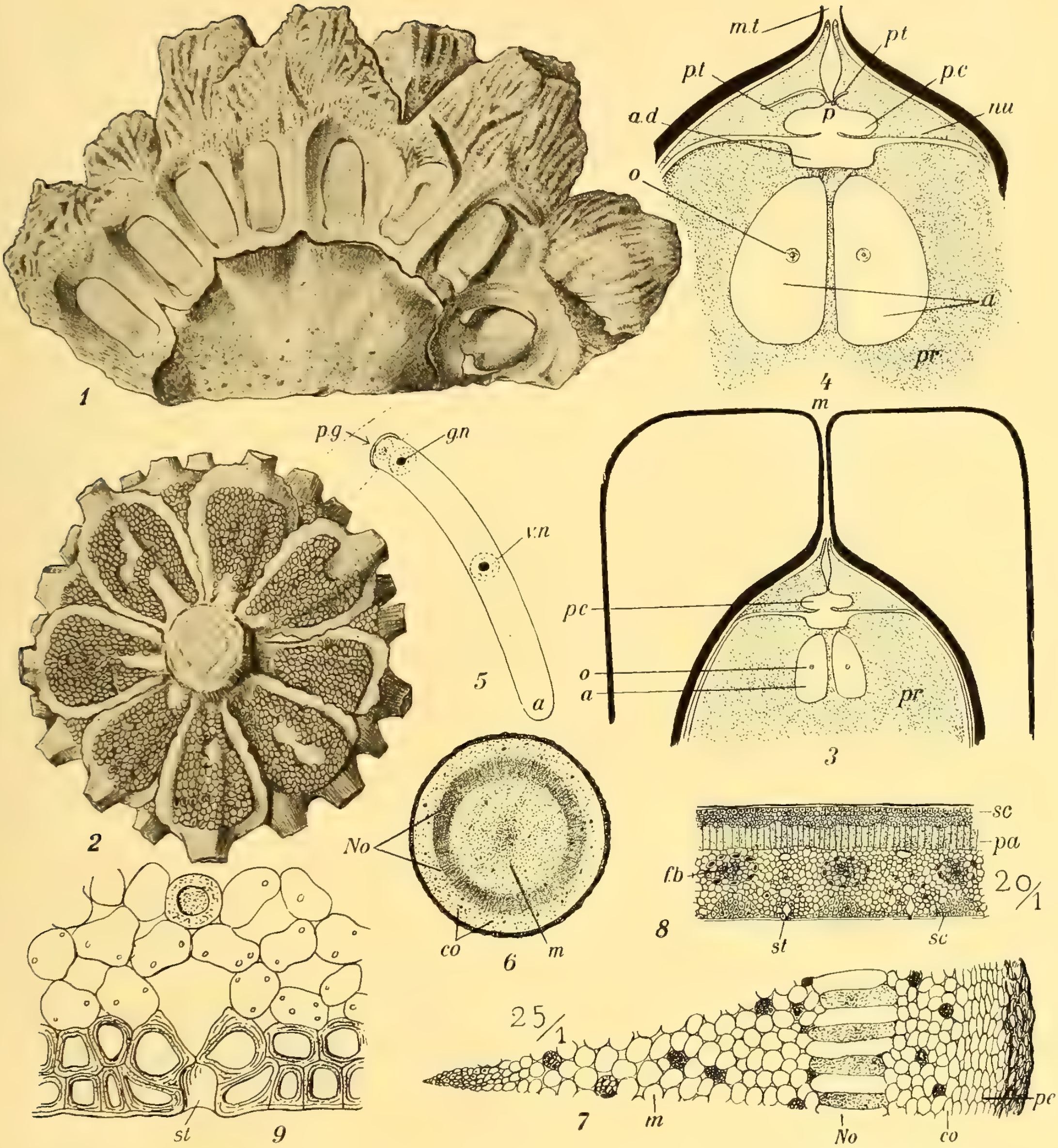


Fig. 62. *Encephalartos Altensteinii* Lehm. 1. One half of a transverse section of a ♀ cone, showing 3 complete scales with two fully developed ovules each, and 2 ovules from partly hidden scales. Seen from below. ½ nat. size. 2. Transverse section of ♂ cone of *E. Lehmanni* Lehm., seen from below. ½ nat. size. 3. Long. section through apex of ovule (facing the axis). 3/1. 4. Portion of Fig. 3. 10/1. *m.* Micropyle. *mt.* Micropylar tube. *p.* Pollen grains (germinating). *pt.* Pollen tubes (haustoria). *pc.* Pollen chamber. *ad.* Archegonial depression. *nu.* Nucellar tissue. *pr.* Prothallial tissue (endosperm). *a.* Archegonia. *o.* Oosphere. 5. Pollen tube, as seen embedded in the nucellar tissue. *pg.* Germinating pollen grain. *gn.* Generative nucleus. *vn.* Vegetative nucleus. *a.* Growing apex. The two dotted lines indicate the walls of the pollen chamber. 300/1. 6. Transverse section through branch of apo-geotropic root. 5/1. *co.* Cortex. *No.* Green layer, containing the alga (*Nostoc*). *m.* Medulla. 7. Portion of Fig. 6, enlarged. 25/1. *pe.* Periderm (cork), the outer layers decayed. *co.* Cortical parenchyma. *No.* Layer with Nostoc (the colourless parts are the cells). *m.* Medulla (pith). 8. Transverse section of leaf. 20/1. *sc.* Sclerenchyma. *pa.* Palisade cells (green parenchyma). *fb.* Fibrovascular bundles. *st.* Stoma. 9. Portion of under side of Fig. 8. 240/1. (Figs. 3–5 from sketches by W. T. Saxton.)

The fertilised ovule ripens into a drupe-like seed, which in the S. A. species is bright orange, the outer layer of the integument forming the skin, the middle layer the pulp and the inner layer with some portion of the nucellus the stony shell, while the remaining tissue of the nucellus forms a copious endosperm. When the ripe seed drops from the cone the embryo is very minute, completing its development slowly while the seed is in the ground. The pulpy coat of the seed contains sugar and attracts birds as well as small rodents, which carry the seeds about and thus disperse them.

The ***embryo*** possesses two cotyledons, and when fully developed, which process may take six months or more from the time that the seed was dropped, it begins to germinate. The hypocotyl lengthens considerably and the radicle develops into a taproot with lateral rootlets and a peculiar kind of coralliform, upright roots (***apo-geotropic***) (Figs. 62, 63), which reach to the surface of the ground. In a certain circular layer of their tissue these roots harbour masses of a green alga [*Nostoc punctiforme* (Kütz.) Hariot]*.

This zone of the tissue of the root consists of narrow, cylindrical cells, arranged radially in such a way that equally large intercellular spaces are left between them. These spaces contain a slimy fluid, in which are embedded innumerable threads (green) of the *Nostoc*, quite similar in appearance to those figured on Plate 2, fig. M, 2 and 3. These roots are not confined to seedling plants, but are also formed by the adult plant later on. We have a good sized tree of *E. Altensteinii* in our garden, which was planted some years ago as a bare trunk without any root to it, and which is now surrounded at its base, close to the stem, by compact masses of these roots, which are peeping out of the ground here and there. There are

* Sometimes called *Nostoc Hederulae* Men. and by others *Anabaena Cycadearum* Reinke. According to Professor N. WILLE it does not belong to the latter genus.

generally also various bacteria present in these intercellular spaces.

It is not certain what the function of these roots may be; but they probably assist in the nutrition of the plant, thus functionally corresponding to the mycorhiza of some conifers (*Pinus*, *Podocarpus*).

The stems and leaves have no resin-ducts; but the former possess numerous branched slime-tubes in the inner bark, hence when they are injured an ample flow of a gummy fluid appears, which soon seals the wound. The same result takes place when a cone or a portion of it is removed, the transparent fluid gradually hardening into a brittle gum.

The stems of *Stangeria* are subterranean, usually consisting of two or three stout branches, while those of most species of *Encephalartos* are generally simple, branching only occasionally and then probably owing to some injury. Most species of the latter genus, however, often produce young shoots from the subterranean portion of the stem, thus giving rise to tufts of plants. Such shoots may be planted like cuttings. The vitality of the plants is astonishing. Trunks of *Encephalartos Altensteinii*, which had been kept lying in a shed for four years, were sent to us from Kaffraria and, on being planted, produced new leaves the next summer.

The leaves of *Encephalartos* are arranged in superposed whorls, a new tuft of leaves appearing every second year in alternation with whorls of flowers*. The young leaves of all species when still tender are often attacked by the larva of a black and yellow moth (*Zeronopsis leopardina*), but when fully developed they are as rigid as horn, especially those of *E. Altensteinii* and *E. Lehmanni*, resembling in their anatomical structure the leaves of some conifers. The epidermis consists of small thick-walled cells, below which

* Plants do not flower regularly in their native habitat, there being often intervals of five or more years, probably according to the nature of the season.

occur two or three layers of hard and tough sclerenchyma, which forms a continuous mantle on the upper side of the leaf, but occurs in longitudinal strands only on the under side. In the furrows between the strands are the stomata, deeply sunk into the epidermal tissue. (Fig. 62, Nos. 8 and 9.)

The pollination of some species of S. A. Cycadaceae is effected by insects. Miss ALICE PEGLER has devoted much time to this question, by observing *Encephalartos Altensteinii* and *E. villosus* at their natural habitat near Kentani in the Transkei. Her first collection of insects consisted entirely of a certain weevil mentioned by PEARSON, viz. *Phloeophagus hispidus*, but as this had been found only on the male plants, it might have been merely feeding on the pollen without visiting the female cones. Later on, however, Miss PEGLER sent us some other collections of insects, among which we found two kinds of beetles, taken on the female as well as the male cones (see Plate 15; Fig. 9). One of these is also a weevil, viz. *Derelomus languidus**. As the insects from the female cone carried some pollen grains of *Encephalartos* the entomophilous nature of the genus can hardly be doubted.

Similar observations have been recently made by Dr RATTRAY in the neighbourhood of East London, who states that the male cones of *E. villosus*, when fully developed and ready to shed their pollen, emit a powerful, nauseous odour and are visited by swarms of a certain weevil†. (May.)

The seeds are often infested with a weevil (*Antliarhinus Zamiae*), which is occasionally so numerous that the entire kernel of the seed is consumed, a small puncture in the shell indicating where the introduction of the eggs had taken place. (Plate 15.)

Plants with cycadaceous characters were predominant in mesozoic times, but at present the family consists only of 9 genera with a total of 100 species. Two genera with 9 or 10 species occur in S. A. (See page 90.)

* Kindly identified by Dr L. PÉRINGUEY, Director S. A. Museum, Capetown.

† Named *Phloeophagus* but obviously *Antliarhinus*. See page 263.

Plate 14.

Stangeria paradoxa *Moore*

Plate 14.

Stangeria paradoxa* Moore
1. Female plant, with young leaf and female cone. 1/8. From Natal.
2. Terminal leaflet of adult leaf.
3. Female cone. Before pollination. Nat. size.
4. Male cone. Nearly fully developed.
5. Scale of male cone (a sporophyll), the under side. Nat. size.
6. Group of ripe pollen bags from sporophyll. 6/1.
7. Pollen grains. 300/1. 8. Ripe seed.
9. Ripe seed in longitudinal section, showing the undeveloped embryo.

Stangeria paradoxa possesses a large, globose or oblong, underground stem, up to 10 inches in diam., mostly divided into 3 or 4 stout branches, which reach with their apex nearly to the surface of the soil (Fig. 63). The plants are evergreen, and the new leaves appear, one only each time or a few in a season, in early summer. Plants of the grassveld have their foliage destroyed by fire from time to time, hence they often possess only one leaf on each branch. The cones are always single and their peduncle projects only a few inches above the ground. The bases of the petioles and of the peduncle of the cone are densely woolly. The leaves are pinnate like those of *Encephalartos*, but the venation is different, each leaflet possessing a strong midrib, the veins running from the midrib like the barbs of a feather. The cones of both sexes are smooth on the outer side, the ovules flesh-coloured, not white as in *Encephalartos*, while the colour of the ripe seeds is the same in both genera. The foliage of the plant is very variable according to the nature of its habitat. In exposed grassy localities of East London and the coastal parts of the Transkei the blade of the leaves is generally not more than 8—12 inches long, dull coloured, leathery when fully developed, and the margin of the leaflets entire. This form has been named *Stangeria Katzeri* (Regel, Gartenflora XXIII (1874), Taf. 798). (See Fig. 63.) In sheltered ravines, however, and among the forest scrub of Natal the plants are more luxuriant, with leaves up to 4 feet in length, the blade being not rarely 2½ feet long; the texture is soft and the colour bright green, while the margin of the leaflets is deeply serrate.

The two extremes may easily be taken for two distinct species, but one finds various intermediate forms. It will be consequently preferable to consider them as varieties, viz. *Stangeria paradoxa* var. *Katzeri* [*St. Katzeri* Regel], Fig. 64, *Stangeria paradoxa* var. *schizodon* [*St. paradoxa* Moore], Plate 14.

The stem of young plants shows in transverse section a central ring of xylem-bundles with several (5—8) spots of meristem scattered in the ground-tissue around it. This meristem does not form strands but merely exists as oblong masses; hence in successive transverse sections these spots change their

* Named after Dr Stanger, a Surveyor General of Natal, who died in 1854.

position. The cells of the ground-tissue are gorged with compound starch-grains. In older stems the grouping of the xylem-bundles is mostly excentric.

According to PEARSON the plants produce apo-geotropic roots similar to those of *Encephalartos* and like them also inhabited by an alga (*Nostoc*).

Pollination is effected by the wind (*fide* RATTRAY).

Fig. 63. *Stangeria paradoxa* Moore var. *Katzeri*. 1. Subterranean stem with young leaf and female cone (long. sect.). 1/4. 2. Cells from central tissue with compound starch granules. 100/1. 3. Two single starch granules. 400/1. 4. Adult leaf. 1/4.

Plate 15.

A: Encephalartos Altensteinii *Lehm.* B: E. villosus *Lehm.*

Plate 15.

A. *Encephalartos Altensteinii* Lehm.
1. Female plant.
2. Scale (sporophyll) of male cone with pollen bags, seen from below.
3. Group of ripe pollen bags, 6/1.
4. Pollen grain. 300/1.
5. Scale of female cone, with nearly fully developed ovules. Seen from below, hence the ovules partly hidden by the stalk of the scale.
6. Scale of ripe cone, one of the two seeds in position. Seen from above.
7. Ripe seed in longitudinal section, showing the large endosperm and the immature embryo.
8. Beetle (a weevil, *Antliarhinus Zamiae*, called *Curculio zamiae* by THUNBERG as he named this genus of plants "*Zamia*"). See his Flora Cap. p. 430.
9. Beetle (*Derelomus languidus*) from the flowers of *E. Altensteinii*, collected on both sexes by Miss A. PEGLER.

B. *E. villosus.* Seedling with coralliform, apo-geotropic root.

C. Moth. *Zeronopsis leopardina.* This moth deposits its eggs on the leaves of several species of *Encephalartos*, and the larvae (see figure B) devour the young fronds as long as these are soft and juicy. It is also found on *Stangeria.*

The genus *Encephalartos*, which is nearly allied to the Australian genus *Macrozamia*, is at present confined to South Eastern and Tropical Africa, its furthest southern locality being near Algoa Bay, where it is represented by *E. horridus*, while *E. Lehmanni** with equally rigid and glaucous leaves, and *E. Friderici-Guilelmi* with very narrow leaflets occur on the mountains of the south eastern Karoo, viz. near Willowmore and Cradock. In former geological periods the genus had a wider range, and although no fossil remains have been found in South Africa as yet, they are known from some tertiary beds of Europe, viz. in the island of Euboea. We may look upon the present species as direct descendants of our cretaceous and tertiary floras, and some of them may, for all we know, have existed in their present form at those remote periods.

The largest species known is *E. Laurentianus* de Wild. a native of the Congo basin, where it reaches a height of 30 feet with leaves up to 20 feet long, while the largest S. A. species, *E. Altensteinii*, rarely reaches one half that size, its trunk being nearly cylindrical and up to 2 feet in diameter.

In *E. villosus* the trunk is mostly hidden in the ground, bearing a rosette of leaves 10—12 feet long (Plate 16, B).

The pith of several species, *e.g. E. caffer*, is, on account of its starch, prepared by the natives like sago and used as food, hence the names ***kaffir bread*** and ***broodboom.***

* Named after CH. LEHMANN, a former director of the Botanic Gardens at Hamburg (1845), who published various papers on Cycadaceae.

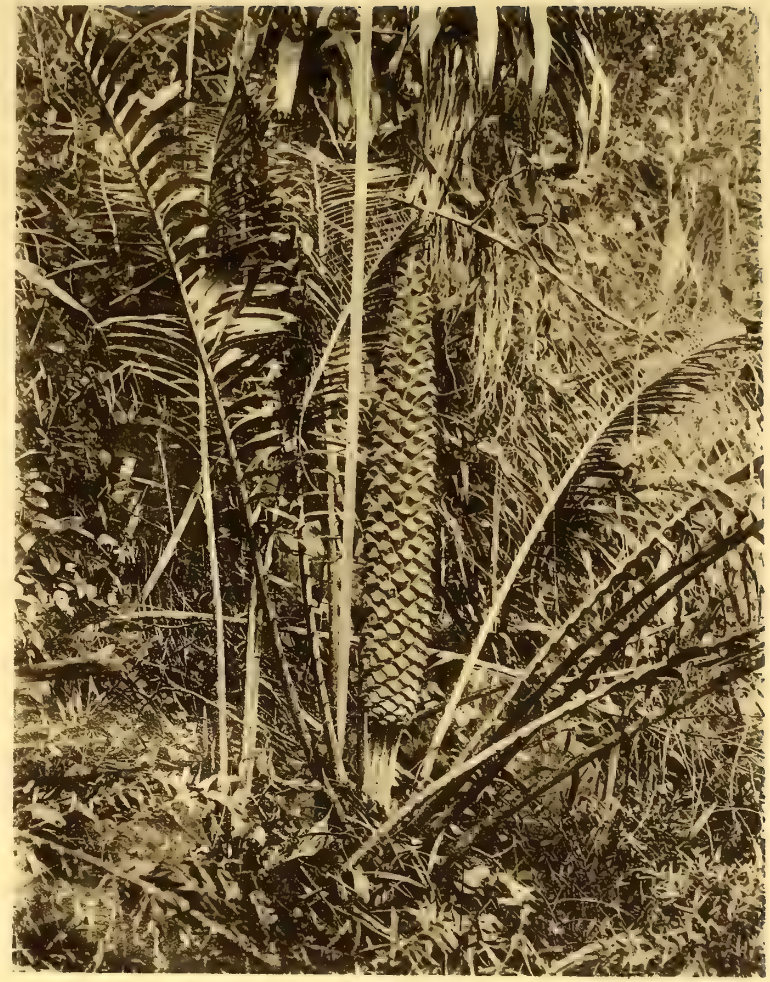
Fig. 64. *Encephalartos Altensteinii* Lehm. Apo-geotropic root of an old plant, gathered by Miss C. Pegler, Kentani. These roots rise to the surface of the ground or within a few inches of it. Nat. size.

Plate 16.

A. *Encephalartos Altensteinii.* This figure represents only the apex of a medium sized female plant, the stem of which is four feet high. Some of the front leaves have been cut away.

The lanceolate fronds on both sides of the stem belong to an epiphytic fern (*Polypodium africanum*). About 1/6 nat. size.

B. *E. villosus.* A male plant. The stem is entirely underground.



Photos by P.S. Laney

A

B

Werner & Winter, Frankfort a/M.

A. **ENCEPHALARTOS ALTENSTEINII** Lehm. ♀
With an epiphytic fern, POLYPODIUM AFRICANUM Mett.
B. **ENCEPHALARTOS VILLOSUS** Lehm. ♂
In a forest near Kentani

Plate 17.

A: Podocarpus latifolius *(Thunb.) Hook.*
B: Widdringtonia juniperoides *(L.) Endl.*
C: W. cupressoides *(L.) Endl.* D: W. Schwarzii *(Marl.) Masters*

Plate 17.

Fam. 2. Taxaceae.

A. *Podocarpus latifolius* (Thunb.) R. Br.
1. Seedling.
2. Seedling with its 2 cotyledons and 3 pairs of leaves; the tap-root with young tubercles of mycorhiza.
3. Flowering twig of male plant.
4. Fruiting twig of female plant with patches of *Corynelia.*
5. Longitudinal section of podocarpium with pseudofruit.
   p, podocarpium; *s*, shell of pseudofruit, derived from the epimatium; *t*, testa; *e*, endosperm; *em*, embryo.
6. Rootlet of tree with mycorhiza.
7. Transverse section of one half of the leaf. The yellow parts are the fibrous sclerenchyma (tracheids).

Fam. 3. Pinaceae.

B. *Widdringtonia* juniperoides* (L.) Endl. The *Clanwilliam cypress.*
1. Twig with a few ripe cones, one of the open cones showing the seeds in position.
2. Seed.
3. Seedling.

C. *W. cupressoides* (L.) Endl. "*Sapreehout*," from "cipres." (Fig. 67 *b*, page 106.)
D. *W. Schwarzii* (Marl.) Mast. Seed.

Podocarpus latifolius†, the *true yellowwood* (*regte geelhout*) and *P. elongatus*, the *Outeniqua yellowwood*, are the two largest forest trees of South Africa and supply nearly one half of all the indigenous timber produced. Both occur in all the forests, but *P. elongatus*, which is the larger of the two, forms only one per cent. of the trees in them, although it is often called the common yellowwood, while *P. latifolius* represents about 10 per cent. Unfortunately all the more easily accessible trees have been felled by the woodcutters, but in some remote parts of the Eastern or Zitzikamma forests one may still find giants of *P. elongatus* 140 feet high, with a clean bole of 50 to 60 feet and a trunk of 10 feet in diameter, the crown often thickly covered with lichens (*Usnea barbata*, the "old man's beard"). See Plates 13 and 18.

Widdringtonia juniperoides, the Clanwilliam cypress, sometimes called a cedar (*cederboom*), is a noble tree, which grows only on the range of mountains that has taken its name from it (Plate 19). The wood is beautifully grained and fragrant and well suited for all kinds of ornamental furniture, but, owing to the reckless felling of all more easily accessible trees in past times, little such timber is available at present. The pews in the little church at Clanwilliam are all made of this wood and are probably unique in this respect.

The attempts to cultivate the tree in regular plantations near its native haunts as well as at Tokai on the Cape Peninsula have not been quite successful as yet, probably because the localities, although possessing sufficient moisture

* Named after Capt. Widdrington, R.N. Died in 1856.

† This name must have the preference over the more familiar one *P. Thunbergii*, for Thunberg had originally described this plant as *Taxus latifolia* (1794), while Hooker's name was established only in 1842.

in the soil, are at too low an altitude, where the atmosphere becomes occasionally extremely dry*. Just as the Pinsapo-pine of Southern Spain (*Abies Pinsapo*) thrives only at an altitude of about 7000 feet in the cloud region of the mountains, so it is with our cypress, and the plantations will have to be made within the region of the southerly cloud-bearing winds, some 3500—4000 feet above the sea.

* A relative humidity of the air as low as 24 % has been recorded at the waterworks on Table Mountain (2400 feet) in December at 8 a.m., hence it would be considerably lower in the middle of the day.

TAXACEAE

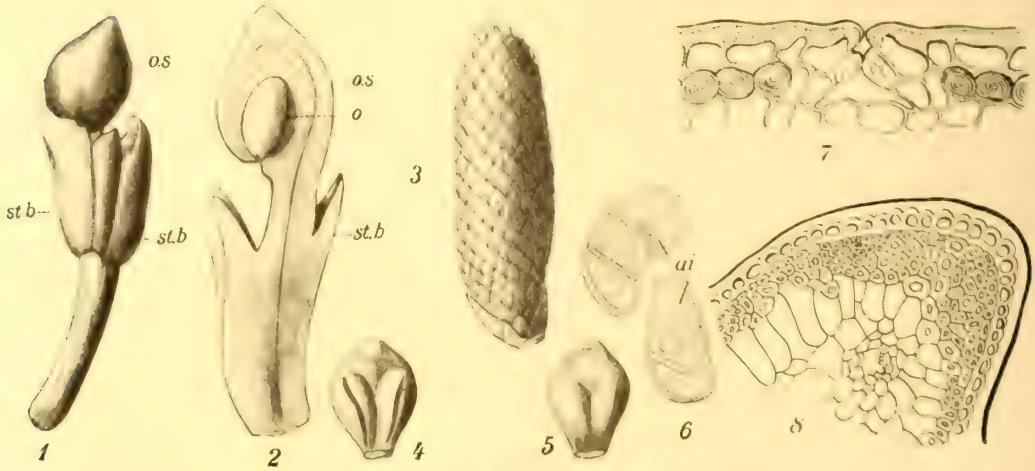


Fig. 65. *Podocarpus latifolius* (Thunb.) R. Br. 1. ♀ inflorescence. 6/1. 2. Long. section through ♀ inflorescence, the ovule entire. *o.s.* Ovuliferous scale (epimatium). *st.b.* Sterile bracts. *o.* Ovule. 3. ♂ catkin. 2/1. 4. Scale of catkin with pollen bags, seen from below. 12/1. 5. The same from above. 6. Pollen grains. 40/1. *ai.* Air chambers. 7. Epidermis of leaf with stoma. 8. Edge of leaf with layer of sclerenchyma. Figs. 1–6 from nature, 7–8 from GERHARD, Knysnawald.

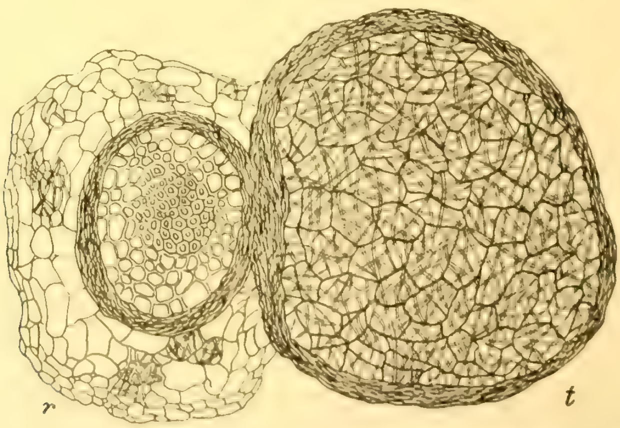


Fig. 66. *Podocarpus latifolius.* Transverse section through root of young plant and tubercle of mycorhiza (the fine threads in the tubercle represent the fungus). *r.* Root. *t.* Tubercle. From material collected on Table Mountain; drawn by Dr H. DOEBELT.

Photo W. Galpin

Werner & Winter, Frankfort a M.

A GIANT YELLOWWOOD TREE
PODOCARPUS ELONGATUS L'Hérit
In the Eastern forests

Class II. CONIFERAE.

(Plates 13, 17, 18, 19.)

Trees or arborescent shrubs, the stems branching. No spermatozoids. Seeds albuminous.

Fam. 2. TAXACEAE.

This family is represented in South Africa by the genus *Podocarpus*, to which the following diagnosis applies.

Dioecious trees. Leaves lanceolate, flat, bifacial or symmetrical. The male flower resembles a catkin, each scale bearing two pollen bags. The female flower pedunculate, consisting of a solitary inverted ovule, embedded in an enlarged, cupule-like scale, the ***epimatium*** (*o.s.* in Fig. 65, 2). When fully developed the globular seed is completely surrounded by the green and resinous tissue of the epimatium, thus forming a pseudofruit. These pseudofruits are inserted singly or as a pair on the ***podocarpium***, formed by the fusion of the swollen apex of the peduncle with two or more sterile bracts (*st.b.*). When ripe the podocarpium (Plate 17, A, 4, 5) generally becomes bright scarlet or purplish with a whitish bloom on it; as it contains sugar, it attracts birds (starlings etc.), which in eating the pulpy body scatter the fruit or carry it away. Occasionally the podocarpium does not develop properly, remaining green and of its original size.

The embryo is embedded in the centre of the albumen and possesses two cotyledons. These are not green as in some other conifers, but produce their chlorophyll only during germination. The roots are covered with small tubercles formed by a ***mycorhiza*** (Fig. 66; Plate 17), which probably assists in the nutrition of the plants, especially when young. Resin-ducts occur in the bark, leaves and the podocarpium, but not in the wood.

To this family also belongs the European yew (*Taxus baccata*), but the fruit of the yew is of a different structure.

The only S. A. genus. **Podocárpus** *L'Hérit.*

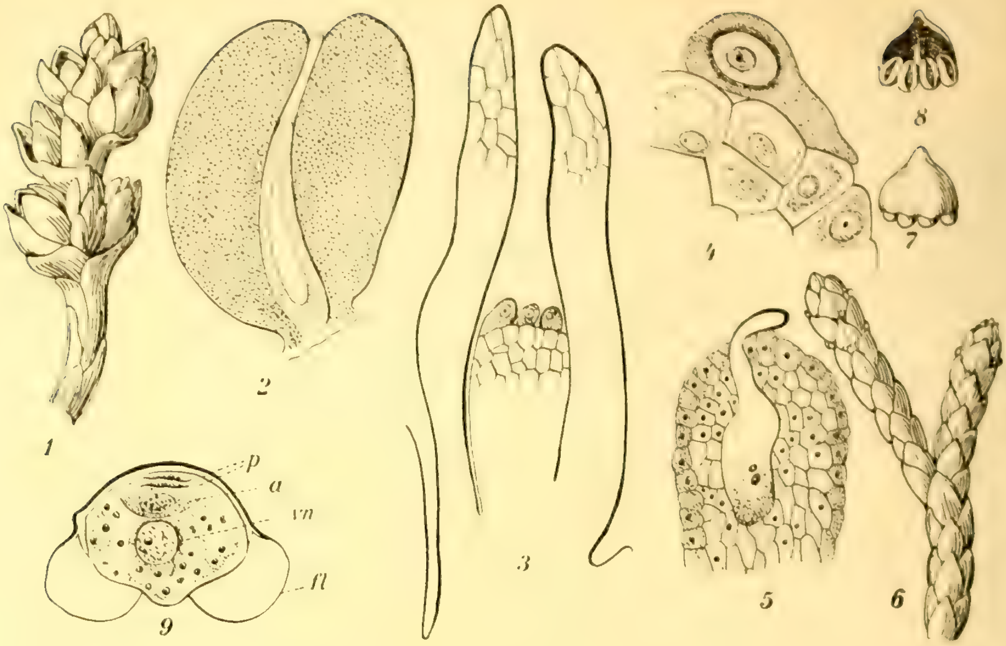


Fig. 67 *a.* *Widdringtonia cupressoides* (L.) Endl. 1. ♀ inflorescence. 4/1. 2. Long. section through ovule, showing the micropyle. 6/1. 3. Micropyle of ovule (long. section), showing 3 pollen grains on the apex of the nucellus. 100/1. 4. Germinating pollen grain on apex of nucellus. 500/1. 5. Pollen tube which has entered the nucellus. 500/1. 6. ♂ inflorescence (twig with sporophylls). 4/1. 7. Sporophyll, the outer side (seen from above). 20/1. 8. The same, inner side (seen from below). 20/1. 9. Pollen grain of Pinus. 600/1. *p.* Rudimentary prothallium. *a.* Antheridial cell. *vn.* Vegetative nucleus. *fl.* Air chambers.

(Figs. 1 and 6–8 from nature; 2–5 from Saxton, Botan. Gaz. vol. 48; 9 from Coulter and Chamberlain)

Plate 19.

Widdringtonia juniperoides (L.) Endl.
The Clanwilliam Cypress.

(For description see page 101.)

Photo. by J. S. Henkel Werner & Winter, Frankfort a/M

THE CLANWILLIAM CYPRESS
WIDDRINGTONIA JUNIPEROIDES (L.) Endl.
On the Cedar Mountains, 4000 feet

Fam. 3. PINACEAE.

(Plates 17, 19.)

Trees. Monoecious or dioecious. Leaves needle- or scale-shaped. The male flower resembles a catkin, each scale bearing two or more pollen bags. The female flower consists of several ovuliferous scales, which finally form a cone. Seeds with a hard shell like a nut, borne on the lignified scales of the cone.

This family is represented in the indigenous flora of South Africa only by the sub-family Cupressineae*, which possesses the following distinctive characters:

Monoecious. Leaves mostly reduced, scale-like, opposite. Scales of cone few in number, decussate, valvate. Embryo with two cotyledons.

The only S. A. genus. 4 S. A. species. **Widdringtonia**† *Endl.*

The more important sub-family Abietineae is practically confined to the northern hemisphere, but several species of *Pinus* have been acclimatised in South Africa, especially *Pinus Pinea*, the Italian pine or stone pine, *P. maritima* from the Mediterranean, called here the cluster pine, *P. halepensis*, the black or Aleppo pine and *P. insignis*. The ordinary or Scotch fir, *P. silvestris* (Grove den), from Northern Europe, and *P. canariensis* from the Canary Islands thrive here properly on the mountains only. The stone pine and the cluster pine are well established on the slopes of Table Mountain and elsewhere.

* The Cupressineae occupy a somewhat anomalous position among the Pinaceae; indeed some authors consider that they should be regarded as a separate family, while others have united them with the Taxaceae under the name of Taxo-Cupressaceae, raising the section Abietineae to the rank of a family, viz. Abietaceae.

† The genus *Callitris* as understood by Bentham and Hooker in the Genera Plantarum and by Eichler in Engler's Nat. Pflanzenfamilien has been subdivided by other authors into several genera. One of these is the section *Widdringtonia*, to which the South African and East African species belong. Masters (Journ. Linn. Soc. xxxvii, p. 267) maintains the individuality of the latter genus on morphological grounds, and Saxton (S. Afr. Journ. Sci. vi, p. 282) has recently shown that the embryological development, of those species of *Widdringtonia* which he was able to examine, differs considerably from that of several of the Australian species of *Callitris*.

Fig. 67 *b*. *Widdringtonia cupressoides* (L.) Endl. On eastern slope of Table Mountain. 900 feet. In the foreground *Fagelia bituminosa* and *Helichrysum corymbosum*; on the right above the rock *Hermas villosa*.

Plate 20.

Welwitschia Bainesii (Hook. fil.) Carrière.

1. ♀ flower ready for pollination. Long. section. 10/1. *b*. Bract (scale of cone), face view. *n*. Nucellus. *i*. Integument. *m.t*. Micropylar tube.

2. Long. section through lower part of micropylar tube and top of nucellar cone, showing numerous pollen grains and pollen tubes. *n*. Nucellus. *int*. Integument. *ep*. Inner layer of integument. *p.g*. Pollen grain. *p.t*. Pollen tubes.

3. Pollen grain. 540/1. *g.c*. Generative cell. *v.n*. Vegetative nucleus.

4. Pollen grain in an early stage of germination. 700/1. *ex*. Exine. *in*. Intine. *g.c*. Generative cell. *t.n*. Tube nucleus.

5. Part of pollen tube, showing elongated generative cell (*g.c*.). 1250/1.

6. A macrospore in long. section. 700/1. *n.m*. Wall of macrospore.

7. Macrospore nucleus in mitosis, showing 25 chromosomes. *n*. Nucellus. *v*. Polar vacuoles. *m.w*. Wall of macrospore. 700/1.

8. A 3-celled proembryo. 305/1. 9. Seed, enclosed in winged perianth. Nat. size.

10. Seed, without the perianth, in long. section, cut parallel to the wing, showing large endosperm and cylindrical embryo. 2/1.

11. Seed, long. section, at right angles to section of Fig. 10.

12. Embryo with spiral suspender. 3/1. 13. Seedling, after Bower. *r*. Root.

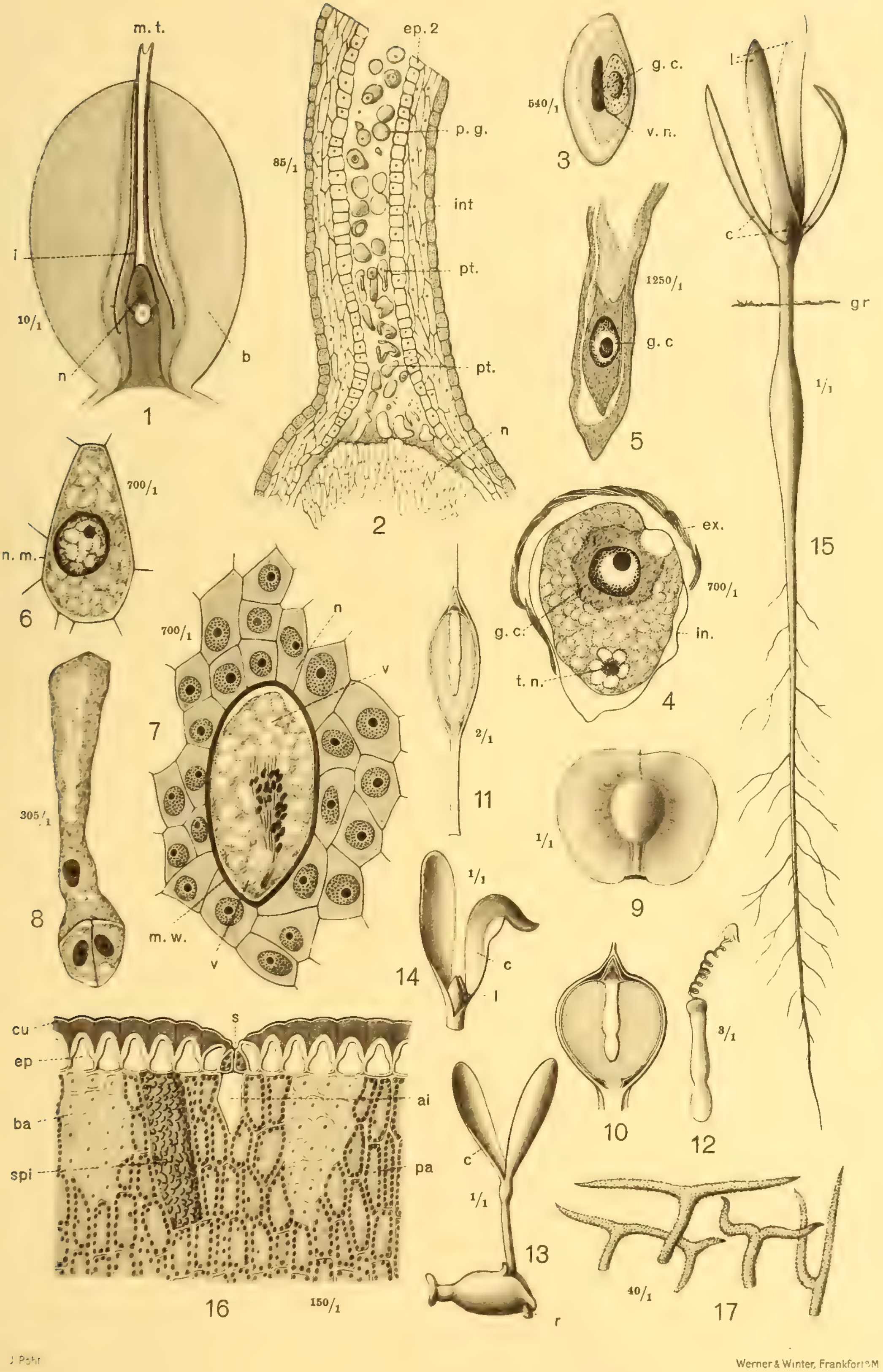
14. A later stage of seedling. *c*. Cotyledons. *l*. Leaves.

15. Young plant, two years old, raised in the Botanic Gardens at Darmstadt.

16. Section through portion of leaf. 150/1. *cu*. Cuticle. *ep*. Epidermis. *ba*. Bast fibres. *spi*. Spicular cell, a fragment. *s*. Stoma. *ai*. Air chamber. *pa*. Green parenchyma.

17. Spicular cells, from leaf, impregnated with crystals of oxalate of lime. 40/1.

Figs. 1 and 12 after Strasburger, Fig. 3 from Wettstein, Handbuch, Figs. 2, 4–8 after Pearson. The others from nature.



WELWITSCHIA BAINESII (Hook. fil.) Carrière

Class III. GNETALES.

Stem woody with vessels in the secondary wood. No resin ducts. Leaves opposite. Flowers with perianth. No spermatozoids.

Fam. 4. GNETACEAE.

The only S. A. genus is *Welwitschia*, to which the following diagnosis applies. (Plates 20, 21; Figs. 68 *a* and *b*.)

Dioecious. Stem simple. Leaves two. Male flowers in spikes, which are about an inch long, arranged in

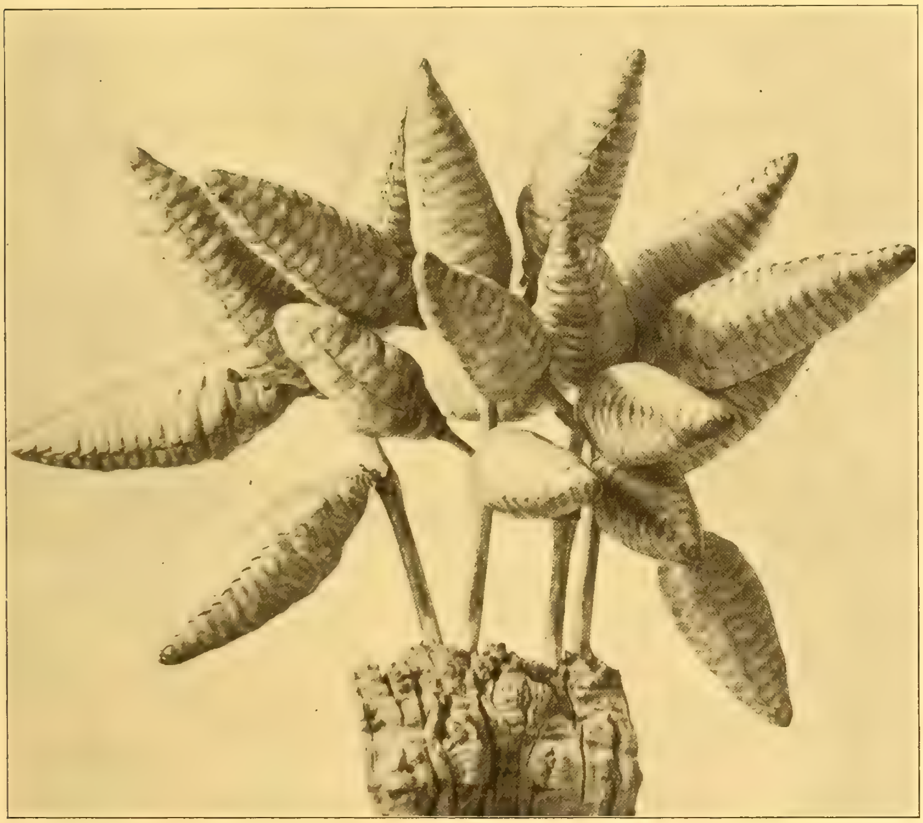


Fig. 68 *a*. *Welwitschia Bainesii* (Hook. fil.) Carrière. Piece of stem with 4 fully developed female inflorescences, the cones ready for pollination. 2/3 nat. size.

complex cymose inflorescences. A number of such cymes appear on the margin of the crown of the stem at the insertion of the leaves. A spike contains from 30—50 flowers, each one being supported by a bract and formed of a 4-partite perianth and 6 stamens with a rudimentary ovule in the centre.

The female flowers form a cone-like spike, $1\frac{1}{2}$ to 2 inches long, a number of such cones, 2—6 or even more, being arranged into a cymose inflorescence, of which 10—30 stand in a row on the margin of the crown of the plant according to its size and age. Each flower is

Fig. 68 *b*. ♀ *Welwitschia Bainesii* (Hook. fil.) Carrière. Desert near the junction of the rivers Khan and Swakop, 25 miles north east of Walfish Bay. Several specimens of Welwitschia visible in the distance, but no other plant.
Photo. by Prof. A. Schenck (1884).

supported by a large bract and consists of a tubular but broadly winged perianth with an erect ovule. When the flower is fully developed and ready for pollination the neck of the ovule elongates into a long tube*, much exceeding the perianth and finally projecting between the scales of

* This tube, although resembling the style of some angiospermous plants in external form, is an entirely different organ, being a part of the ovule.

the cone. The tube becomes filled with a fluid, and the pollen captured at the mouth of the tube is thus enabled to reach the nucellus. Professor PEARSON has observed that a hemipterous insect, *Odontopus sexpunctatus*, visits the flowers, and he thinks that it probably assists in their pollination*. There is scarcely any increase in the size of the cone after fertilisation, nor much change in the colour of the scales†. The seeds ripen quickly, for the principal flowering season is in January, while the cones are ripe in May. The ripe cones gradually break up and the seeds, enclosed in the membranous winged perianth, are scattered by the wind. If provided with sufficient moisture the seed germinates readily within a week or two, producing a strong elongated tap-root which penetrates into the stony ground or into a fissure of the rock, finally branching into secondary lateral roots. The roots of large plants reach to a depth of 10 or 15 feet, being thus enabled to utilize the apparently insignificant but regular supply of moisture, deposited on rocks and gravel by the mist from the sea, which finally percolates into the subsoil. The annual rainfall in these parts of the Namib is on an average less than one inch, and there are years without any appreciable rain.

The embryo possesses two cotyledons (Plate 20; Figs. 13, 14, 15) which soon perish and the first pair of leaves, which follows the cotyledons, remains the only one, the leaves continuing to grow at their base as long as the plant lives. Gradually the leaves become torn into shreds by the wind and their ends are often buried in the accumulating sand, the base of the leaves bulging upwards. The flat or more or less depressed crown of the stem is generally flush with the surface of the ground, but occasionally the soil or stones or rocks, which surrounded the young plant, are

* Plant-bugs are generally injurious to plants.

† The blood-red colour in HOOKER's monograph must be due to some erroneous information.

removed in the course of time, thus exposing the swollen apex of the stem; hence one sometimes finds old plants showing 3 to 4 feet of their stem above the ground. Some of the largest specimens have a diameter of three feet and leaves up to ten feet long. The leaves owe their durability largely to the numerous fibrovascular bundles which traverse them longitudinally, and to the numerous spicular cells which are scattered through the tissues, these cells being either simple or branched and highly impregnated with oxalate of lime. The colour of the male flowers, when shedding their pollen, is a deep salmon, while that of the female cones is a glaucous green with a trace of red at the edges, which deepens and spreads a little during the ripening process, while the green assumes a more yellowish tint.

The only genus.

Welwitschia *Hook. fil.*

Plate 21.

Welwitschia Bainesii *(Hook f.) Carrière*

Plate 21.

Fam. 4. Gnetaceae.

Welwitschia Bainesii (Hook. fil.) Carrière (*Welwitschia mirabilis* Hook. fil.).

1. Male plant of medium size in flower. 1/5 nat. size.
2. Young female inflorescence, about half grown. Nat. size.
3. Female bud, the ovule, which is not fully developed as yet, shining through the perianth. 20/1.
4. Male inflorescence, some flowers open. Nat. size.
5. Male flower, showing the 6 stamens. 6/1.
6. Abortive pistil from male flower. 6/1.
7. Pollen grain. 250/1.
8. Ripe cone, showing the shrivelled micropylar tubes projecting between the scales.

This curious plant was originally discovered (1865) by Fr. Welwitsch in the desert plains of Southern Angola, South East of Mossamedes, where its native name is "*N'tumbo.*" He proposed the name *Tumboa* and in honour of the famous African traveller T. Baines the specific name "*Bainesii.*" Subsequently Sir Joseph Hooker published an exhaustive monograph of the plant under the name of *Welwitschia mirabilis*; hence although the latter name may be better known at present, conformity with international rules requires the adoption of the prior specific designation.

Soon afterwards the plant was observed by Baines in the rocky country between the rivers Khan and Swakop, about 20 miles due East from the mouth of the latter river, and subsequently it was recorded from the neighbourhood of the Kuisib river, South of the Tropic of Capricorn. Another locality exists about 60 miles to the North East of Swakopmund near the isolated mountain called Spitzkopje.

It is not improbable that some other colonies of the plant do exist in some unexplored parts of the Namib* or the Kaoko region. At the principal southern locality it occurs in a narrow strip of country only a few miles broad and about 10 miles long, extending from the neighbourhood of the former railway station "Welwitsch" to Heikamchab on the Swakop. According to the information given me by Dr Voit, there are several thousand plants in that strip, but very few young ones have been observed by him, while some of the older specimens have assumed very curious shapes. On the other hand numerous young plants, with crowns from two inches in diameter upwards, have been observed by Mr C. Bohr a little to the North East of Cape Cross, near a hill called Mont Durissa.

The *Welwitschia* is of great scientific interest, being the most highly developed gymnospermous plant known to us either in the living or the fossil state. It is not a connecting link between the gymnosperms and the angiosperms, but the final stage of a separate line of development of the vegetable kingdom, that, as far as known to us, led no further.

* The reported occurrence of the plant much further South, viz. in Namaqualand, about 20 miles from the railway station Tschaukaib, is due to some misunderstanding. (From verbal information by Dr P. Range.)

PART IV

ANGIOSPERMAE


Berzelia lanuginosa
Berzelia lanuginosa
Protea cynaroides
Leptocarpus paniculatus
Ground robin
Erica lutea
Leptocarpus paniculatus
Phylica reflexa
Psoralea pinnata
Alciope tabularis
Cliffortia ruscifolia
Anthospermum aethiopicum

PART IV

ANGIOSPERMAE

ANGIOSPERMAE.

The alternation of sexual and asexual generations, such a dominant feature in the life-cycle of the Archegoniatae, is here quite obliterated, the sexual organs being produced by the sporophyte.

The male organs, called ***pollen grains***, develop in ***anthers***, and these are mostly borne at the end of slender stalks called ***filaments***, filament and anther forming the ***stamen***.

The female organ, the embryo-sac, is embedded in an ovule, which in its turn is situated within the pistil. An ***ovule*** generally consists of three parts, viz. one or two ***integuments***, the ***nucellus*** and, embedded in the latter, the ***embryo-sac***. It possesses an opening or a channel called the ***micropyle***. The ***pistil*** is generally produced at its apex into a ***style***, and this bears a receptive surface at its end, termed the ***stigma***.

The pollen grain is transported to the stigma mostly by outside agency, viz. by wind, insects or birds and in a few cases, where the flowers are submerged, *e.g. Ceratophyllum*, *Zostera*, *Najas*, by currents in the water*, but occasionally there is also ***self-pollination*** by direct contact between anther and stigma, *e.g. Viola*, *Anacampseros*, *Argyrolobium*. The pollen grain germinates on the stigma, emitting a slender thread called the ***pollen tube***. This tube carries the sexual nucleus of the pollen grain in its apex and, penetrating through the tissue of the style into the ovular cavity of the pistil, enters the ovule, in most cases through the micropyle. In this way the sexual nucleus of the pollen grain reaches

* If the pollen of plants is transported from flower to flower by wind, they are termed "***anemophilous***"; if by insects "***entomophilous***"; if by birds "***ornithophilous***"; and if by water "***hydrophilous***."

the *oosphere* of the embryo-sac, hence ENGLER'S name Siphonogama* for Gymnosperms and Angiosperms.

Under the influence of the male nucleus various changes take place in the oosphere, finally resulting in the formation of the *embryo*, while the surrounding tissue within the embryo-sac may further develop into a permanent tissue, called the *endosperm*†, and the nucellar tissue outside the embryo-sac may, although rarely, develop into a similar tissue, called the *perisperm* (see Fig. 70 and Vol. IV, Fig. 51). Endosperm and perisperm are generally filled with reserve material for the nutrition of the germinating embryo. Often, however, neither endosperm nor perisperm are present, the food materials being stored in the cotyledons of the embryo; occasionally there are no such reserve materials, *e.g.* in the case of orchids.

Classification.

The natural grouping of angiospermous plants into Monocotyledons and Dicotyledons was recognised very early, having been known a considerable time before LINNAEUS. In 1789 BERNARD DE JUSSIEU introduced it as one of the principal criterions in his Natural System of Plants, and every later system has retained it in some form or other. JUSSIEU as well as DE CANDOLLE included the gymnospermous plants among the dicotyledons, but when ROBERT BROWN (1827) showed the fundamental difference in the ovules of gymnosperms and angiosperms, the former were separated from the dicotyledons, thus establishing three classes of Flowering Plants, viz.

Gymnosperms, Dicotyledons and Monocotyledons.

It is, however, a far more difficult problem to ascertain the mutual relationship of these three classes.

In BENTHAM and HOOKER'S Genera Plantarum (1862—1883) and in the Flora Capensis, which is based upon this

* The few exceptions among some gymnospermous plants, viz. *Cycas*, would not affect the general suitability of the term.

† This endosperm is not homologous with that of most gymnosperms, though it corresponds in some degree to the endosperm of *Gnetum*.

system, the gymnosperms stand, for the sake of convenience as RENDLE puts it, between the dicotyledons and monocotyledons, but more recent workers have generally placed them, in accordance with the progress of our knowledge of the genetic origin of plants, at the beginning of the system of Flowering Plants.

This sequence of classes, viz.

Gymnosperms, Monocotyledons, Dicotyledons, is apt to give the impression that the monocotyledons represent an earlier and more primitive type of the angiosperms, thus constituting an intermediate stage of development between the gymnosperms and the dicotyledons. But that is not so, for the most primitive of living angiosperms are to be found among the dicotyledons and not among the monocotyledons, where no such primitive characters occur, and although we do not know the connecting links between the present angiosperms and the gymnosperms, the gap in our knowledge would not be larger if no monocotyledonous plants were known to us either in the living or the fossil state.

Both, dicotyledons and monocotyledons, as we know them at present, have originated from some primitive angiosperms, which are now extinct and of which no records exist, for unfortunately no fossil remains of plants are known which could throw some light on the nature of these early ancestors of the recent angiosperms.

> "There is no document available," as LAURENT* says, "which would definitely indicate the origin of the mysterious appearance of the class (viz. the dicotyledons)"; and ZEILLER† states at the same time: "While we do not find any trace of dicotyledons and hardly any indications of monocotyledons in the Upper Jura of Portugal, we see them both at the beginning of the lower cretaceous period of the same region, that means to say only a little higher, establish themselves and multiply rapidly."

* L. LAURENT, Les progrès de la paléobotanique angiospermique dans la dernière décade. Progressus Rei Botanicæ, Vol. I, p. 367. 1907.

† R. ZEILLER, Les progrès de la paléobotanique de l'ère des gymnospermes. Ibid., Vol. II, p. 225. 1907.

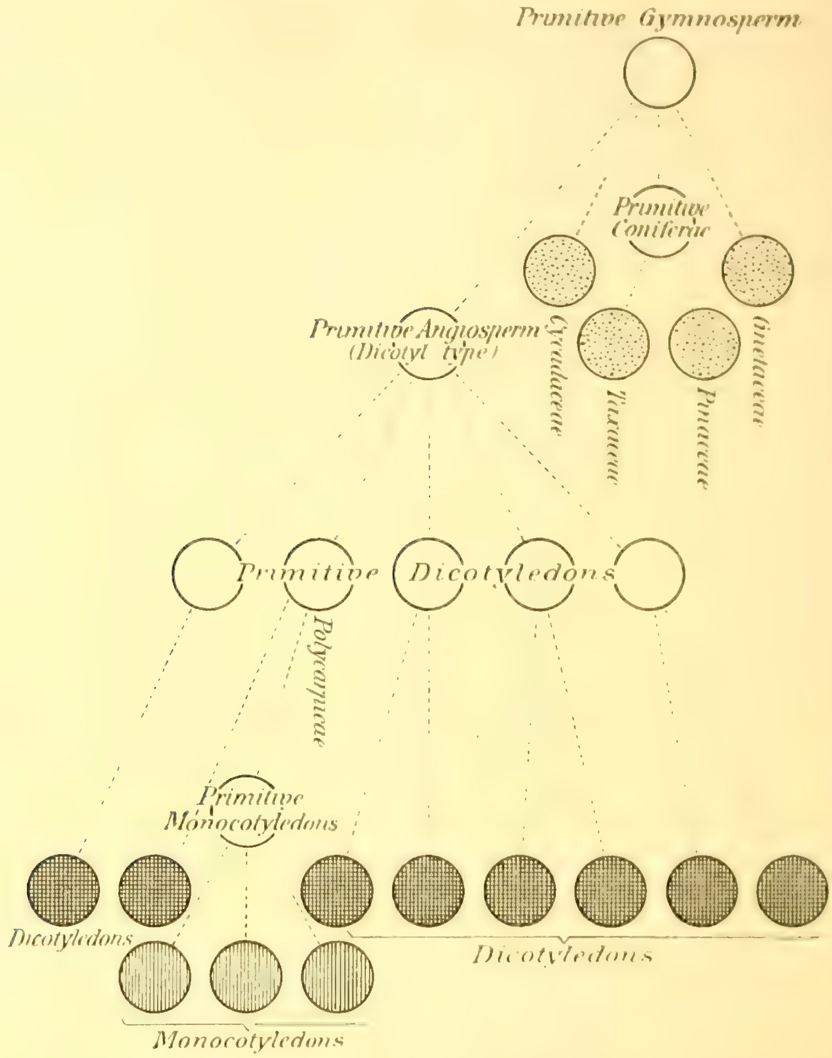
We are consequently forced to draw our conclusions almost entirely from the existing vegetation, and here recent investigations render it feasible to trace the monocotyledons back to some primitive member of the group Polycarpicae (Ranales). There are various features in the anatomy of roots and stems, as well as in the structure of the sexual organs of Nymphaeaceae and other members of the group Polycarpicae, which support the view that the ancestors of the present Helobiae originated from some primitive member of that group, and that the monocotyledons consequently are a lateral, although very early branch of the dicotyledonous main line of development.

No linear arrangement of groups, such as a book demands, can do full justice to their genetic sequence; but the insertion of the monocotyledons immediately after the gymnosperms would interrupt the natural sequence of the groups to such an extent that this fairly independent branch is better referred to the end of the system*.

In order to express the views prevailing at the present time on these questions we venture to append the rough diagram overleaf, which, it must be well understood, is to a large extent hypothetical, for speculation has still a wide field in these matters.

* For a fuller discussion of the subject see (1) COULTER and CHAMBERLAIN, Morphology of Angiosperms; (2) FRITSCH, Die Stellung der Monocotylen, Leipzig, 1904; (3) RENDLE, Classification of Flowering Plants, Vol. 1, Cambridge, 1904; (4) WETTSTEIN, R. von, Handbuch der Systematischen Botanik. Second Edition. Vienna, 1911.

Fig. 69. Theoretical diagram, representing the more or less probable stages in the development of the orders of the Angiosperms.



The number of branches in the diagram is quite arbitrary and merely intended to show that there are several lines of independent development.

The two classes of the Angiosperms, viz. Dicotyledons and Monocotyledons, although numerically unequal are structurally well distinguished from each other. For the convenience of the student we have arranged the principal characters in a tabular form:

Dicotyledones.

Root. The radicle of the seed generally develops into a tap-root with lateral branches or into a system of branched roots. Main root and branches possess secondary growth and are often woody.

Stem. The fibro-vascular bundles are arranged usually as a cylinder within the ground tissue; hence they show a circular distribution on a cross-section. In young shoots or near the apex of older shoots the bundles are independent of each other, occurring as free strands in the ground tissue, but later on, through increase in size and the development of intermediary bundles, they form a complete cylinder which is covered on the outer side by the epidermis and cortical tissues, while its centre is filled by the pith. The cambium of the bundles remains active during the whole lifetime of the plant, at least periodically, producing new phloem cells on its outer side, thus increasing the bark, and new xylem cells on its inner side, thus increasing the wood of the stem. Such bundles are termed open.

Leaves. Often provided with a petiole. The fibro-vascular bundles (nerves) mostly laterally branching (feather-veined).

Flowers. Mostly 4- or 5-merous, but not rarely one or all of the whorls simpler by abortion.

Seed. Food materials stored either in a separate tissue (albumen, endosperm), or in the cotyledons. Cotyledons lateral, two. On germination they may develop into a pair of green leaves (*e.g.* radish), or they may shrivel up, the plumule developing the first pair of leaves (*e.g.* bean).

Monocotyledones.

Root. No tap-root; the radicle of the embryo soon dies after germination, while numerous adventitious roots originate from the base of the stem. These roots are fibrous (not woody) and do not increase in thickness subsequently.

Stem. The fibro-vascular bundles are irregularly distributed in the ground tissue, but are generally more numerous towards the circumference of the stem. The cambium of the bundles is of limited activity, hence there is no subsequent increase in their size. For this reason the stem generally does not possess the power of subsequent growth in thickness; in some of the larger species, however, the stem increases in thickness by the formation of new bundles between the older ones, *e.g. Aloe.*

Leaves. Mostly sessile. The fibro-vascular bundles more or less longitudinal and parallel; in a few cases with lateral branches, *e.g. Strelitzia.*

Flowers. Trimerous, but there are a few exceptions, *e.g. Potamogeton.*

Seed. Mostly with albumen. Embryo with one apical cotyledon, which acts as a haustorial organ for the absorption of the food materials stored in the albumen. In some orders it has no other function, but in others it finally forms the first leaf of the seedling.

DICOTYLEDONES.

Subclass I. Choripetalae.

Perianth absent or single or double; if double the members of the inner whorl free. Fam. 1—106.

Subclass II. Sympetalae.

Perianth double, the members of the inner whorl more or less connate. Fam. 107—141.

CHORIPETALAE.

Series I. **Monochlamydeae***, Fam. 1—23.

A. *Perianth none.*

Order I. Piperales.

Perianth none (S. A.). Flowers hermaphrodite or unisexual. Stamens 1—10. Ovary sessile, solitary, 1-celled, 1-ovuled.

Flowers very small, spicate; leaves entire, with or without stipules. Fam. 1.

Order II. Salicales.

Perianth none. Flowers dioecious, with a cup-shaped or scale-like disc. Stamens 2 or more, inserted on a torus. Carpels 2, connate. Ovary 1-celled; ovules

* The Monochlamydeae are not a sharply circumscribed natural group, the term, which means "bearing one floral envelope," merely indicating a simpler stage of development than that which is represented by the Dialypetalae and the Sympetalae. Just as these subclasses include some reduced forms, which have only one perianth, as *e.g. Clematis* in Ranunculaceae, *Cliffortia* and its allies in Rosaceae, *Euphorbia* in Geraniales and several entire families of the Myrtiflorae, as the Penaeaceae and their allies, so, on the other hand, we find a double perianth in some families of the Monochlamydeae, viz. *Portulaca*, *Silene*, *Dianthus* and a few others. There is no universal line of demarcation in this respect.

See also Wettstein, Handb., Second edition, p. 489.

numerous. Fruit a bivalved capsule. Seeds numerous, small, with a basal tuft of hairs, exalbuminous.

Woody plants. Leaves mostly entire, stipulate. Flowers spicate. Fam. 2.

Order III. Myricales.

Perianth none. Flowers unisexual; monoecious or dioecious. Stamens 2 or more. Carpels 2, connate. Ovary 1-celled, with 1 basal, erect ovule. Fruit indehiscent, pseudo-drupaceous, 1-seeded; seed exalbuminous.

Woody plants. Flowers in simple or rarely compound spikes. Fam. 3.

B. *Perianth simple, bract-like.*

Order IV. Urticales.

Perianth simple, 2—3-merous, regular. Stamens opposite the perianth-segments. Pistil of 1 carpel (or 2), superior, 1-ovuled. Fruit a nutlet. Herbs or woody plants. Leaves with stipules; inflorescence mostly corymbose. Fam. 4—6.

C. *Perianth simple, mostly coloured, or double, as in some families of the Centrospermae.*

Order V. Proteales. (S. A.)

Perianth simple, coloured, 4-merous; stamens opposite the perianth-segments and adnate* to them. Carpel 1, 1-celled and 1-ovuled*. Shrubs or trees; leaves alternate*, entire or divided, exstipulate. Flowers spicate or capitate. Fam. 7.

* Exc. *Brabeium.*

Order VI. Santalales.

Perianth simple, 4—5 parted. Stamens opposite the perianth-segments. Carpels 2—3; connate; ovules often reduced. Fam. 8—12.

Order VII. Aristolochiales.

Perianth simple, coloured and showy, tubular. Ovary inferior, 1- or 4- or 6-celled; ovules numerous. Climbing shrubs or root parasites (S. A.). Fam. 13—15.

Order VIII. Polygonales.

Perianth simple, regular, sometimes coloured. Ovary 1-celled; ovule solitary, straight, rarely curved. Leaves with stipules. Flowers small. Fam. 16.

Order IX. Centrospermae.

Perianth simple or double, often showy. Stamens generally as many as the perianth-segments and opposite them. Carpels 1 or more, connate or quite fused; ovules 1 or many, campylotropous. Embryo curved. Albumen mostly central. Mostly herbs. Fam. 17—23.

Series II. Dialypetalae.

Perianth double, except in a few cases. Fam. 24—106.

A. *Carpels mostly free, superior.*

Order X. Ranales (Polycarpicae).

Perianth various, sometimes simple. Stamens numerous. Carpels many, rarely 1. [Exc. Menispermaceae.]
Herbs or woody plants. Fam. 24—30.

B. *Carpels mostly connate, superior.*

Order XI. Rhoeadales.

Perianth double, regular or irregular, carpels 2 or many, connate. Herbs or shrubs. Inflorescence generally racemose. Fam. 31—35.

(Key to the families 1—35 on pages 125—127.)

[ORDERS TREATED IN VOL. II.]

C. *Carpels in some families free and superior; otherwise flowers generally perigynous or epigynous.*
Fam. 36—77.

Order XII. Rosales.

Perianth various, not rarely reduced. Carpels sometimes free and equal in number to the petals, but more frequently connate and reduced to 3 or 2 or 1. Ovules many, occasionally reduced to 1 or 2 in each cell, as in *Roridula*, some Leguminosae etc. Fam. 36—48.

Order XIII. Geraniales.

Perianth double or none, as in *Euphorbia*, mostly 5-merous. Carpels 5—2, when ripe often separating; ovules 1 or more, epitropous with a ventral raphe, the micropyle being turned upwards, or more rarely with a dorsal raphe and the micropyle turned downwards.
Fam. 49—62.

Order XIV. Sapindales.

Characters similar to Geraniales, but differing from that group by the reverse position of the ovules, the raphe being dorsal with the micropyle turned upwards or ventral with the micropyle turned downwards. Fam. 63—71.

Order XV. Rhamnales.

Perianth double. Stamens as many as perianth-segments, opposite them. Carpels 5—2, united. Ovules 1—2. Fam. 72, 73.

Order XVI. Malvales.

Perianth double, rarely absent, mostly 5-merous. Sepals generally valvate. Stamens mostly numerous, free or the filaments connate, or as many as the perianth-segments or double their number. Carpels 2 or more. Ovules mostly numerous. Fam. 74—77.

D. *Carpels rarely free, mostly connate, sometimes inferior.* Fam. 78—106.

Order XVII. Parietales.

Perianth double. Stamens and carpels many or, as in *Viola* etc., few. Carpels mostly connate. Placentae parietal or meeting in the centre, rarely basal. Fam. 78—90.

Order XVIII. Opuntiales.

Perianth double; sepals and petals inserted spirally. Carpels 4 or more, inferior. Succulent plants. Fam. 91.

E. *Carpels connate and inferior, generally adnate to the axis.*

Order XIX. Myrtiflorae.

Flowers regular; perianth double, rarely absent. Floral axis more or less tubular, carrying the sexual organs in the base or on the margin of the tube. Carpels 2 or more. Fam. 92—103.

Order XX. Umbelliflorae.

Flowers regular. Perianth double. Stamens as many as the petals. Carpels 2. Flowers umbellate. Fam. 104—106.

* Orders treated in Volume II.

SYNOPSIS OF FAMILIES OF VOLUME I (1—35).

Series I. Monochlamydeae.

[Fam. 1—23.]

Order I. Piperales.
(page 128) 1. **Piperaceae**

Order II. Salicales.
(page 130) 2. **Salicaceae**

Order III. Myricales.
(page 132) 3. **Myricaceae**

Order IV. Urticales (S. A.)

A. Trees. Flowers solitary or cymose. Fruit a drupe.
(page 134) 4. **Ulmaceae**
Subfam. **Celtideae**

B. Trees. Flowers enclosed in a fleshy receptacle. Fruit a pseudo-syncarp.
(page 137) 5. **Moraceae**
Tribe **Ficeae**

C. Herbs, with or without stinging hairs. Fruit a nutlet.
(page 140) 6. **Urticaceae**

Order V. Proteales.
(page 141) 7. **Proteaceae**

Order VI. Santalales.

A. Ovules free (not embedded in the tissue of the placenta).

a. Ovary inferior, 1-celled. Placenta central, with mostly 3 pendulous ovules. Ovule without integument. Fruit nut-like or drupaceous.
(page 159) 8. **Santalaceae**

b. Ovary inferior, 1-celled. Placenta central, with 2 pendulous ovules. Ovule without integument. Fruit a pseudo-syncarp.
(page 163) 9. **Grubbiaceae**

c. Ovary free, divided into 2 stories; the lower compartment 4-celled, with a central placenta and 4 pendulous ovules. Fruit a drupe.
(page 165) 10. **Olacaceae**

B. Ovules indistinct, embedded in the tissue of the ovary. Green, parasitic half shrubs.
(page 166) 11. **Loranthaceae**

C. Fleshy root-parasites, devoid of chlorophyll. Ovules free in one genus (*Mystropetalon*) and embedded in the tissue of the placentae in the other (*Sarcophyte*).
(page 170) 12. **Balanophoraceae**

Order VII. Aristolochiales.

A. Inflorescence axillary or terminal, usually 1-flowered. Flowers bisexual. Androecium cylindrical, in most cases of 6 stamens. Stigma lobed. Placentae axile. Seeds with copious endosperm. Climbing shrubs.

(page 172) 13. **Aristolochiaceae**

B. Inflorescence racemose. Flowers unisexual. Androecium cylindrical, formed of 8—12 anthers. Stigma cylindrical. Placentae parietal. Seeds with thin endosperm. Root parasites.

(page 174) 14. **Rafflesiaceae**
Subfam. **Cytineae**

C. Flowers solitary, bisexual. Androecium flat, 3—4-lobed, formed of numerous connate anthers. Stigmatic surface flat, expanded, 3—4-lobed. Placentae pendulous from the roof of the ovarial cavity. Seeds with copious perisperm. Root parasites.

(page 176) 15. **Hydnoraceae**

Order VIII. Polygonales.

(page 180) 16. **Polygonaceae**

Order IX. Centrospermae.

A. Perianth bract-like. Carpels 1-ovuled.

a. Perianth herbaceous (rarely 0), the segments mostly enlarging with the fruit and enclosing it.

(page 182) 17. **Chenopodiaceae**

b. Perianth-segments membranous, often coloured.

(page 186) 18. **Amarantaceae**

B. Perianth simple, often petaloid. (A double perianth occurs in *Limeum* and *Semonvillea* and pseudopetals in some Aizoaceae, viz. *Orygia* and *Mesembrianthemum*.)

a. Ovary 1-celled, 1-ovuled. Fruit enclosed within the hardened perianth-tube.

(page 190) 19. **Nyctaginaceae**

b. Ovary 2- or more-celled; cells 1-ovuled. Fruit capsular or indehiscent. Inflorescence racemose.

(page 193) 20. **Phytolaccaceae**

c. Ovary 2- or more-celled; cells with 2 or more ovules (exc. in some Mollugineae). Inflorescence cymose or flowers solitary.

(page 194) 21. **Aizoaceae**

C. Perianth double, but the petals sometimes abortive.

a. Herbs or shrubs with entire, mostly succulent leaves. Sepals 2, deciduous.

(page 210) 22. **Portulacaceae**

b. Herbs, sometimes half shrubby, with narrow, mostly opposite leaves. Calyx 4—5-cleft or -parted.

(page 212) 23. **Caryophyllaceae**

Series II. Dialypetalae. (Fam. 24—35.)

Order X. Ranales (Polycarpicae).

A. Ovary superior.

a. Stamens numerous. Sepals and petals often numerous.

I. Aquatic herbs.

1. Carpels several, borne on a concave receptacle. Leaves large, entire, floating on the surface.
(page 216) 24. **Nymphaeaceae**

2. Carpel 1. Leaves lacerate, submerged.
(page 218) 25. **Ceratophyllaceae**

II. Terrestrial plants.

1. Herbs or climbing shrubs. Carpels many, borne on a flat or convex receptacle. Oil-cells absent.
(page 220) 26. **Ranunculaceae**

2. Shrubs, erect or suberect. Flowers 3-merous. All parts with oil-cells.
(page 225) 28. **Anonaceae**

b. Stamens 3—15. Carpels 1-ovuled. Sepals few, petals few (rarely numerous). Shrubby.
(page 223) 27. **Menispermaceae**

B. Ovary inferior, 1-celled, 1-ovuled.

a. Stamens in 3 whorls, anthers opening with valves.
(page 226) 29. **Lauraceae**

b. Stamens in 1 or 2 whorls. Anthers splitting.
(page 230) 30. **Monimiaceae**

Order XI. Rhoeadales.

A. Sepals 2, deciduous. Albumen oily.
(page 232) 31. **Papaveraceae**

B. Sepals 4. Albumen o.

a. Ovary closed at the apex.

I. Stamens many or 4, similar. Ovary stipitate.
(page 233) 32. **Capparidaceae**

II. Stamens 6, tetradynamous. Ovary sessile.
(page 240) 33. **Cruciferae**

b. Ovary gaping at the summit, placentae 3—4, parietal. Petals 2 (S. A.), minute. Herbs.
(page 243) 34. **Resedaceae**

C. Sepals 5. Petals 5. Seeds large, winged. Albumen o.
(page 244) 35. **Moringaceae**

Fam. 1. Piperaceae (S. A.).

Shrubby or herbaceous plants with entire leaves. Flowers without a perianth, sessile on a fleshy rhachis, forming a cylindrical spadix, bisexual or unisexual. Stamens 2—5; ovary sessile, 1-celled; ovule 1, erect, basifixed; fruit a drupe; seed with a minute embryo, a small endosperm and a large perisperm. Flor. Cap. Vol. v, 1, p. 487.

The structure of the stem of Piperaceae somewhat approaches the monocotyledonous type, as it contains several circles of fibro-vascular bundles. *Peperomia* affords one of the few examples of an embryo-sac with 16 nuclei.

Fig. 70. *Peperomia retusa* Dietr. 1. Plant in flower. 2. Spike. 5/1. 3. Bisexual flower. 20/1. 4. Same in long. section. 5. Fruit, in long. section. 20/1. *p*. Perisperm.

Uses: The black pepper of commerce consists of the unripe fruits of *Piper nigrum* L., while the white pepper is obtained from the same plant by removing the shell of the ripe fruit.

KEY TO THE GENERA.

A. Stigmas 2—5.

[Syn. *Coccobryon* and *Cubeba* in Harv. Gen.] *P. capense* (*bospeper*). **Piper** *L.*
Over 600 species, but 2 only in S. A. (forests).

B. Stigma 1, terminal, penicillate. Stamens 2.
Over 400 species, 5 in S. A.
(Small succulent herbs, growing in woods.) **Peperómia** *Ruiz & Pav.*

Fig. 71. Stump of tree covered with epiphytes. 1/5 nat. size. *Peperomia reflexa* Dietr. *Polypodium lanceolatum* L. *Hymenophyllum tunbridgense* Sm. *Lomaria attenuata* Willd. In a wooded ravine of Table Mountain.

Fam. 2. Salicaceae.

Trees or shrubs with simple, entire leaves. Flowers dioecious, in catkins, each flower supported by a bract. Perianth none. ♂ flower: stamens 2—5 or more; ♀ flower: ovary sessile, 1-celled, with 2 parietal placentas and numerous, anatropous ovules. Styles 2; fruit a bivalved capsule; seeds numerous, minute, without endosperm, each one enclosed in a basal tuft of hairs.

The Cape willow, *wilgeboom*, *Salix capensis*, is widely distributed along the banks of rivers. The flowers attract bees and beetles. The seeds are easily spread by the wind, but lose their vitality within a few weeks. *S. Wilmsii* occurs in the Transvaal and *S. Woodii* in Natal. Two species of poplar are well acclimatised, viz. the silver-poplar (*P. canescens*) and the Lombardy-poplar (*P. pyramidalis*); the former spreading rapidly when planted in swampy situations. (*Populierboom.*)

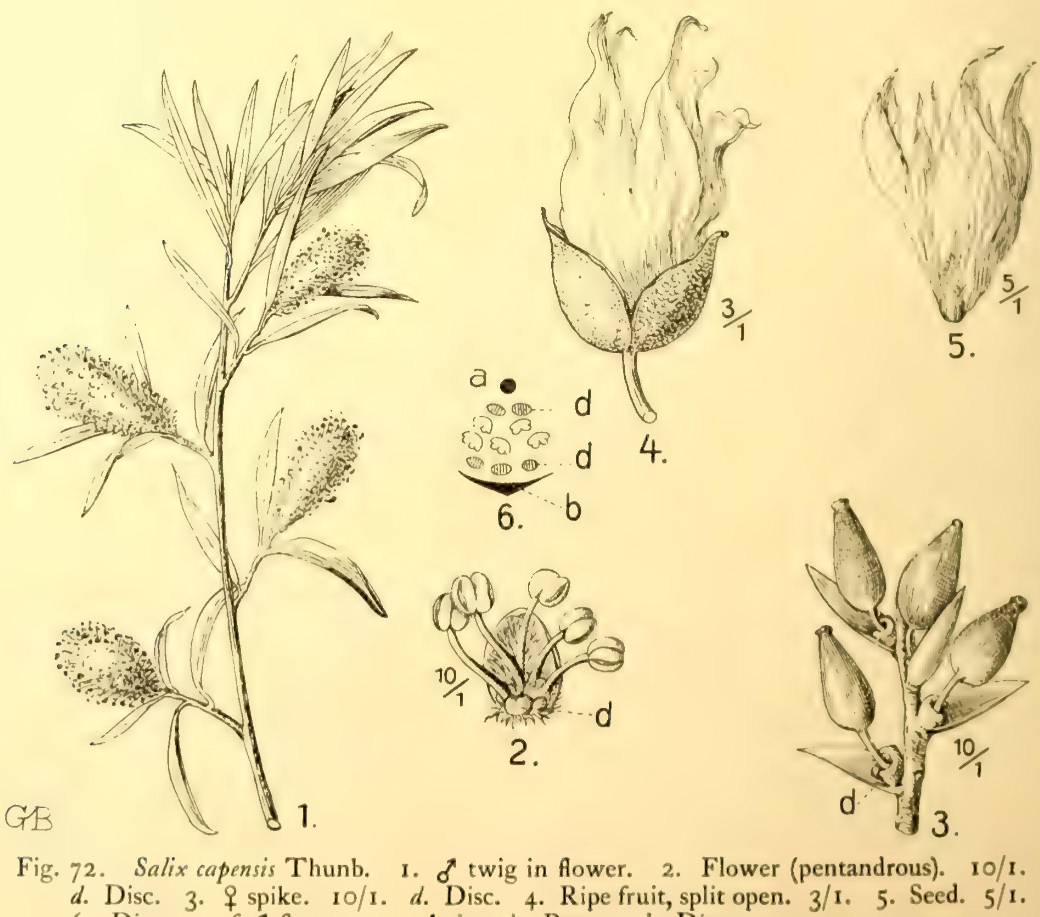


Fig. 72. *Salix capensis* Thunb. 1. ♂ twig in flower. 2. Flower (pentandrous). 10/1. *d.* Disc. 3. ♀ spike. 10/1. *d.* Disc. 4. Ripe fruit, split open. 3/1. 5. Seed. 5/1. 6. Diagram of ♂ flower. *a.* Axis. *b.* Bract. *d.* Disc.

Fig. 73. Willow (*Salix capensis*) at the junction of the Orange and Vaal Rivers.

KEY TO THE GENERA.

A. Floral disc replaced by a few scales or teeth. Floral bracts entire. Leaves narrow. (S. A.)

Three indigenous and several introduced species. 1. **Salix** *L.*

B. Flowers, both sexes, with cup-like disc; bracts lacerated. Leaves broad.

2 introduced species. 2. **Pópulus** *L.*

Fam. 3. Myricaceae.

Shrubs with simple or divided, exstipulate, persistent leaves. Flowers without perianth, unisexual, monoecious or dioecious, in simple or compound spikes (catkins), each flower supported by a bract. ♂ catkins cylindrical, stamens 2—8, mostly 4; filaments filiform; anthers 2-celled. ♀ spikes short, few-flowered; ovary sessile, with 2—6 hypogynous scales, 1-celled; ovule solitary, erect; stigmas 2, elongate, papillose, mostly coloured. Fruit dry, indehiscent, 1-seeded, the exocarp of some species secreting a layer of wax. Seed without endosperm.

The only genus. (Plate 23.)
32 species, 9 in S. A.* **Mýrica** *L.*

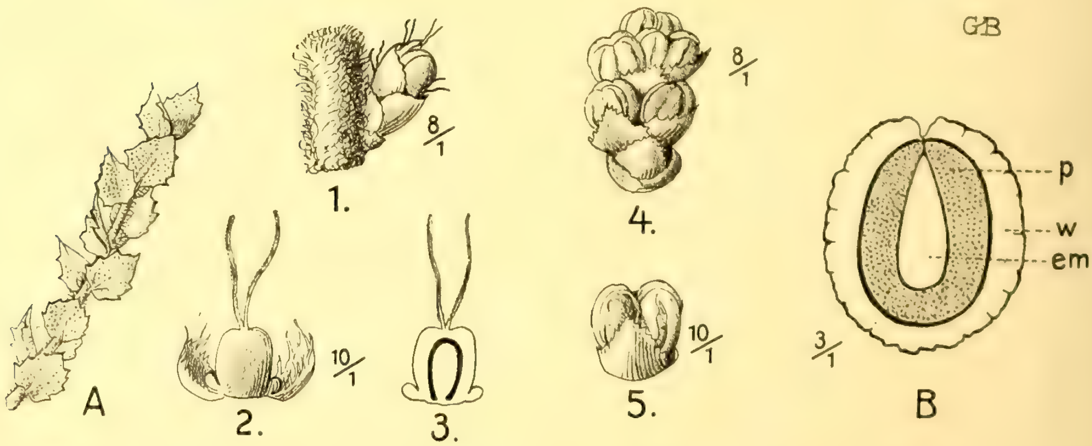


Fig. 74. *Myrica.* A. *M. quercifolia* L. 1. ♀ catkin. 4/1!. 2. ♀ flower. 10/1. 3. ♀ flower in long. section. 4. ♂ catkin. 8/1. 5. ♂ flower. 10/1. B. *M. cordifolia* L. Fruit in long. section. 3/1. *em.* Embryo. *p.* Stony endocarp. *w.* Wax.

* The number of species of each genus has been obtained from various sources. In those families which are dealt with in the more recent volumes of the Flora Capensis (for dates of publication see page 248), viz. Vols. IV—VII, we mostly follow that work. For the other families, which are either contained in Vols. I—III or not published as yet, we have availed ourselves of the register of the species of South Africa kept in the Bolus Herbarium.

MYRICACEAE ULMACEAE (CELTIDEAE) URTICACEAE

Plate 23

A: Myrica quercifolia *L.* B: M. cordifolia *L.*
C: Celtis Kraussiana *Bernh.* D: Fleurya capensis *Wedd.*

Plate 23.

Fam. 3. **Myricaceae.** 4. **Ulmaceae.** 6. **Urticaceae.**

A. *Myrica quercifolia* L. 1. Female twig. 2. Male twig.
B. *Myrica cordifolia* L. 1. Fruiting twig. 2. Fruit (drupe) in transverse section.
C. *Celtis Kraussiana* Bernh. 1. Flowering twig, the terminal flower bisexual, the others staminate. 2. Bisexual flower. 3/1. 3. Anther. 24/1. 4. Staminate flower, 5-merous. 6/1. 5. Staminate flower, 4-merous. 6/1. 6. Fruiting twig. 7. Drupe, the upper half of the pulpy pericarp removed. 2/1. 8. Seed, taken out of the stone, in long. section.
D. *Fleurya capensis* Wedd. 1. Small plant. 2. Flower, one anther just exploding. 5/1. 3. Fruit with persistent calyx. 12/1. 4. Stinging hair. 20/1.

Myricaceae.

Myrica. This genus has a wide distribution, occurring in Europe, Asia, America and Africa. There are nine species in South Africa, all dioecious, evergreen, low shrubs or shrublets with spicate, wind-pollinated flowers.

The fruits of several species are covered with closely set white scales of wax, which attract birds, *e.g.* starlings, thus assisting in the dissemination of the plant.

The layer of wax on the berries of some species is so considerable that it is technically exploited. The farmers boil the berries with water, strain the hot mixture and allow the melted wax to solidify. The ***berry wax*** (myrica wax) is of a pale greenish colour and considerably harder than beeswax. It is, however, according to an investigation by Dr B. v. d. Riet, not a wax but a fat, consisting of the glycerides of stearic, palmitic and myristic acids. (Trans. S. A. Phil. Soc. Vol. xvi, 443 (1906).)

Myrica cordifolia, the ***wax berry bush***, is a common shrub of the sandy flats along our southern coast and an important auxiliary in the fixing of the sand dunes, as, when once properly established, it puts a stop to the shifting of the sand by constantly pushing new shoots through the accumulating dune.

Ulmaceae-Celtideae.

Celtis. Flowers polygamous; the ♂ in clusters, calyx mostly 4-parted, the segments concave or boat-shaped, the two outer ones strongly keeled and imbricating the other two, greenish white, with a touch of pink. Stamens 4, inserted under the rudimentary pistil; ☿ flower usually solitary near the end of the branches; stamens as in the male flowers; ovary pilose, ovate, with two large, papillose, recurved stigmas. Fruit a small, ovoid, 1-seeded drupe; embryo curved, with folded cotyledons and a small endosperm.

Celtis Kraussiana. The ***Camdeboo Stink wood.*** This appears to be the only S. A. species, as according to Sim the name *Celtis rhamnifolia* is merely a synonym. The tree reaches a considerable height in the forests of the East, but remains small in the West, *e.g.* in the ravines of Table Mountain. It is one of the few indigenous arborescent plants of the South West which has deciduous leaves, thereby indicating its eastern origin.

Urticaceae. (Page 140.)

Fleurya. This genus is nearly allied to *Urtica*, of which we have several indigenous as well as two European species in South Africa, viz. the common garden *nettle*, *U. urens*, and the large leaved *Urtica dioica* (***brandnetel***). *Fleurya* differs from *Urtica* by its leaves, which are alternate, and the shape of its fruitlets. Its four species are all annuals of the eastern districts.

The structure of the stinging hairs is in principle the same as in *Urtica*, but they differ slightly in shape. The inflated base, which contains the acrid juice, probably formic acid, is set in an elastic cup; while the sharp, slantingly cut apex is protected by a little knob which easily breaks off when touched, leaving a very sharp, finely perforated point, similar in shape to the needle of a hypodermic syringe. When touched by an animal and thereby deprived of its protecting cap, the hair can easily penetrate the skin, and the acrid fluid is forced into the wound by the contracting cup which surrounds its base.

Urera tenax, a fibre plant (Natal), is figured in Transv. Agr. Rep. 1903.

Fam. 4. Ulmaceae.

Tribe Celtideae.

Trees or shrubs. Leaves simple, with stipules. Flowers unisexual or bisexual, monoecious or polygamous; ♂ flowers in clusters; perianth simple, 4—5-parted; stamens as many as the perianth-segments and opposite them. Ovary 1-celled; styles 2; ovule solitary, pendulous. Fruit a drupe; seeds with scanty endosperm or quite without it. Wood without laticiferous vessels.

KEY TO THE GENERA.

A. Fertile flowers bisexual, solitary, in the axils of the upper leaves. Calyx-lobes of ♂ fl. imbricate; styles 2, deciduous. Embryo with broad cotyledons. (Plate 23.)
Over 70 species, 4 S. A.
1. **Celtis** *L.*

B. Calyx-lobes of ♂ fl. valvate. Embryo with narrow cotyledons.

a. Flowers polygamous; ♂ and bisexual fl. often together in the same tuft; drupe minute, crowned by the 2 persistent styles and surrounded by the persistent calyx. Stipules free.
2 S. A. species (N.).
(*Sponia* Comm.) 2. **Trema** *Loureiro*

b. Fertile flowers all unisexual; stigmas very long and villous, deciduous. Stipules intra-axillary, connate.
1 S. A. species (E.).
3. **Chaetácme** *Planch. & Harv.*

Photo J Belgrove

A

Photo. R. Marloth.

B

Werner & Winter, Frankfort a/M.

A. **FICUS CORDATA** Thunb.
On the farm Kransvlei near Clanwilliam
B. **FICUS CAPENSIS** Thunb.
Fruiting tree in the Municipal Gardens at Capetown

Plate 25.

A: Ficus capensis *Thunb.* B: F. cordata *Thunb.*

Plate 25.

A. *Ficus capensis* Thunb. 1. Twig. 2. Part of inflorescence with very young buds. 3. Part of inflorescence with some young figs (flowering), visited by wasps (*Blastophaga*); also some ripe figs. 4. Ripe fig in long. section. A large specimen. 5. *Blastophaga*, larva, taken from a fully grown but unripe fig. 6. *Blastophaga*, developed insect, escaped from ripe fig. 10/1.

B. *Ficus cordata* Thunb. with ripe fruits. In nature the bunches are hanging (see Plate 24).

Ficus.

There are quite a considerable number of species of *Ficus* in South Africa, some of them being very similar in foliage but different in their fruit. They adapt themselves to various climates and localities, the same species remaining either dwarf under extreme conditions or growing into a lofty tree when more favoured by moisture and warmth, *e.g. Ficus cordata*. (Plate 24.)

One of the largest species is *Ficus natalensis*, which occurs in the eastern coast districts from Natal to the Limpopo, its trunk being occasionally up to six feet in diameter. It often begins its life as an epiphyte on the trunk of another tree, which it at length overwhelms by its weight or destroys by depriving it of the necessary sunlight. [See Fig. 75 *b* and illustration of *Mimusops*, vol. III.] If the roots of the *Ficus* have become sufficiently strong before this happens, they will be able to support the tree during its further life, otherwise it topples over and a ring of young trees may spring up from its broken roots. The *Wonderboom** on the northern slope of the Magaliesbergen near Pretoria, *Ficus salicifolia*, has probably originated in such a way. (Plate 26.)

Ficus cordata, commonly called *melkboom*†, is one of the most widely spread South African trees. It always inhabits rocky situations and especially cliffs of the central districts from Worcester northwards right beyond our limits in Rhodesia and Damaraland. The roots penetrate deeply into the fissures of the rock until they reach a sufficiently permanent supply of moisture, while the stem flattens itself against the wall of the cliff to such an extent that it is sometimes ten feet broad but one foot thick only. (Plate 24.)

* A fuller account of this tree or rather family group of trees is given by H. W. T. Wager in Addresses and papers of the Brit. and S. A. Assoc. Adv. Science, Vol. III, 1905, and by Burtt-Davy in Trans. Roy. Soc. S. A. Vol. II, 365, 1912.

In the first named paper the species is referred to *Ficus cordata* Thunb., which it resembles in its foliage, and in the other one it is named *Ficus Pretoriae* spec. nov. While it differs from *F. cordata* (Plate 25) by the smaller and always more or less stipitate fruits, it is not distinct from *F. salicifolia* Vahl, being one of the numerous forms of this variable and widely spread species (Transvaal, Trop. and subtrop. Africa, Arabia).

† Melkboom, meaning milk tree, is not the same thing as melkhout (milkwood). The latter name belongs to *Sideroxylon inerme* (Sapotaceae, Vol. III). Both contain milky juice.

Ficus capensis. ***Wild fig***; ***Bosvijge.*** This is a lofty tree, 50 or more feet high, especially in the forests of the south-eastern districts from Knysna to Natal, but occurring also further north in Rhodesia. The tree flowers twice a year, the flowers appearing in large bunches on the trunk of the tree or even on its main roots near the trunk. Its fruits attain a considerable size, being as big as the smaller kinds of cultivated figs. The pulp is sweetish but rather dry, and the fruits are, like those of the other species, viz. *F. cordata*, *F. lutea*, etc. always filled with the larvae or adult insects of some species of *Blastophaga* or its allies.

How absolutely dependent the species of *Ficus* are on the presence of the proper insect is well illustrated by an observation which the author made a few years ago in the Municipal Gardens of Capetown. There is one tree of *Ficus capensis* in the garden, probably the only one on the Cape Peninsula, which, to judge from its size, may be 60 years old. Mr CHALWIN, who recently retired from the management of the gardens after more than 25 years' service, had seen the tree producing flowers every year as far back as he could remember, but they never developed into fruits, dropping off every year when about the size of hazelnuts. In 1907 we received a box of nearly ripe fruit of *Ficus capensis* from the Knysna and found them all teeming with *Blastophaga*. In taking some of the fruit to a friend we passed through the Municipal Gardens; that season the tree developed a large number of ripe fruits, all of them well infested with the insects (see Plate 25). The tree has not borne again since that time. In a few fruits of *Ficus capensis*, which we recently sent to Prof. BRAUER, director of the Zoological Museum at Berlin, occurred 5 species of Chalcidiae, belonging to the genera *Blastophaga*, *Goniogaster* and *Apocrypha*, all apparently undescribed. There is a large field open to a specialist here, as the number of species of *Ficus* in Africa alone exceeds 160.

The wonderboom near Pretoria is a good illustration of the vitality of the species of *Ficus*. The present tree, which seen from a distance forms a well rounded mass, represents at least three generations. The parent tree, which originally stood in the centre of the present clump, must have disappeared some centuries ago, leaving a circle of trees that have sprung up from its base. In the course of ages, some of these trees or of their lateral branches fell over and touching the ground with their crown, in some cases 30 feet from the centre, became rooted there and formed a third generation of trees, all of them now combining their lofty crowns into one dome-shaped canopy of foliage. (Plate 26.)

Photo R Marloth

Werner & Winter, Frankfort a M.

The **WONDERBOOM** near Pretoria
FICUS SALICIFOLIA Vahl
Interior of the group of trees

Fam. 5. Moraceae.

Tribe Ficeae.

(Plates 24, 25, 26; Figs. 75, 75 *a*.)

A large family of trees, many of them useful to man. Caoutchouc (India Rubber) is obtained from the milky juice of *Castilloa elastica* (Central America), *Ficus elastica* (Trop. Asia) and others. *Artocarpus incisa* (bread-fruit) is largely cultivated in tropical countries. *Ficus Carica*, the fig tree. *Morus nigra* and *M. alba* (mulberry), of the tribe Moreae, from Southern Asia and China, the latter specially important as food for the silkworm*.

One S. A. genus. About 15 species in S. A. **Ficus** *Tourn.*

Flowers (florets) unisexual, inserted on the inner face of a fleshy, globose or pyriform receptacle (young fig), which is supported at its base by a few-leaved involucre, while the opening at the apex (***ostiole***) is closed by means of closely set bracteoles. The perianth of the florets is 3—5-parted.

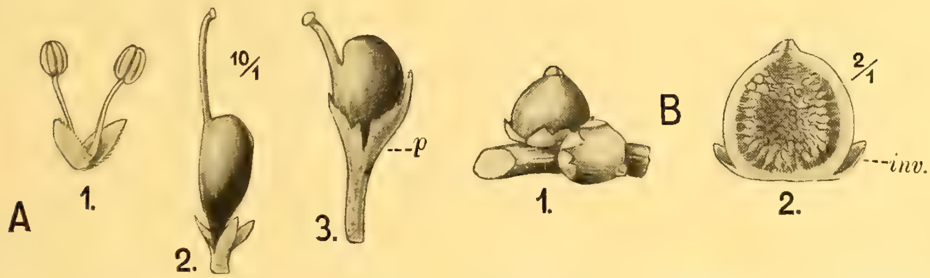


Fig. 75 *a*. *Ficus*. A. *F. capensis* Thunb. 1. ♂ flower. 2. ♀ flower. 3. Gall flower. *p*. Perianth. B. *F. cordata* Thunb. 1. Twig with 2 young figs at time of flowering. 2. Ripe fig (2/1) in long. section. *inv*. Involucre.

There are two kinds of female and one of male florets, the latter being in most species monandrous (one stamen), but in two of the S. A. species, viz. *Ficus capensis* and *F. gnaphalocarpa* (*F. damarensis* Engl.) they are diandrous (two stamens). Of the female florets one

* Another useful and interesting tree is *Maclura aurantiaca*, the so-called "osage orange," which according to some superstition is supposed to be employed in producing the Malta oranges (red flesh). It is a small North American tree, yielding a flexible wood (bow wood). The fruit contains a yellow, fetid juice, with which the Indians used to paint their faces when going to war.

kind has a long, filiform style and produces seed when fertilised, while the others, which have a short style, only act as receivers for the eggs of the fig-insect; they are consequently called *gall-flowers*. The fruitlets (achenes) are surrounded by the perianth.

Fig. 75 *b*. *Ficus natalensis* Hochst. In the Woodbush (Transvaal). Epiphytic on a tree of *Lonchocarpus Capassa*, which is nearly enveloped by the decurrent roots of the *Ficus*. The small portion marked "1" is the host*, while the greater part of the circumference (indicated by the figure "2" and the arrows) belongs to the *Ficus*. Photo. by Frank Menne.

A vast genus of over 600 species, especially numerous in tropical Asia, containing some trees of enormous size and age, viz. the East Indian banyan-tree (*Ficus benghalensis*) and the sycamore (*F. sycomorus*), an African species which supplied the indestructible wood for the coffins of the Egyptian mummies. There are about two hundred species in Africa, 15 of them occurring within our limits.

* Called *Olifants oor* by the colonists.

The mutual adaptation of plant and insect to each other, which the remarkable mode of pollination in *Ficus* reveals, is one of the most interesting chapters of Natural History.

The insects visiting the figs at their flowering season are little wasps of the tribe Chalcidiae, and as far as known, each species of *Ficus* is inhabited by its own particular kind or kinds, that of the cultivated fig being named *Blastophaga grossorum**.

There are three kinds of florets, their distribution differing according to species. In *Ficus capensis* each inflorescence appears to contain all three kinds, but in other species purely female receptacles also occur. The female insect having found its way through the ostiole into the young fig, deposits its eggs in the ovaries of the gall flowers, which are short-styled, while the long style of the perfect florets does not allow the ovipositor to enter the ovary. The inflorescences are distinctly protogynous, and the male flowers at this stage still undeveloped. When, however, the larvae are full grown and begin to change into the adult, winged insect, the male flowers develop and their anthers open, exposing the pollen. As these flowers are situated around the ostiole, the insects, in endeavouring to escape, become dusted with pollen, and when at last successful they carry some of it to the next young fig, which is in its first stage, thus effecting cross-pollination.

It is specially noteworthy, that the plants are not only dependent upon the insects for the transport of the pollen, as is the case in many other flowers, but that here the anthers of the male florets do not even properly develop unless the gall flowers have become infested with the insect, the stimulus produced by the development of the latter being evidently transmitted to the former.

* The insects of the South African species of *Ficus* belong to several genera, but for the sake of convenience one may retain the general designation *Blastophaga* (see page 136).

Fam. 6. **Urticaceae.**

Herbs, rarely half-shrubs, some armed with stinging hairs which inject an acid fluid when penetrating the skin. Flowers unisexual, monoecious or dioecious; perianth 3—5-parted or tubular and toothed. ♂ flowers: stamens as many as calyx lobes, mostly 3—5, or 1; filaments inflexed in the bud, elastically stretching when ripe, thus scattering the pollen. ♀ flowers with or without a perianth; ovary 1-celled, with 1 stigma and 1 basal, erect ovule. Fruit an achene. (Plate 23, page 134.)

Some species yield a valuable fibre, viz. *Urtica cannabina*, *Urera tenax* and *Boehmeria nivea*, the ramie-plant.

KEY TO THE GENERA.

A. ♂ flowers with 3—5 stamens.

a. Leaves with stinging hairs (S. A.).

I. Leaves opposite; stigma penicillate; achene equal-sided. About 30 species, 2 native and 2 introduced. — 1. **Úrtica** *Tourn.*

II. Leaves alternate.

1. Stigma capitate. (Trop.) 2 species in Na. — 2. **Úrera** *Gaud.*

2. Stigma linear. 4 S. A. species (E., N.). (Plate 23.) — 3. **Fleúrya** *Gaud.*

b. Leaves unarmed. ♀ flowers with a tubular, 3—4-toothed perianth enclosing the ovary. 2 S. A. species (N.). — 4. **Pouzólzia** *Gaud.*

B. ♂ flowers with 1 stamen.

a. ♂ and ♀ flowers together in involucred glomerules.

I. Involucral bracts free or nearly free; perianth of ♂ flower tubular, of ♀ wanting. Herbs with rigid hairs. 1 S. A. species. *F. candida*. No. — 5. **Forskólea*** *L.*

II. Involucral bracts forming a bell-shaped cup toothed at the margin. Smooth herbs. 1 S. A. species. *D. ambigua*. — 6. **Droguétia** *Gaud.*

b. ♂ and ♀ flowers together in nude glomerules; perianth of ♂ flower obliquely funnel-shaped, the limb hood-like, acuminate. 3 S. A. species. (*Didymodoxa* E. Mey.) — 7. **Australína** *Gaud.*

* Named after PETER FORSKOL, a pupil of LINNAEUS and later professor of botany at Copenhagen. He died during a journey of exploration in Arabia, 1763.

Fam. 7. Proteaceae (S. A.).

(Plates 22, 27—36, Figs. 76—79.)

Shrubs or trees with persistent, exstipulate, entire or multifid leaves and bisexual or (in 2 genera) unisexual flowers. Perianth simple, 4-parted, mostly coloured on the inner side. Stamens 4, inserted in the concave apices of the calyx lobes or (*Brabeium*) at their base. Ovary superior, with or without 4 hypogynous scales, 1-carpellary, 1- (S. A.) ovuled. Fruit a nut or achene or, as in some Australian tribes, a capsule. Seeds without endosperm.

A large family of over 1000 species, especially well represented in Australia and at the Cape (300), but also occurring in Trop. Africa (30), South America (36), Eastern Asia and the Malayan archipelago (50).

The species with larger flowers are ornithophilous, *e.g. Protea*, *Leucospermum*, *Mimetes*, the style straightening elastically when released by the splitting of the perianth; the others are visited by bees, beetles, flies and other insects.

The fruits are mostly adapted to dispersal by wind, viz. by means of wings (*Leucadendron*), tails (*Protea*), hairs (*Protea*, *Faurea*). The large felt-covered fruits of *Brabeium* float on water.

Uses: In some parts of South Africa the principal firewood. The wood of *Faurea saligna* (*terblanz*) is very beautiful although not strong. The nectar of several species of *Protea*, *e.g. P. mellifera*, *pulchella*, is collected and evaporated to a syrup, which enjoys a great reputation as a household-remedy (*bosjesstroop*). The leaves of *Leucadendron argenteum* (*silver tree*) are used for wreaths and floral ornaments. The seeds of *Brabeium stellatifolium* (*wild almond*) are roasted and used as coffee. The bark of several species is used for tanning, *e.g. Mimetes lyrigera.*

The cultivation of South African Proteaceae in European conservatories appears to be attended with great difficulties. *Protea speciosa* is recorded as having been

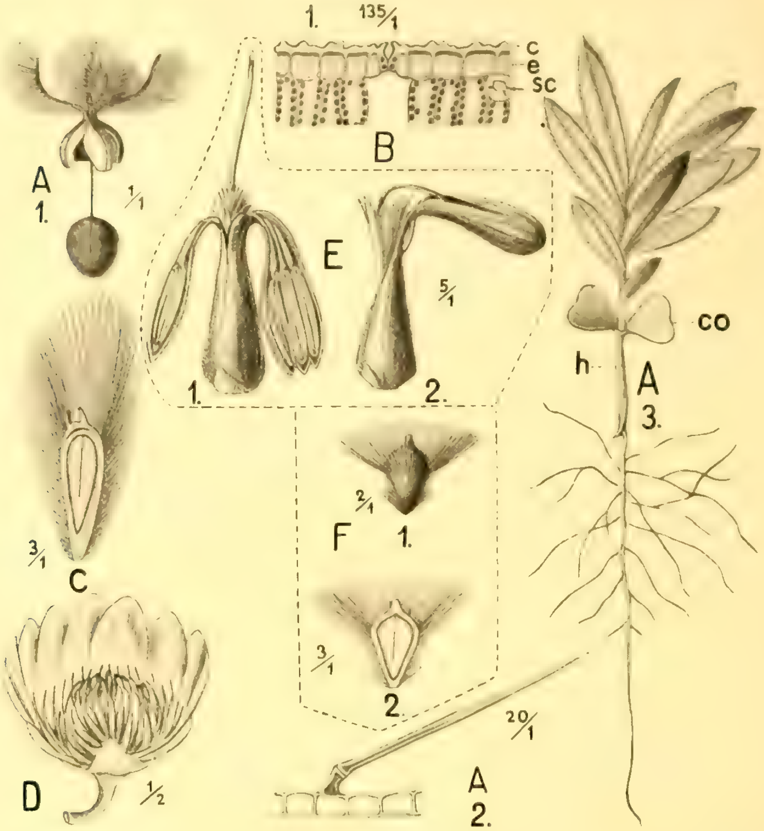


Fig. 76. *Proteaceae.* A. *Leucadendron argenteum* (L.) R. Br. 1. Ripe nut with persistent style and calyx. 2. Piece of epidermis of leaf with one of the hairs. 20/1. 3. Seedling. *h.* Hypocotyl. *co.* Cotyledons. B. *Protea grandiflora* Thunb. Section of leaf with stoma. *c.* Cuticle, covered with wax. *e.* Epidermis. *sc.* Sclerenchyma. C. *Protea neriifolia* R. Br. Nut, long. section. D. *Protea rosacea* L. Long. section through capitulum. E. *Faurea saligna* Harv. 1. Flower, open. 2. Bud, just before opening. 5/1. F. *Serruria Burmannii* R. Br. 1. Nut. 2/1. 2. Nut in long. section. 3/1. (The block of this illustration is smaller than contemplated by the artist, hence the magnifications are only 2/3 of what is stated.)

raised from seed and finally flowered at Kensington in 1800. Numerous others were cultivated at the same period by Geo. Hibbert at Clapham, but at present this is rarely done. *Protea cynaroides* was seen by us in flower at Kew in May 1911, but the shoots were thin and slender, over 10 feet high and tied up against a trellis, not stout and robust as on the wild plant. (Plate 22.)

KEY TO THE GENERA.

(See also Flor. Cap. Vol. v, Sect. 1, 502.)

Tribe I. Proteeae.

Perianth tubular, the segments partly or completely separating. Anthers sessile, inserted at the base of the spoon-shaped limb of the perianth-segments.

A. Flowers regular, by abortion unisexual.

a. ♂ flowers in cylindrical spikes; ♀ flowers capitate with linear bracts.
Endemic. Ca*. 3 species. 1. **Aúlax** *Berg.*
Flor. Cap. 505.

b. Both kinds of flowers capitate; the ♀ inflorescence developing into a cone-like, compact head with broad scales.
(Fig. 76; Plates 28, 29.)
Endemic. 55 species, a few eastern.
2. **Leucadéndron** *Berg.*
Flor. Cap. 509.

B. Flowers bisexual. Hypogynous scales 4.

a. Perianth irregular, 2-labiate; 1 segment free, the lower 3 more or less cohering.

I. Flowers and fruits capitate.

1. Antheriferous limbs of the 3 lower perianth-segments cohering. Nuts bearded and tailed by the persistent style. (Figs. 76—78; Plates 22, 29, 30, 35.)
Over 100 species of which about 85 in S. A.
3. **Prótea** *L.*
Flor. Cap. 552.

2. Limbs of all perianth-segments separating. Nuts smooth, not tailed. (Plates 31, 36.)
31 S. A. species, 1 in Rhodesia, 1 Abyssinian (?).
4. **Leucospérmum** *R. Br.*
Flor. Cap. 610.

II. Flowers and fruits spicate. Nuts bearded. (Plate 34; Fig. 76.)
14 species, 5 in S. A., 1 in Madagascar.
5. **Faúrea** *Harv.*
Flor. Cap. 639.

b. Flowers regular or nearly so; all 4 segments separating.

I. Perianth-segments equal.

1. Heads terminal, ∞-flowered, solitary, corymbose or glomerated.

× Leaves pinnatifid with filiform segments or (rarely) filiform. Nut shortly pedicillate. (Fig. 76; Plate 33.)
Endemic. Ca. 48 species. 6. **Serrúria** *Salisb.*
Flor. Cap. 654.

* The letters Ca. indicate "Cape region," also designated as the "South Western region."

× × Leaves small, entire, flat. Heads small, with inconspicuous bracts. (Plate 32.)
Endemic. Ca. 5 species. 7. **Diastélla** *Knight*
Flor. Cap. 650.

× × × Leaves large, expanded. Heads large, with large showy bracts. (Plate 32.)
1 endemic species, Caledon mountains.
8. **Orothámnus** *Pappe*
Flor. Cap. 650.

2. Heads axillary and few-flowered, each head surrounded by a large foliage bract. Nut sessile. Leaves flat.
Endemic. Ca. 9 species, middle-sized trees or shrubs. (Plate 32.) 9. **Mimétes** *Salisb.*
Flor. Cap. 643.

3. Heads 1—6-flowered, involucred, congested into a terminal spike or rarely forming a terminal glomerule. Nut shortly pedicillate.

× Leaves either all pinnately divided or dimorphic, the lower ones being multifid and the upper ones flat. Heads 4-flowered. Nut sessile. (Plate 33.)
Endemic. Ca. 13 species.
10. **Paránomus** *Salisb. & Knight*
Flor. Cap. 708. Under *Nivenia R. Br.*

× × Leaves either all linear or some of the lower decompound.

o Inflorescence globose. Stigma oblong.
Endemic. Ca. 13 species.
11. **Sorocéphalus** *R. Br.*
Flor. Cap. 701.

oo Inflorescence cylindric. Stigma obliquely capitate.
Endemic. Ca. 5 species.
12. **Spatallópsis** *Phillips*
Flor. Cap. 698.

II. The upper perianth-segment larger. Stigma obliquely discoid.
Endemic. Ca. 21 species. (Plate 33.)
13. **Spatálla** *Salisb.*
Flor. Cap. 686.

Tribe II. **Persoonieae.**

Perianth-segments free; stamens with filaments, the filaments free or shortly adhering to the claws of the perianth-lobes. (Fig. 79; Plate 34.)
1 endemic species. Ca. 14. **Brabéium** *L.*
Flor. Cap. 504.

Photo E. J. Steer

Werner & Winter, Frankfort a/M.

SILVERTREES

LEUCADENDRON ARGENTEUM R. Br.

On the slopes of the Lionshead near Capetown

Flowering (Sept.)

*Leucadendron** *argenteum* (L.) R. Br. *The Silver tree, Witteboom.*

(Plates 27, 28; Fig. 76.)

The silver tree has a small area of distribution, occurring naturally only on the Cape Peninsula, while the patches on various hills of the Paarl and Stellenbosch districts are, in our opinion, due to dissemination by the hand of man. On the slopes of Table Mountain, the Lion's Head and the Devil's Peak, or the mountains further south, it always occupies very windy and comparatively dry situations, where soft-leaved trees or shrubs cannot persist in summer, especially not during a prolonged period of South East wind. It is, however, just at such times that the silver tree shines more brilliantly than usual.

This beautiful gloss the leaves owe to their coat of fine silky hairs, with which nature has provided them on both sides as a protection against excessive transpiration during dry weather, and it is remarkably well adapted to this function.

In winter or during other rainy weather the hairs on the surface of the leaf (Fig. 76, A, 2) are half raised, forming an angle of about 30 degrees with it and consequently allowing the air to circulate freely between them and to diffuse in and out through the stomata. In dry weather, however, and especially when strong winds exert their exhausting influence on the vegetation, the hairs move downwards by means of the basal cell which collapses on one side, acting like a hinge (Fig. 76, A, 2). The hairs are thus tightly pressed against the leaf, forming a continuous layer and shutting off completely communication between the tissue of the leaf and the atmosphere. To this movement the brilliant optical effect is due. The smooth layer of glossy hairs naturally reflects the light more strongly than the rough surface formed by their projecting

* Although grammatically incorrect the spelling as originally published must be adhered to. LINNAEUS, BERGIUS, ROBERT BROWN and others write it as above.

points, hence the more vivid glittering of the silver trees in summer when the South wind ruffles their leaves.

The female inflorescence of *Leucadendron* develops into a cone. In most species the nuts are winged, while in the others the persistent perianth assists in their distribution.

Winged fruits are frequent in various families, but the mode of dispersal of *Leucadendron argenteum*, *L. plumosum* and a few others is unique.

While the cones of pines and firs become pendulous during their development, those of Leucadendron remain upright, hence the seeds cannot leave the cones unless the branches are shaken by a strong wind. When this takes place they do not, however, drop straight to the ground, like the seeds of the stone pine, for the modified perianth-segments support them. In the flower the lower part of the perianth is tubular, but during the growth of the nut this portion has developed into a membranous coat, while the segments have been changed into large feathery wings.

The cones ripen late in autumn (April, May); during dry and windy weather their scales curve back and allow the nuts to escape. In doing so the membranous coat splits from below and glides to the end of the persistent style (Fig. 76, A, 1). Here, however, it is retained by the knobbed stigma, and as on leaving the cone the calyx spreads its feathery segments horizontally, the nut remains suspended between the four wings like an aeronaut from his parachute, to be carried away by the wind to colonise new ground.

Plate 28.

Leucadendron argenteum (L.) R. Br.

Male flower-heads, one with buds and the other with open flowers. October. 1/2 nat. size.

Werner & Winter Frankfort a/M.

TWIGS OF THE SILVERTREE

LEUCADENDRON ARGENTEUM R. Br.

Bud and open flowers (♂)

Plate 29.

A: Leucadendron decorum *R. Br.* B: Protea rosacea *L. (P. nana).*
C: P. Mundtii *Klotzsch*

Plate 29.

A. *Leucadendron decorum* R. Br. 1. Flowering twig of male plant, with fly. 2. Female flower. 5/1. 3. Male flower with abortive style. 3/1. 4. Nut. Nat. size.
B. *Protea rosacea* L. (*P. nana*).
C. *Protea Mundtii* Klotzsch, with visiting beetle (*Trichostetha capensis*).

LEUCADENDRON

(Plates 27, 28, 29, 61.)

Trees or shrubs with entire, sessile, hairy or glabrous leaves and terminal heads. Flowers in involucred heads, dioecious. ♂ flower: Calyx regular, the spreading segments bearing the anthers in the spoon-shaped apices; a small abortive pistil generally present. ♀ flower: the perianth-segments and the clavate stigma just project beyond the scales of the cone. Fruit a nut, enclosed between the scales of the cone, either flat and winged, as in most species, *e.g. L. decorum*, or globose and crowned by the persistent style and calyx, as in the silver tree and the more widely distributed *Leucadendron plumosum* (shrubby).

The genus includes over 50 species, of which only two are known to occur outside the Cape region.

Leucadendron decorum. Leaves elliptical, glabrous, with a red mucro. The male heads 1—2 inches in diameter, the floral leaves larger and bright yellow, while the bracts of the involucre are brown and membranaceous with recurved points; the perianth is bright yellow or tinged with orange. The female heads are more oblong or conical, less showy and less numerous than the others, about an inch in diameter when in flower, growing to about 2 inches during their further development. The winged nuts are black and shining.

When in flower this shrub is a great ornament to the mountains and hills of the South West, as a single shrub may bear hundreds of bright coloured heads which are so crowded that they exclude the foliage from view. Flowering in spring; the flowers are visited by several kinds of flies and beetles. (See also Plate 61.)

One of the species of *Leucadendron*, viz. *L. concinnum*, commonly called ***Langbeen***, is employed as a remedy against malaria in the Breede River valley. According to the investigations of the Merck Research Laboratory at Darmstadt the leaves contain an amorphous glucoside, named ***Leucoglycodrin*** and a white, bitter, crystallised principle, named ***Leucodrin***.

Protea rosacea. This graceful little shrublet, which flowers in spring, is not unfrequent on the mountains of Tulbagh, Ceres and Wellington. No painting can adequately render its beauty, the bracts are a deep claret colour, translucent and particularly beautiful when illuminated by the sun.

Leaves acerose, mucronate, closely set; flower-heads solitary, terminal, hemispherical and pendulous. Involucral bracts glabrous, the outer ones ovate and subacute, the inner ones narrow-oblong, obtuse, longer than the flowers. Named ***Schaambloem*** on account of the drooping flower-heads.

Fig. 77. *Protea Mundtii* Klotzsch April. Mountains near Stellenbosch. 3500 feet.
Photo. by E. Dyke

Protea Mundtii. This species forms shrubs 4—6 feet high on the mountains of Stellenbosch and Paarl, flowering in winter. Our coloured figure shows the head a little more opened than it is in reality. Like other species it is visited by various beetles, one of the most frequent visitors being *Trichostetha capensis.* Not rarely also the larger species, *T. fascicularis,* which has a metallic green body and tufts of golden brown fur, is found on this and other species of *Protea* or *Leucospermum.* (See Plate 31.)

Plate 30.

A: Protea scolymocephala *L.* B: P. speciosa *L.* C: P. tenuifolia *R. Br.*

Plate 30.

A. *Protea scolymocephala* L. With visiting beetle (*Mylabris cincta*).

1. Flowering twig. 2. Bud. 3. Flower, open. (Note the three segments joined to the tip.)

B. *Protea speciosa* L.

1. Capitulum and a few leaves. 2. Achene. 3. Achene in long. section, without the style.

C. *Protea tenuifolia* R. Br.

Protea*.

(Figs. 76—78 *a*.)

The genus *Protea* includes some of the most conspicuous trees and shrubs of South Western Cape Colony and has at the same time a more general distribution in Africa than any other of the larger genera of the family. Only *Faurea*, with 14 species, approaches it in this respect. The systematic characters of the florets and fruits are so typical and constant, that the genus is easily recognised, and we are well informed with regard to its distribution even in the less known regions beyond the Zambesi, but the use of vernacular names has led to various erroneous statements concerning the distribution of its species. The common ***sugar bush***, *Protea mellifera*, is one of the most widely spread Cape species, occurring everywhere in the South West and extending eastwards as far as Kaffraria, but the "***suikerbosjes***" of the Transvaal and Rhodesia, for which various travellers quote the same name, belong to other species.

There are about 25 species of *Protea* in Angola, Rhodesia and Eastern Africa, one of them, viz. *P. abyssinica*, extending from Rhodesia to Abyssinia.

The largest flower-head is that of *Protea cynaroides*, which measures not rarely 12 inches in diameter or even more. (Plate 22.)

The largest tree of the genus is *P. grandiflora*, commonly called the ***wagenboom***.

In the South Western districts of the Cape most species of Protea flower at the beginning or in the middle of winter, while in the eastern and northern parts the flowering season is spring and summer. Even the same species adapts itself in this respect to the different climatic conditions, for while *Protea cynaroides* flowers on the Cape Peninsula in March and April, it does so at George, which is about 200 miles to the East, in October and November.

Protea scolymocephala. This species forms small shrublets, 2—3 feet high, in the sandy tracts of the Cape Flats and their neighbourhood, the involucral bracts being generally whitish green.

* Named by Linnaeus after the mythical Proteus of the ancients (famous for his power of assuming many different forms) on account of the great diversity of habit in the species of this group.

Protea tenuifolia. The stems of this and some allied species spread in the ground, the flower-heads only and the surrounding leaves appearing above the surface. A nearly allied species, *P. lorea*, has needle-shaped leaves, 8 to 10 inches long, the young shoots looking like fir-twigs. On hills near Stellenbosch, Caledon and other coastal districts.

Protea speciosa. (Plates 29 and 35.) This shrub produces short erect shoots, 1 to 2 feet high, with beautiful elliptical or ovate leaves provided with a strong red margin. The heads are particularly showy on account of the brown fur of the bracts. The leaves are generally found injured by caterpillars, while hardly any of the other species are liable to such attack. The scarcity of butterflies in the Cape region may be partly due to the want of

Fig. 78 *a*. *Protea neriifolia* R. Br. July. Hex River Mountains. 4200 feet.
Photo. by Izaak Meiring

food which their larvae could find here, for almost all the indigenous plants and especially the shrubby species are well protected against the attacks of insects, either by an abundance of tannin like most Proteaceae, or by aromatic oils like the Rutaceae, or by sharp and acrid ingredients like many monocotyledons.

An allied species with larger and even more beautiful heads, viz. *P. grandiceps*, was formerly not unfrequent on the mountains of the Cape Peninsula, but is now extinct there. When Pappe came to the Cape in 1830 extensive thickets of it still flourished on the slopes of the Devil's Peak, but these entirely disappeared during his time, owing to a series of bush fires.

Plate 31.

A: Leucospermum crinitum *R. Br.* B: L. puberum *R. Br.*
C: L. buxifolium *R. Br.* D: L. medium *R. Br.* E: L. hypophyllum *R. Br.*

Plate 31.

LEUCOSPERMUM.

A. *L. crinitum* (Thunb.) R. Br.
B. *L. puberum* R. Br.
C. *L. buxifolium* (Thunb.) R. Br.
D. *L. medium* (Thunb.) R. Br. 1. Flower-head with visiting beetle (*Trichostetha fascicularis*). In the centre of the capitulum a few buds.
2. Bud, just opening. 3. Flower, open.
E. *L. hypophyllum* (Thunb.) R. Br.

LEUCOSPERMUM (see also Plate 36).

Flowers bisexual, irregular, the claws of three calyx segments cohering, while the fourth one is free below or for its entire length, all the apices being separated. Style filiform, curving upwards or finally straight, deciduous; stigma glabrous, thickened, mostly obliquely truncate and furrowed or angular. Nut sessile, subglobose, smooth.

Small trees or shrubs, some trailing on the ground, with dense terminal heads of yellow, red or orange-coloured flowers, the style being generally most brilliantly coloured.

About 30 species, of which a few occur beyond the borders of the Cape region, *e.g. L. Zeyheri* and *L. attenuatum* on the Drakensbergen, *L. saxosum*, recently described by SPENCER MOORE, on the Chimanimani mountains in Gazaland, and *L. Rochetianum*, of doubtful generic relationship, in Abyssinia.

The others are all confined to South Western Cape Colony, the most common kind being *Leucospermum conocarpum*, called "*kreupelhout*" by the colonists; it forms dwarf trees with a globular crown (Plate 36). The large yellow flower-heads are often visited by sugar birds, especially by the long-tailed *Promerops cafer.*

The orange-coloured heads of *L. obovatum*, *L. medium*, and *L. lineare* are even more gorgeous, and *L. reflexum* of the Cederbergen surpasses them all in the graceful appearance of its flower-heads.

Leucospermum crinitum. Heads crowded at the end of the branches, subcylindrical, the bracts long-pointed and pilose or ciliated, as long as the flowers, bright red or orange. A shrub 3—6 feet high, flowering in spring. Frequent on the hills of Paarl, Stellenbosch and Caledon.

Very similar is *L. penicillatum*, which differs by its oblong leaves and the longer involucral bracts.

Leucospermum puberum. A low, spreading shrub, 2—3 feet high, with pilose twigs and leaves. The flower-heads are mostly solitary, one inch in diameter when fully expanded; the involucral bracts are more or less herbaceous, pilose, ovate-acuminate, dark red on the inner side.

Frequent near Paarl, Tulbagh, Caledon and other districts, flowering in spring.

Leucospermum buxifolium. Twigs and leaves pilose or silky, sessile; the flower-heads 3—5, aggregated at the ends of the branches, their involucral bracts brown, ovate-acuminate, pilose. Calyx pilose, the inner side red, three segments separating for about one-half of their length, the fourth one a little further, leaving the lower part of the tube entire.

Leucospermum medium. Leaves glabrous, sessile, ovate, with a cordate base and two or three callous-tipped apical teeth, 2 inches long. Heads large, measuring with the expanded styles 4—5 inches in diameter, the perianth and styles being bright orange-red.

A divaricately branched shrub, 2—5 feet high, with numerous very beautiful heads, flowering in November and December. Frequent on hills near Caledon and the adjoining districts. Flowers often visited by sun birds (*Cinnyris*).

Leucospermum lineare. With similar flowers but needle-shaped leaves; frequent on the Stellenbosch and Paarl Mountains.

Leucospermum hypophyllum. A low shrublet, its branches creeping on the ground, the leaves standing vertically upright, those originating on the lower side of the branch with longer petioles, all elongate-spatulate, toothed at the obtuse apex. Heads 1—3, terminal, subglobose, 1—3 inches in diameter, the involucre conical, the bracts almost broader than long, with short points.

Flowers numerous, fragrant; calyx deep yellow, silky on the outer side.

Fairly frequent in sandy plains, flowering in winter and spring.

Plate 32.

A: Orothamnus Zeyheri *Pappe* B: Diastella serpyllifolia *Knight*
C: Mimetes hirta *Knight*

Plate 32.

A. *Orothamnus Zeyheri* (Meissn.) Pappe
B. *Diastella serpyllifolia* Knight 1. Flowering twig. 2. Flower, laid open. 2/1.
C. *Mimetes hirta* (L.) Knight 1. Flowering branch, with visiting bird (*Anthobaphes violacea*). 2. Ovary with hypogynous scales. 8/1. 3. Fruit (nut) with persistent perianth. 8/1.

The three genera represented on this plate are treated by De Candolle and later on by Bentham and Hooker, also by Harvey, as one genus, but they have been recently separated again by Mr E. Phillips in the Flora Capensis (Vol. v, sect. 1, pp. 502 sqq.). They are easily distinguished from each other by the nature of the capitulum.

Orothamnus Zeyheri is a small shrub of the mountains south of Sir Lowry's Pass; it has beautiful, quite singular looking flower-heads, the bracts of the involucre being bright red, glossy and transparent, almost fleshy.

Diastella serpyllifolia is a low, straggling shrublet with decumbent branches, common on the Cape Flats and in other sandy districts of the coast. Several other species of the same genus differ principally by the shape of their leaves.

Mimetes Salisb. (Eu-Mimetes).

This genus as now limited is easily recognised by the compact racemose arrangement of its flower-heads, each small, more or less cylindrical head being sheltered by a hooded, brightly coloured leaf. The segments of the perianth are quite free and the nut is sessile.

Mimetes hirta. Shoots numerous from a common crown, 2—3 feet high, with a very showy spike of headlets. Fairly frequent on the sandy flats of the mountains south of Simonstown and Sir Lowry's Pass.

Mimetes lyrigera (*M. cucullata*). This medium sized tree resembles *Leucospermum conocarpum* in shape. When in flower it forms a very conspicuous object even seen from a distance. The flowers are regularly visited by sun birds, *Cinnyris*, *Anthobaphes*, and *Promerops*.

The bark is rich in tannin and consequently often gathered as a tanning material by stripping the trees and shrubs. As this destruction, for all stripped trees must die, is repeated whenever the younger ones have become large enough for the purpose, the plant has disappeared from many hills and mountains where it used to abound, and full-grown specimens, with a crown 20 feet in diameter are now only rarely met with.

Fig. 78 *b*. ***Witch's Broom*** on *Protea Lepidocarpodendron* L. From neighbourhood of Capetown. 1/2 nat. size. Photo. by E. J. Steer This outgrowth consists of several hundred dwarfed shoots of the *Protea*, and is due to a disease caused by the mycelium of a fungus (probably belonging to Uredineae). Such deformed shoots occur on various shrubs and trees, being fairly frequent on several species of *Protea*, *e.g. P. grandiflora*, *P. mellifera*, etc.

Plate 33.

A: Spatalla procera *Knight* B: Serruria anethifolia *Knight*
C: Paranomus crithmifolius *(R. Br.)* D: Serruria aemula *Knight*

Plate 33.

A. *Spatalla procera* Knight 1. Flowering twig. 2. Capitulum of three open flowers. 3. Upper segment of perianth with anther and pistil. 2/1. 4. Pistil with hypogynous scales. 2/1. 5. Ovary, long. section.

B. *Serruria anethifolia* Knight Leaf and inflorescence.

C. *Paranomus crithmifolius* (R. Br.) Knight 1. Small twig with visiting beetle (*Leucocelis adspersa*). 2. Capitulum of 4 flowers, viz. one of them open, one just opening and two buds.

D. *Serruria aemula* Knight 1. Flowering twig with bee. 2. Flower. 2/1.

SPATALLA.

The genus *Spatalla* as accepted by BENTHAM and HOOKER and also by HARVEY (Genera, Ed. II, 332), has been divided by Mr PHILLIPS into two genera, all species with a regular perianth and an ovate-conical stigma having been transferred to the new genus *Spatallopsis* (Kew Bull. 1910, No. 8).

The genus *Spatalla*, thus restricted, is more natural and easily recognised by its peculiar inflorescence, the irregular perianth and the shape of the stigma.

Spatalla procera is a common shrublet, 1—2 feet high, of the Hottentot Hollands mountains, flowering in spring.

SERRURIA*.

The genus *Serruria*, one of the largest of the family, is entirely confined to the south-western districts like *Spatalla*.

All the species are small shrubs, mostly not more than 2 or 3 feet high, with much divided leaves, but *Serruria florida* is taller (Fig. 78 *c*).

Serruria anethifolia is fairly numerous on the hills of Sir Lowry's Pass and Caledon.

Serruria aemula, a common shrublet of the Cape Flats, is often visited by bees and beetles.

PARANOMUS† Salisb. & Knight

Similar in their foliage to the preceding are several species of *Paranomus* (*Nivenia*†), but others bear two kinds of leaves, the upper ones being larger and entire, while only those lower down the stem are more or less divided. The upper leaves evidently increase the showiness of the shrubs.

Shrubs, 2—5 feet high, with bisexual, capitate flowers; the heads 4-flowered, involucred by four tomentose closely adpressed bracts and disposed in terminal spikes. Calyx regular, the segments coiling backwards, bearing the anthers in the spoon-shaped apices, entirely deciduous. Hypogynous scales 4; style filiform, straight; stigma clavate. Nut sessile. About 15 species, all endemic in the South West.

* Named after BURM. JOS. SERRURIER, Professor of botany at Utrecht.

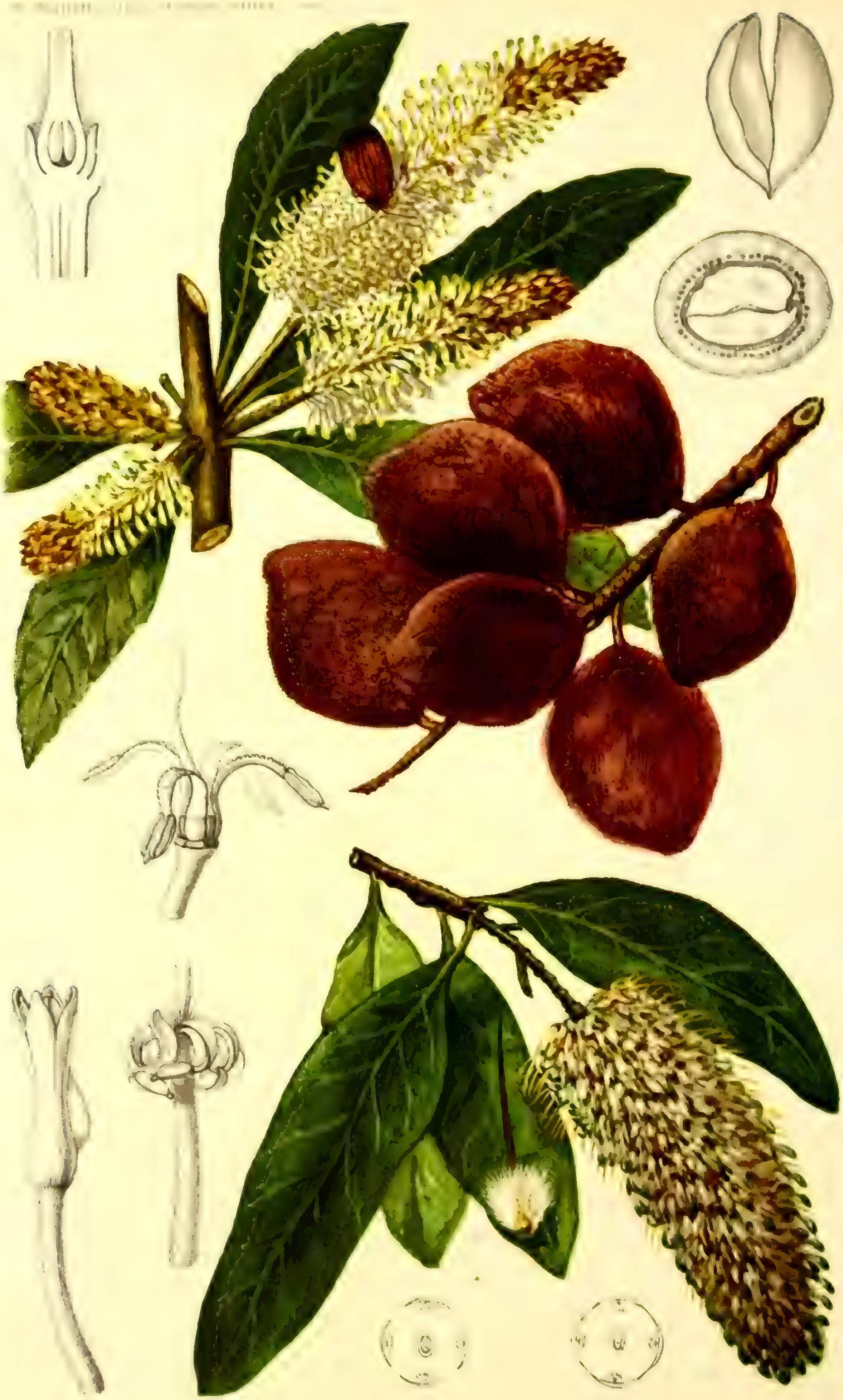
† As the name *Nivenia* had been applied by VENTENAT to a genus of Iridaceae (1808) before ROBERT BROWN established his *Nivenia* (1810), the latter genus must bear SALISBURY's name "*Paranomus*" (1807). For *Nivenia* Vent. see Vol. IV.

Paranomus crithmifolius (R. Br.) Knight (Syn. *Nivenia crithmifolia*). Young branches tomentose; leaves glabrous, bi- to tri-ternate, the segments filiform; spikes 1—2 inches long, the calyx tomentose on the outer side, the segments glabrous and purplish-maroon on the inner side; style pilose below, glabrous near the stigma.

Shrub 2—5 feet high, frequent on the hills at Caledon and neighbouring districts.

Fig. 78*c*. *Serruria florida* R. Br. 1/2 nat. size. Photo. E. J. Steer A very graceful shrub, 6—8 feet high, with drooping, rose-coloured flower-heads. Known only from some of the upper tributaries of the Berg river near Frenchhoek.

Plate 34.



A: Brabeium stellatifolium *L.* B: Faurea Galpinii *Phillips*

Plate 34.

A. *Faurea Galpinii* Phillips [Tribe Proteeae] 1. Flowering twig. 2. Diagram of flower. 3. Achene. From the Zoutpansberg.

B. *Brabeium stellatifolium* L. [Tribe Persoonieae] 1. Piece of flowering twig with visiting beetle (*Lycus* spec.). 2. Diagram, indicating the two pendulous ovules. 3. Bud, just opening. 7/1. 4. Flower, open, showing the free stamens, the upper part of the style being cut away. 5. Stamens and pistil with nectariferous cup, the perianth cut away, the disc shining through the filament of the anterior stamen. 7/1. 6. Ovary and disc, long. section, the ovules entire. 15/1. 7. Bunch of ripe fruits. 8. Transverse section of fruit. 9. Embryo.

Faurea.

This genus includes the only really large trees of the family in South Africa, and it is the only genus of African Proteaceae which has its head-quarters outside the Cape region, viz. Trop. Africa. Of the 14 species known up to the present, one only occurs in the Cape Colony and even there not in the Cape region as such, but in the forests of the Knysna. This species, described as *F. arborea** in Sim's Forest Flora, and now called *F. Macnaughtonii*, is restricted to one district (Gouna), where the total number of trees has been estimated by Mr Collin McNaughton to be about 30,000.

Three other species occur in the Transvaal, viz. *Faurea Galpinii* (in the Zoutpansberg district), *F. saligna*, a fine tree with a wide range from Warmbad right on to the Matopos and perhaps beyond, and *F. speciosa*, a tropical species. (Fig. 76, E.) For illustration of *F. saligna* see Vol. II, Fig. of *Parinarium Mobola*.

The wood of several species of *Faurea* is beautifully grained and known among the colonists as *terblanz* or Transvaal *beukenhout*. The flowers are ornithophilous.

In naming this genus from specimens collected by Burke and Zeyher near the Magaliesbergen Harvey writes:

"I bestow the generic name as an affectionate tribute to the memory of my lamented friend W. C. Faure Esq., son of the Rev. A. Faure, senior minister of the Dutch Reformed Church at Capetown, a young man of much promise, and a most ardent botanist, whose death occurred under peculiarly trying circumstances. He was an officer and fell ill with cholera shortly after coming to India, but recovered. When trying to join his regiment and passing through a difficult part of the country, he was shot by some unknown person concealed in the bush. 1844."

Brabeium.

This genus, with its solitary species, is the only member of the family in Africa which does not belong to the tribe Proteeae, being the only African representative of the tribe Persoonieae, which, on the other hand, are numerous in Australia.

* The name *F. arborea* had been previously given by Engler to an East African species.

Brabeium stellatifolium (*wild almond*) is an arborescent shrub, 15—25 feet high, growing near river beds or mountain streams or in damp kloofs of the South West. It flowers early in summer, when various kinds of insects, viz. bees, flies, wasps and beetles frequent the fragrant trusses of flowers.

Fig. 79. *Brabeium stellatifolium* L. Flowering branch. ½.

The fruits (*Wilde amandel*) ripen at the beginning of winter and look very handsome, not unlike half-ripe almonds in shape and colour. The kernel (seed) tastes like bitter almonds and contains a bitter glucoside, which yields prussic acid on fermentation. The fruits float on water and are dispersed by streams.

Photo. R. Marloth

Werner & Winter Frankfort a/M.

PROTEA SPECIOSA L. and **PROTEA CYNAROIDES** L. (buds).
On the Devilspeak near Capetown, 3000 feet, March

Photo R. Marloth

Werner & Winter, Frankfort a/M.

LEUCOSPERMUM CONOCARPUM R. Br.
KREUPELHOUT
On the slopes of Table Mountain near Campsbay

The colonists gather the fruits and remove the bitter principle by keeping them submerged in running water for several weeks. The dried and roasted seeds are used like coffee and often preferred to it. The natives call this preparation "*gu*" [pronounced like the word "good" without the letter *d*, provided one does not attempt to imitate the click].

Fam. 8. Santalaceae.

(Plate 37, A—C; Fig. 80.)

Shrubs or half shrubs with simple, sometimes minute leaves. Flowers bisexual or by abortion dioecious (*Thesidium*). Perianth simple, its tube joined to the inferior ovary; segments 4 or 5, small or minute; stamens as many, opposite, inserted at their base. Ovary inferior, 1-celled; ovules 2—4, pendulous from the apex of a central, chord-like placenta, without integuments. Style simple, mostly minute. Fruit nut-like or drupaceous. Seed solitary, without testa, protected by the hardened endocarp, with large endosperm and an axile, inverted embryo.

The development of the embryo-sac shows several deviations from the general angiospermous type.

About 250 species, belonging to 26 genera, in various parts of the world.

Several genera of this family, viz. *Thesium* and *Thesidium*, are ***half-parasites***, attaching themselves to the finer rootlets of various shrubs or herbs by means of ***haustoria***. *Thesium strictum* grows on various Restionaceae and grasses. *Thesidium fragile* on *Metalasia muricata*, *Chymococca empetroides* and others. Like the mistletoe these plants use the host only for assisting them in drawing supplies of water and mineral matter from the soil, assimilating the raw sap in their green parts, viz. leaves and stems or the latter only. It is probable that these plants or their ancestors attacked the roots of other plants originally for the sake of the water only, but gradually took advantage of this opportunity and became parasitic.

Fig. 80. *Thesium strictum* Berg. A leafless shrub, six feet high, with green stems. Slopes of Table Mountain.

Plate 37.

A: Colpoon compressum *Berg.* B: Thesidium fragile *Sond.*
C: Thesium strictum *Berg.* D: Grubbia stricta *DC.*
E: G. rosmarinifolia *Berg.*

KEY TO THE GENERA.

A. Calyx not produced into a tube above the ovary. Shrubs.

a. Flowers bisexual. Leaves opposite.
Endemic. Two species. (Plate 37.) 1. **Colpoon** *Berg.*
(Syn. *Rhoiacarpos*)

b. Flowers dioecious or polygamo-dioecious, the male flowers in terminal racemes. Leaves alternate. Semi-parasites.
O. abyssinica (Transvaal sumach). 4 species in Trop. Afr.
2. **Osyris** *L.*

B. Calyx produced into a tube above the ovary. Shrublets with alternate, often scale-like leaves.

a. Flowers bisexual; calyx 5-lobed.

I. Fruit a drupaceous pseudocarp.
1 S. A. species (*O. natalensis*). 4 in Trop. Afr.
3. **Osyridicárpos** *A. DC.*

II. Fruit nut-like, with a hard, dry shell.
Semi-parasites, attached to the roots of various herbs and shrubs by means of haustoria.
About 70 S. A. species. (Plate 37.) 4. **Thesíum** *L.*

b. Flowers dioecious. Fruit embedded in a succulent coloured cup. Semi-parasites on the roots of shrubs.
Endemic. 6 species. (Plate 37.) 5. **Thesídium** *Sond.*

Plate 37.

Fam. 8. Santalaceae.

A. *Colpoon compressum* Berg. 1. Fruiting twig. 2. Flower. 3/1. 3. Flower, long. section, showing the spiral columnar placenta in the centre, with three pendulous ovules, each one curving upwards. 5. Insect from flower. (Class *Colembola.*) 3/1.
B. *Thesidium fragile* Sond. 1. Male twig. 2/1. 2. Female twig in flower. 2/1. 3. Fruiting plant.
C. *Thesium strictum* Berg. 1. Young plant, parasitic on roots of *Thamnochortus dichotomus.* 2. Flower. 3/1. 3. Ovary, long. section, showing the three pendulous ovules, the spiral placentae artificially drawn out. 5/1.

Fam. 9. Grubbiaceae.

D. *Grubbia stricta* DC. Twig with flowers and fruits.
E. *Grubbia rosmarinifolia* Berg., in flower.

Colpoon.

Colpoon compressum, ***Pruimbast***, ***Cape sumach***. A shrub 5—8 feet high, with entire, glaucous leaves, small greenish flowers and dark purple fruit. Flowers generally 4-merous, but some of those which terminate the primary axis of the cymose inflorescences are occasionally 5-merous.

The leaves contain a glucoside ***Osyritrin*** and much tannin; they are largely used for tanning leather, hence the colonial name of the shrub ***Cape sumach***. In the northern parts (Transvaal, Bechuanaland, Rhodesia, German South West Africa) occurs the allied species *Osyris abyssinica* Hochst., which is employed for the same purpose, going under the names of ***bergbast*** and ***Transvaal sumach***. Neither of them is, however, in any way allied to the real sumach, *Rhus coriaria*, which belongs to the family Anacardiaceae, being largely cultivated in Sicily and other Mediterranean countries.

Thesium.

This genus occurs in various parts of the world, comprising over 50 species in tropical and over 70 in South Africa. Most of them or probably all are semi-parasites, at any rate in their youth. Their roots produce long thin threads, which attach themselves to the roots of other plants by producing a disc-shaped sucker at the point of contact.

Thesium strictum (Fig. 80), which is almost devoid of leaves, and *Th. euphorbioides* with large oval succulent leaves, both fairly frequent in the South West, are 6—8 feet high, while most other species do not exceed 1 or 2 feet.

Thesidium.

This genus principally differs from *Thesium* by its dioecious flowers and the succulent fruit, which is a kind of pseudo-drupe with a fleshy basal ring.

Thesidium fragile is not unfrequent in the Cape Flats, growing on the roots of *Metalasia muricata*, *Chymococca empetroides* and probably some other shrubs.

Grubbia.

Grubbia stricta. This species has a fairly wide distribution within the Cape region but, although evidently adapted to dry localities, it does not occur outside its limits. Shrubby; 2—5 feet high; foliage very dull, almost fawn coloured. The fruit when ripe is very conspicuous through its bright red colour and may attract birds, although there does not seem to be anything pulpy or juicy in it. It is a curious form of pseudocarp consisting of a whole inflorescence like a mulberry or pine-apple, but generally carrying only one fully developed seed. (Plate 37, D.)

Grubbia rosmarinifolia. This shrub, of similar size, is more dependent on moisture and consequently found only in swampy localities of the mountains, flowering in winter. The leaves are narrow lanceolate, but appear to be almost needle-shaped on account of the revolute margins. While the upper epidermis is glabrous, the lower side of the leaf is thickly covered with a whitish wool; but almost nothing of this woolly surface is visible, for the margins of the leaf are so strongly recurved that they nearly touch each other at the midrib, just leaving a thin white line over the latter uncovered. Transpiration through the stomata is thus impeded in a double way, firstly by the wool among which the stomata are hidden, and then by the revolute margins which form two wind-sheltered channels, through which the escaping air must pass before it reaches the outer atmosphere. The shrub is consequently well able to endure short periods of extreme dryness of the air or to withstand the exhausting effects of strong winds*.

This feature of our vegetation, which is so frequent in many genera and even entire families of the south western flora, often imparts great uniformity and monotony of appearance to the landscape; but when in flower, the various shrubs and shrublets reveal their astonishing diversity.

Fam. 9. Grubbiaceae.

(Plate 37, D, E; Figs. 81 *a* and *b*.)

Shrublets with linear or lanceolate, persistent leaves. Flowers in axillary, small glomerules, bisexual; perianth simple, 4-parted, the segments valvate, greenish, clothed with long hairs on the back. Stamens 8, with slender filaments and a short connective. Ovary inferior,

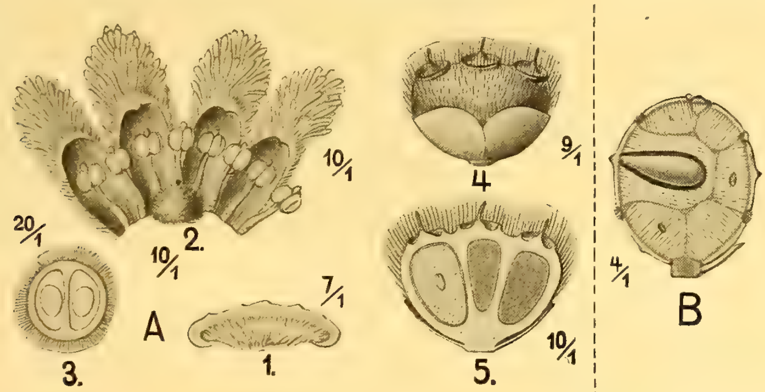


Fig. 81 *a*. *Grubbia*. A. *G. rosmarinifolia* Berg. 1. Transverse section of leaf. 7/1. 2. Flower laid open. 10/1. 3. Transverse section of ovary. 20/1. 4. Fruit (from 3 flowers). 5. Same in long. section, two cells barren. 10/1. B. *G. stricta* DC. Fruit in long. section, 4/1, the solitary seed entire.

1-celled, with a central placenta, which is joined to a septum in the bud. Ovules 2, pendulous, without integument. Fruitlets compound, only 1 of each inflorescence with a perfect seed. Seed with a thin testa, derived from the outer layer of the nucellus; endosperm oily.

* Even on the mountains of the South West occur occasional days on which the relative humidity sinks as low as 25 %.

The relationship of the family has been misunderstood by some authors. SONDER (Flor. Cap. II, 325) included it in Hamamelideae but BENTHAM placed it near Santalaceae.

One genus only of 4 species, all endemic in the Cape region.
Grúbbia*, *Berg.*

Fig. 81 *b*. *Grubbia rosmarinifolia* Berg. With *Dovea mucronata*.
Edge of a swamp on Table Mountain. 2600 feet. August.

In one section (*Ophira* L.) each inflorescence consists of 3 connate flowers, and the pseudocarp originating from it is covered with hairs, being thereby adapted to dispersal by the wind. In the other section (containing only *G. stricta*) several 3-flowered heads are joined into a cone-like inflorescence and form a sub-succulent, 1-seeded pseudocarp.

* Named after MICHAEL GRUBB, a Swedish merchant of the 17th century, who on his way home from China bought a parcel of plants collected by JOHANN AUGE, the Company's gardener at Capetown, and took them to BERGIUS at Stockholm.

Fam. 10. Olacaceae. Tribe Ximenieae.

Spiny shrubs. Flowers regular, perfect. Calyx small, 4—5-toothed. Petals 4—5, valvate. Stamens 8—10. Ovary free, divided into two stories by an internal annular projection of the wall, the lower compartment 4-celled, with a central placenta and four pendulous ovules. Fruit a 1-seeded drupe. Seed with copious endosperm and a small embryo placed near the apex.

The only S. A. genus.

Ximénia* *Plum.*

Two species, one endemic (*X. caffra*), the other one widely distributed in Tropical America and Africa (*X. americana*, called *wild plum, wilde pruim* in the Transvaal). Flor. Cap. II, 235. The seeds contain much oil, but this is very pungent.

See coloured illustration in Transvaal Agric. Journ. Vol. IV, No. 15, Plate 81.

NOTE. The genera *Apodytes* E. Mey. and *Cassinopsis* Sond. included by HARVEY in this order will be found under Icacinaceae (Vol. II).

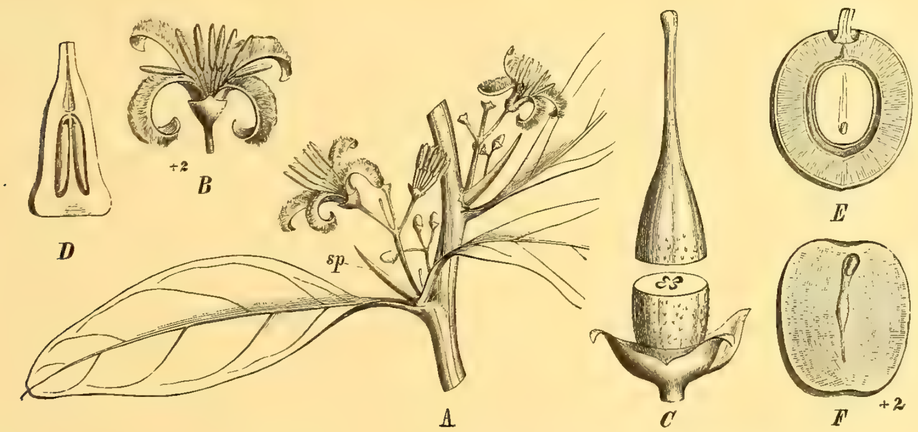


Fig. 82 *a.* *Ximenia americana* L. *A.* Twig with axillary inflorescences. *sp.* Spine. *B.* Flower. *C.* Calyx and pistil. 8/1. *D.* Long. section through ovary. *E.* Fruit, long. section. *F.* Seed with embryo. (From Engler and Prantl)

* Named after FRANZ XIMENES, a Spanish naturalist who published a book on medicinal plants (1615).

Fam. 11. Loranthaceae.

(Plates 38, 39.)

Shrubby, chlorophyll-bearing semi-parasites, with expanded or rudimentary leaves, living on trees or shrubs.

Flowers regular, but very different in the two South African genera. Ovary inferior, immersed in the enlarged receptacle. In the central tissue of the ovary (corresponding to a rudimentary placenta) several embryo-sacs originate, but generally one only develops into an embryo, rarely 2 or 3. Fruit a berry-like pseudocarp, formed by the fleshy receptacle, the pericarp (sometimes mistaken for a testa), the fleshy endosperm and the embryo. The cotyledons contain chlorophyll.

The inner layer of the receptacle becomes transformed into a viscid mass, called *viscin*, by means of which the seeds easily adhere to the beaks of birds when these eat the fruit; they are then attached to the branches of shrubs or trees by the bird in his endeavours to get rid of them, hence the colonial name "vogelent." The embryo germinates on the branch, and when the rootlet touches the bark, it develops a disc from which strands of thallus enter the bark and spread in the young wood*. [See green parts on Plate 38, C, 1.] The parasite does not draw assimilated food from the host but only water and mineral matter, appropriating the rising sap for its own work of assimilation, and thus it deprives the upper end of the branch, on which it perches, of the necessary supplies, thereby often killing it. It is sometimes said that the seed must have passed through the intestines of a bird before it is able to germinate, but one often finds germinating embryos in the unopened fruit. (*Continued on page* 169.)

* In the case of *Viscum minimum* no buds originate from the disc, but the strands of thallus within the stem of the *Euphorbia* produce little shoots, which penetrate the epidermis here and there. The parasite remains embedded in the body of the host, and only the flowers appear at the surface.

Plate 38.

A: Loranthus oleifolius *Cham. et Schl.* **B**: Viscum minimum *Harv.*
C: V. capense *L. f.*

Plate 38.

A. *Loranthus oleifolius* Cham. & Schlecht. 1. Twig with buds and open flowers, parasitic on shrub of *Royena pallens*. 2. Perianth-segment with stamen. 3. Fruiting twig, the uppermost fruit germinating. 4. Seed with germinating embryo, the pericarp removed. 5. Seed in long. section.

B. *Viscum minimum* Harv. 1. Piece of stem of *Euphorbia polygona* (not coloured), with entire fruiting plant (nat. size) of the parasite. The fruits are many times the size of the plant itself. 2. Plant with two buds. 8/1. From specimens collected near Port Elizabeth by Mr J. L. Drège.

C. *Viscum capense* L. f. 1. Twig of female plant, parasitic on a branch of *Rhus lucida* L., showing also two germinating seeds. 2. Twig of female plant in flower. 3. Female flower. 3/1. 4. Section through female flower*. *p.* Perianth. 5. Twig of male plant in flower. 6. Male flower with two bracts. 4/1. 7. Transverse section through perianth and anthers of male bud. 8. Anthers with numerous pollen chambers. 4/1. 9. Long. section through fruit (pseudoberry). 2/1. (Note the green embryo.) *p.* Pericarp. *en.* Endosperm. 10. Seeds germinating, one with two embryos.

Loranthus.

This genus of parasitic shrublets has its headquarters in Tropical Africa, where over 200 species occur, while South Africa (excl. of Rhodesia) possesses about 15. They live on various indigenous trees and shrubs, *e.g. Acacia*, *Rhus*, *Grewia*, *Euphorbia* etc. and adapt themselves also to many introduced trees, viz. poplars, willows, oak, apple, pear, fig, pomegranate etc.

An interesting case has come under the author's observation, where *Melianthus comosus*, a herbaceous or at any rate not woody plant, was infested by *Loranthus namaquanus*. The host plant is known as "*kruidje-roer-me-niet*" [see Vol. II] and occurs almost anywhere along the watercourses of the Karoo. Although it possesses injurious properties, the farmers do not experience any loss through it, as the animals do not touch it on account of its unpleasant smell. The *Loranthus*, however, like the common mistletoe (*Viscum*), is eagerly eaten by the animals, and the farmers state that they have lost goats, which had eaten some *Loranthus* that was growing on the *Melianthus*. If the animals had really not eaten some of the *Melianthus* together with the *Loranthus*, this occurrence would indicate that the poisonous principle had passed from the host into the parasite growing on it.

Occasionally some species of *Loranthus* reach a considerable size, clumps up to three feet in diameter having been observed by the author on some willows along the Groote River near Ladismith (C. C.).

As the flowers of all the South African species are brightly coloured and often very numerous, the bushes of *Loranthus* form very showy objects and attract various kinds of sun birds. The buds open gradually with slits at

* The tissue of the ovule passes so gradually into that of the wall of the ovary that one cannot readily discriminate between them. The dark portion in the centre of the figure represents the tissue which contains the embryo-sac.

their side, the perianth-segments remaining connected at their apex. When a bird inserts its beak through the slit in order to reach the nectar at the base of the tube, the segments separate suddenly and coil back, throwing the pollen of the attached stamens on the bird, thus securing the transport of the pollen to other flowers.

The fruits are large pseudoberries, with generally a red skin and a comparatively large seed. The embryo is green and sometimes germinates before the fruit is removed from the bush.

Viscum. *Mistletoe. Mistel. Vogelent.*

This genus is quite cosmopolitan, occurring in America as well as in the old world; but while there is only one species of mistletoe in Europe, viz. the common *Viscum album*, there are 12 in South Africa.

Viscum capense. This is the most widely spread species in South Africa, easily recognised by its leafless twigs and white fruit. It occurs on many kinds of shrubs and trees, particularly often however on species of *Rhus* and *Acacia*. Another equally indifferent species, as far as the host is concerned, is *V. rotundifolium*, with bright red pseudoberries which are often so numerous that the whole plant appears to be covered with them. On the other hand some species are quite partial with regard to their host, like the curious *V. minimum*, which is known to occur only on *Euphorbia polygona* near Port Elizabeth. Fig. B.

The entire plant of *V. minimum*, as far as visible, is not much larger than a pin's head, practically consisting merely of a minute thallus and two buds, each 2—3 mm. long. When the fruit is fully grown it surpasses the plant itself many times in size.

Viscum capense is dioecious, but occasionally a specimen of the one sex has developed on one of the other sex, producing an apparently monoecious plant; or two individuals of opposite sex may have started growing in close proximity to each other and formed a ***natural graft***. Similarly a *Viscum* may be found growing on a *Loranthus* or the reverse may be seen, and sometimes other parasites, like *Cassytha* or *Cuscuta*, may attack either of them as they do many other plants. The embryo of *Viscum* is also green like that of *Loranthus*, occasionally there are two or even three embryos in the same fruit. (See Plate 38, C, 10.)

Plate 39.

A. The tree represented on this plate (*Zizyphus mucronata*, Rhamnaceae, see Vol. II) had suffered so much from the numerous clumps of mistletoe on it that it was near dying.

B. *Loranthus Dregei.* The section through parasite and host shows the intimate connection between the two and the cup-shaped outgrowth of the latter, obviously caused by the stimulus exerted by the former on its host. The large holes in the wood of the parasite are caused by a grub which had lived in it.

According to Dr S. Schönland the same species causes the so-called "wood-flowers" on *Burkea africana* (Transvaal).

A

Photos R. Marloth.

B

Werner & Winter, Frankfort a/M.

A. The **CAPE MISTLETOE**
VISCUM CAPENSE L. f., parasitic on ZYZIPHUS MUCRONATA
Near Griquatown
B. **LORANTHUS DREGEI** Eckl. et Zeyher
The thallus (native name "dumba") attached to a branch of ACACIA CAFFRA

Plate 40.

Mystropetalon Thomii *Harv.*

The ancients used to gather the fruit in order to prepare bird lime from it, and as the birds often plant the seeds themselves a Roman writer refers to this relation between bird, plant and man as follows:

"ipsa sibi avis mortem creat, cum *Viscum* serat, quo postmodum ab aucupibus capiatur." PLAUTUS

The mistletoes contain much less tannin than some of the host-plants on which they grow, hence they are eagerly eaten by grazing animals in the Karoo and other arid regions. In times of drought the farmers who live along the river beds of the Karoo, cut off those branches of the acacias which bear mistletoes (*Viscum capense* and *V. rotundifolium*), thus making the latter accessible to their stock.

Over 600 species, belonging to 21 genera, especially numerous in the Tropics. Two S. A. genera.

A. Flowers bisexual, showy, ornithophilous, perianth tubular in bud, the 4—6 segments elastically separating when touched by the beak of a nectar-seeking bird (*Cinnyris*).
Over 300 species, of which 20 in S. A. **Loránthus** *L.*

B. Flowers unisexual, monoecious or dioecious, greenish and inconspicuous; perianth-segments small, bearing the anthers on their face; anthers with numerous pollen-bearing chambers, which open by pores. ♀ flowers with a short capitate stigma. Pseudocarp scarlet or white.
Over 60 species, 12 in S. A. **Viscum** *Tourn.*

Plate 40.

Fam. 12. **Balanophoraceae.**

Mystropetalon Thomii Harv.

Plant parasitic on a root of *Protea mellifera*; the shoot on the right-hand side in the first (female) stage, the spike on the left with ripe fruits below and male flowers above, the latter visited by a bee.

1. Female flower surrounded by the bracts. 4/1. 2. Female flower, without the bracts, showing the globular receptacle, the ovary, the limb of the perianth (nectary) and the style. 3. Long. section through nectary, ovary and receptacle. 6/1. 4. Male bud with supporting bracts. 3/1. 5. Male flower with supporting bracts, open, showing the two stamens. 3/1. 6. Pollen grain. 500/1. 7. Fruit with persistent bracts, the two lateral bracts larger than at flowering time. 2/1. 8. Fruit with enlarged receptacle, transformed into an ***elaiosome*** (*el*). 8/1. 9. Long. section through fruit (achene) and elaiosome. Embryo (*em*) apical, very minute. 10/1. 10. Ants carrying fruits into their nest. 11. Young plant of *Protea mellifera*, three years old, with a young thallus of *Mystropetalon*. The leaves of the *Protea* are all vertical, as in many other species of Proteaceae, especially when the plants are young.

Fam. 12. Balanophoraceae (S. A.).

(Plates 40—42.)

Fleshy root-parasites with bract-like, coloured leaves.

Flowers unisexual, monoecious or dioecious, in dense heads or spikes. Male perianth tubular, limb 3-parted, the segments spoon-shaped, valvate in bud. Stamens 2 or 3. Female perianth rudimentary, limb 3-parted (*Mystropetalon*) or perianth 0 (*Sarcophyte*). Ovary inferior, 1-celled; placenta central, with 3 pendulous, nude embryo-sacs (*Mystropetalon*), or the latter embedded in the ovarial tissue. Fruit different in the two South African genera. Seed with large-celled granular endosperm.

Forty species of which 12 belong to *Balanophora* (East Indian Archipelago), while most of the other genera (13) consist of 1 or 2 species only.

Two South African genera.

A. Flowers in dense, fleshy, monoecious spikes, each flower supported by 3 coloured bracts, the male flowers uppermost; ♂ flower with 2 stamens; ♀ flower seated on a globular, fleshy receptacle, the ovary completely embedded in and fused to the perianth-tube; limb of perianth 3-parted, crowning the ovary and acting as a ***nectary***. Fruit an achene or more accurately a pseudonut, inserted on the enlarged receptacle. Thallus small, irregular, attached directly to the roots of the host.

Two species, dark red or crimson, parasitic on the roots of Proteaceae. Flor. Cap. II, 573.

1. **Mystropétalon**, *Harv.*

B. Dioecious, the sexes different. ♂ flowers with 3 stamens, the anthers multilocular. ♀ flowers without a perianth, aggregated in small globular heads, their ovaries fused together, the stigmas peltate. The heads arranged in a much branched inflorescence. Fruit a syncarp, each capitulum developing into a 1-seeded, globose pseudoberry. Thallus fleshy, swollen, directly attached to the roots of the host-plant (*Acacia*, *Ekebergia*).

One species only (*S. sanguinea*), a dark red parasite of the Eastern Province and East Africa*. Flor. Cap. II, 573.

2. **Sarcóphyte**, *Sparrm.*

* The East African plant is somewhat different and may be another species.

(Plate 41 is facing page 171.)

Photo. A. Fuller. ♀ A ♂

Photo. R. Marloth. B Werner & Winter, Frankfort a/M.

A. **SARCOPHYTE SANGUINEA** Sparrman

(1/2 nat. size)

B. **MYSTROPETALON THOMII** Harvey

Group of plants with some old capitula of the host plant (PROTEA MELLIFERA)

Caledon May

Plate 41.

Sarcophyte sanguinea *Sparrm.*

Plate 41.

Sarcophyte sanguinea Sparrman

1. Female plant parasitic on root of *Acacia caffra*. 2. Twig of male plant. 3. Male flower. 3/1. 4. Transverse section through anther, showing the numerous pollen chambers (after Engler and Prantl). 15/1. 5. Pollen grains, cohering in lumps. 275/1. 6. Section through female capitulum. 5/1. 7. Median section through portion of female capitulum, corresponding to one flower. 14/1. 8. Transverse section through portion of capitulum representing one ovary with its three embryo-sacs.

Mystropetalon.

This genus consists of two species which occur in the Caledon district, extending westwards nearly to Sir Lowry's Pass. Both are parasitic on the roots of Proteaceae, principally on *Protea mellifera*, but we have seen *M. Thomii* also on *Protea longifolia* and *Leucadendron salignum*. It is quite possible that more species may be attacked by the *Mystropetalon*, but as *P. mellifera* is very common in the district and as its roots spread for several yards beyond the outskirts of the bush, it is not easy to find a patch of the parasite at a sufficient distance from this species to be sure of the real host.

The thallus does not put out any rootlets, like the *Harveya*, but as soon as the seedling has germinated in contact with a root of *Protea*, it gradually increases in size until sufficiently large for the production of the flowering shoots (spadix), a process which may require several years. During the development of the flowers of the lower portion (♀) of the spike, in a centripetal direction, the buds of the upper portion (♂) remain small; hence when the time for the development of the male flowers comes all female flowers are withered, some carrying ripe fruits at that period.

The flowers secrete an ample supply of nectar, which attracts birds, flies and bees, but there does not seem to be any scent about them. The receptacle increases in size during the development of the fruit, finally becoming filled with fat. Ants gather the fruitlets on account of this fatty appendage (*elaiosome*) and carry them into their subterranean nests*; the fruits are thus dispersed in various directions and buried at a sufficient depth in the soil to enable the haustorium formed by the germinating seed to reach the root of a *Protea*. The flowers mostly appear when the autumnal rains have soaked the ground (April, May), but if these come too late, the plant appears to remain dormant until the warmer spring weather sets in.

Sarcophyte.

Sarcophyte sanguinea. This plant occurs in the eastern and north eastern districts on the roots of *Acacia caffra* and, as stated by Harvey, also on

* The author has found the seeds in the nests deprived of the gynophore.

(Plate 42 is facing page 170.)

Ekebergia capensis (Meliaceae). The sexes are different in appearance, and Miss ALICE PEGLER at Kentani, who has devoted much time to the study of the plants in her neighbourhood, informs us that one often finds only one sex represented within a considerable area. Both kinds of flowers emit a strong smell of decaying meat and are visited by small flies.

The thallus grows to a considerable size, resembling a large tuber, sometimes more than six inches in diameter; when fully developed it produces the flowering shoot or shoots, the male plants being more branched than the others (see Plate 42, A). The colour of both is a very dark red, resembling, especially in the female plant, that of dry flesh.

As with various other parasites, *e.g. Viscum*, there is a considerable reduction in the development of the ovary, the tissues corresponding to the ovary, ovule and embryo-sac passing imperceptibly into each other. In sections taken directly from the living plant no dividing lines are visible, and it is only by a slightly different transparency that one can recognise the tissues corresponding to these organs.

Fam. 13. Aristolochiaceae.

This family is represented in Africa by the widely spread genus *Aristolochia*, which includes herbs as well as climbing shrubs, but all the African species possess the latter habit.

Flowers bisexual, zygomorphic; perianth simple, corolloid, gamophyllous, often tubular. Stamens 6, connate with the style, the anthers extrorse. Ovary inferior, 6-celled, with numerous ovules in each cell; style short and stout, the stigma 6-lobed. Fruit a capsule; seeds albuminous.

The only genus.

Aristolóchia *L.*

Numerous species in America and Asia, a few in Europe, and about 40 in Africa, one of them, *A. Petersiana*, coming within our limits in the Northern Transvaal*.

* Collected by BAINES (Flor. Trop. Afr. Vol. VI, sect. 1).

The flowers of *Aristolochia* are adapted to pollination by insects, especially by small flies, which are attracted by the dull colour of the flowers and the fetid smell which most of them emit. The flowers are protogynous, the

Fig. 82 *b*. *Aristolochia Petersiana* Klotzsch. A. Branch with a leaf and two flowers. 3/4. B. Flower in longitudinal section. 3/2. C. The ovary and gynostegium. 3/1. From specimens collected in East Africa.

stigma being receptive while the anthers are still closed. Flies which have entered a freshly opened flower are barred from leaving it at once by various contrivances. In some species, as in the often cultivated European *A. Clematitis*, the upper and narrow part of the perianth-tube is guarded by reversed bristles which point inwards, so that until these bristles shrivel the insects will not be able to escape. The shrivelling, however, takes place only after the anther-cells have opened and the pollen becomes exposed; hence the escaping flies, coming in contact with the anthers, necessarily carry away some of the pollen and deposit it on the receptive stigma of another flower in an earlier stage.

Several species are cultivated in gardens and on trellises, among them the European *A. Clematitis*, the North American *A. Sipho* (Dutchman's pipe), the South American *A. brasiliensis*, which has a 2-lipped perianth, and *A. gigantea*, with a large salver-shaped flower.

Fam. 14. Rafflesiaceae. Tribe Cytineae.

(Plate 43.)

Fleshy root parasites. Inflorescence few-flowered, racemose. Dioecious.

Calyx tubular, regular, 4- or 6-parted, with 4 or 6 large nectariferous cavities between the perianth-segments. Male flowers: stamens 8 or 12, sometimes a few abortive, all united into a central column with vertically placed anthers and short projecting connectives. Female flowers known of one species only: ovary inferior, 1-celled, showing the 6 nectariferous tubes as swollen ridges on its outer side; style thick, the stigma fleshy, capitate, faintly radiate-lobed; placentae 12, parietal; ovules very numerous.

To this family (Tribe Rafflesieae) belongs the famous *Rafflesia Arnoldi*, the largest flower known, which has a diameter of over 3 feet. It is parasitic on the roots of a climbing *Cissus* in the forests of Sumatra.

Pilostyles aethiopica (Tribe Apodantheae), a tiny, blood red parasite only a few millimetres in diameter, occurs in clusters on the branches of trees in Angola and Rhodesia.

The only genus. Flor. Cap. Vol. v, 1, 485.

Cýtinus *L.*

Plate 43.

A: Cytinus dioicus *Jussieu* B: C. capensis *Marl.*

Plate 43.

A. *Cytinus dioicus* Jussieu

1. Male plant, parasitic on *Relhania ericoides* from Porterville Road. 2. Male flower, three perianth-segments removed. 3. Antheriferous apex of staminal column. 3/1. 4. Female flower, three perianth-segments removed. 5. Female flower, without the perianth. 6. Transverse section of ovary [Fig. 6 after Harvey].

B. *Cytinus capensis* Marl. (Trans. Roy. Soc. S. A. Vol. II, 1912) 1. Male plant. 2. Segment of perianth, outer side. 3/2. 3. Transverse section through portion of perianth. 3/1. 4 and 5. Trichomes of perianth. 5/1.

Cytinus.

The genus *Cytinus* consists of four species; one being parasitic on the roots of *Cistus* shrubs in the Mediterranean countries, one occurring in Madagascar and two at the Cape.

Fig. 82 *c*. *Cytinus capensis* Marl. 1/4 nat. size. Parasitic on the roots of *Metalasia muricata*. From Cape Flats. Photo. E. Dyke

Cytinus dioicus. This species has been observed in various parts of Southern Cape Colony from Saldanha Bay to Kaffraria; it appears to be parasitic upon several species of plants, being recorded from *Agathosma* (*fide* Bolus), *Selago* (*fide* F. C. Kolbe), *Eriocephalus* (*fide* Harvey) and *Relhania ericoides.* The two sexes are very similar in appearance and as occasionally they occur together in one lump, one might mistake such a case for a monoecious plant.

The colour varies; the specimens seen by the author were all bright orange, varying occasionally towards a more yellow or reddish tint, but Miss

Pegler states that at Kentani (Transkei) she has seen it a deep red. In the Western Province the plant flowers in spring, the total length of the shoots inclusive of the raceme of three to four flowers being 3—4, or rarely 5 inches, but the stem is not visible, as only the flowers appear above the surface of the ground, generally hidden between the shrublets on which the plant grows.

It is not known what visitors are attracted by the flowers, but from analogy we should think them to be sun birds, as the pollen is very coherent, the grains being white, globose and slightly three-lobed.

Cytinus capensis. Until recently *C. dioicus* was the only species of *Cytinus* known from South Africa, but in August 1910 Mr E. Dyke found the original from which our figure of this new species is drawn. The locality is near Zeekoe Vlei on the Cape Flats, and although Mr Dyke, on learning what an interesting find he had made, searched the neighbourhood repeatedly, he found only one other specimen of it, also a male plant, hence the other sex is not known as yet. The plant grows on the roots of *Metalasia muricata*, not in lumps near the main stem, like *C. dioicus*, but as a row or series of isolated shoots out of a horizontal root of the host, only the apex of the corymbose racemes projecting above the sandy soil. The flowers are 4-merous, like those of *Cytinus Hypocistis*, but dioecious and not monoecious as in that species. The perianth-segments are a deep claret and have a curious kind of covering, the short trichomes being lobed and divided in various ways.

Fam. 15. Hydnoraceae (S. A.).

(Plate 44.)

Fleshy root-parasites with a creeping thallus. Flowers bisexual, regular. Perianth fleshy, 3- or 4-parted*, the segments valvate. Stamens 3 or 4, compound, inserted just below the mouth of the perianth, each one with numerous vertical pollen-cells, connate into a 3- or 4-lobed fleshy ring. Ovary inferior, 1-celled; stigma broad, fleshy, 3- or 4-lobed, each lobe formed of many parallel lamellae, the upper ends of the placentae, which have numerous ovuliferous processes hanging from the roof of the ovarian cavity. Ovules orthotropous, with 1 integument. Seeds numerous, minute, with perisperm and endosperm.

Two genera of root-parasites, *Hydnora* (Africa) and *Prosopanche* (2 species) in the Argentine.

The only S. A. genus. Flor. Cap. v, 1, p. 486.

Hydnóra *Thunb.*

* One East African species (*H. abyssinica*) has a 5-merous variety, and the common S. A. species (*H. africana*) has occasionally a 4-lobed perianth.

Plate 44.

Hydnora africana *Thunb.*

Plate 44.

Hydnora africana Thunb.

1. Thallus attached to root of *Euphorbia mauritanica*, with two buds and a fully developed flower, the latter visited by a carrion beetle, *Dermestes vulpinus*. 2. Section through thallus and the root of the host. 3. Flower at an early stage, long. section, one perianth-lobe and part of androecium removed. *bb*. Bait-bodies with larva of *Dermestes* feeding on one of them. *a*. Androecium. *st*. Stigma. *pl*. Placentae. *o.c*. Ovarial cavity. 4. Transverse section through perianth-segment. 5. Part of fig. 4 enlarged. 6. Androecium. 7. A slice of the androecium with two pollen cells. 2/1. 8. Transverse section through three pollen cells. 5/1. 9. Pollen grains (two views). 275/1. 10. Stigma. 11. Some placentae (pendulous), with numerous ovules. 3/1. 12. Lump of seeds from fruit pulp. Nat. size. 13. Seed. 10/1. 14. Seed in long. section. 20/1. *em*. Embryo. *e*. Endosperm. *p*. Perisperm, filled with starch. 15. Beetle found feeding on bait-body in flower: *Cryptochile costata* (Fam. Tenebrioidae).

Hydnora.

The genus consists of eight species, three of which occur within our limits, one, viz. *Hydnora Solmsiana*, having been recently described from German South West Africa.

Hydnora africana. This species grows principally on the roots of *Euphorbia mauritanica*, sharing the wide distribution of this shrub in South Africa from the Karoo of Worcester to the tropical parts of Great Namaqualand. It is, however, not confined to this species of *Euphorbia* as its host, for we have also observed it on *Euphorbia decussata* in the Karoo and on *E. gummifera*, *E. gregaria* and *E. lignosa* in the Namib and other parts of Great Namaqualand.

The thallus or underground stem of the parasite is stout, 5- or 6-angled and warty on the surface, spreading horizontally in the ground a few inches below the surface. It does not produce any roots or rootlets, but when it comes into contact with a root of the *Euphorbia* it sends strands of its tissue into it, thereby causing an increased growth of the attacked root and finally producing quite a large knob through which the parasite diverts the descending sap of the *Euphorbia* into its own body. When sufficient material has accumulated in the thallus it produces buds, which on increasing in size, finally break through the surface of the ground and open just above it, the ovary remaining underground.

The whole plant is highly impregnated with tannin, and is therefore safe from the attacks of herbivorous animals, but each perianth-lobe bears a pure white, spongy body, which is free from tannin and at the same time rich in albuminous matter*. This substance soon decays, producing the smell of old meat, but even when quite fresh it acts as a bait for carrion beetles. These, having once entered the flower, are prevented from leaving it by a fringe of hairs and bristles on the margins of the perianth-lobes, and must

* This organ was first described and figured by ROBERT BROWN, being called by him "pulvinulus carnosus." See BROWN's beautifully illustrated essay "On the female flower and fruit of *Rafflesia Arnoldii* and on *Hydnora africana*." Trans. Linn. Soc. 1844, p. 235. Later authorities, however, appear to have overlooked BROWN's statement, as these fleshy bodies are not mentioned by them.

perforce remain in the flower for several days until the bristles shrivel and allow the insects to escape. As the stigma is fully developed before the anthers shed their pollen, a flower which has just opened will be in the receptive stage, while after some days when the insects leave it, fresh pollen will be available to be carried to another flower; thus cross pollination is secured.

Up to the present the author has observed three species of carrion beetles in the flowers of *Hydnora africana*, and in one case (*Dermestes*) also the larvae feeding on the bait-bodies. The most common one, at any rate near Worcester, is *Dermestes vulpinus*, the much dreaded destroyer of specimens in collections of Natural History all over the world. Whether this insect is originally South African or not, cannot be said, for it is now cosmopolitan, and it is not impossible that some stray introduced individuals may have reached the Hydnoras and settled among them.

The fruit develops underground into a globular body, the placentae becoming modified into a gelatinous, starch-bearing mass in which the tiny seeds are embedded; morphologically such a fruit would be called a pseudo-berry or pulpy pome, like the guava. Porcupines, baboons and jackals* dig up the fruits, eat the pulp and naturally carry the seeds to their haunts among the bushes, thus securing the dissemination of the plant.

The dry thallus is collected and used for tanning leather.

Hydnora triceps, with 3-flowered shoots, is of similar size: it is known only from Little Namaqualand.

Hydnora Solmsiana has, like the two Abyssinian species, a 4-lobed perianth, which is on the outside of a lighter colour than that of *H. africana*. The inner side is pale salmon or the colour of the human skin. The perianth-lobes are not fringed on the margin like those of *H. africana*, but a broad belt on both sides of the central depression is thickly studded with bristles directed towards the centre. The androecium is much elongated, while the stigma is nearly flat, both being 4-merous. Does not emit the smell of bad meat.

Some of the flowers found by Mr C. Bohr near Windhuk contained large numbers of a small beetle (*Carpophilus binotatus*), which apparently feeds on the white and tender coat lining the margin of the central depression of the perianth-lobes. (See Fig. 82 *d*, 3.) There is no central bait-body here as in *H. africana*, but the edges of the central depression and the belt alongside it, as far as the bristles occur, are covered with a layer of a pure white, spongy substance, which, on the specimen received by us, showed signs of nibbling by insects. As the bristles point inwards they evidently allow the entry of the beetles, but not their escape. Dr L. Péringuey informs us that these beetles generally live on decaying fruits.

Hitherto found only on the roots of *Acacia horrida* in Great Namaqualand (Keetmanshoop) and Hereroland (Windhuk), where it appears after the first rains in December.

* Hence the colonial name "*bariaankost*" or "*jakhalskost*." The hottentots call it "*kanni*."

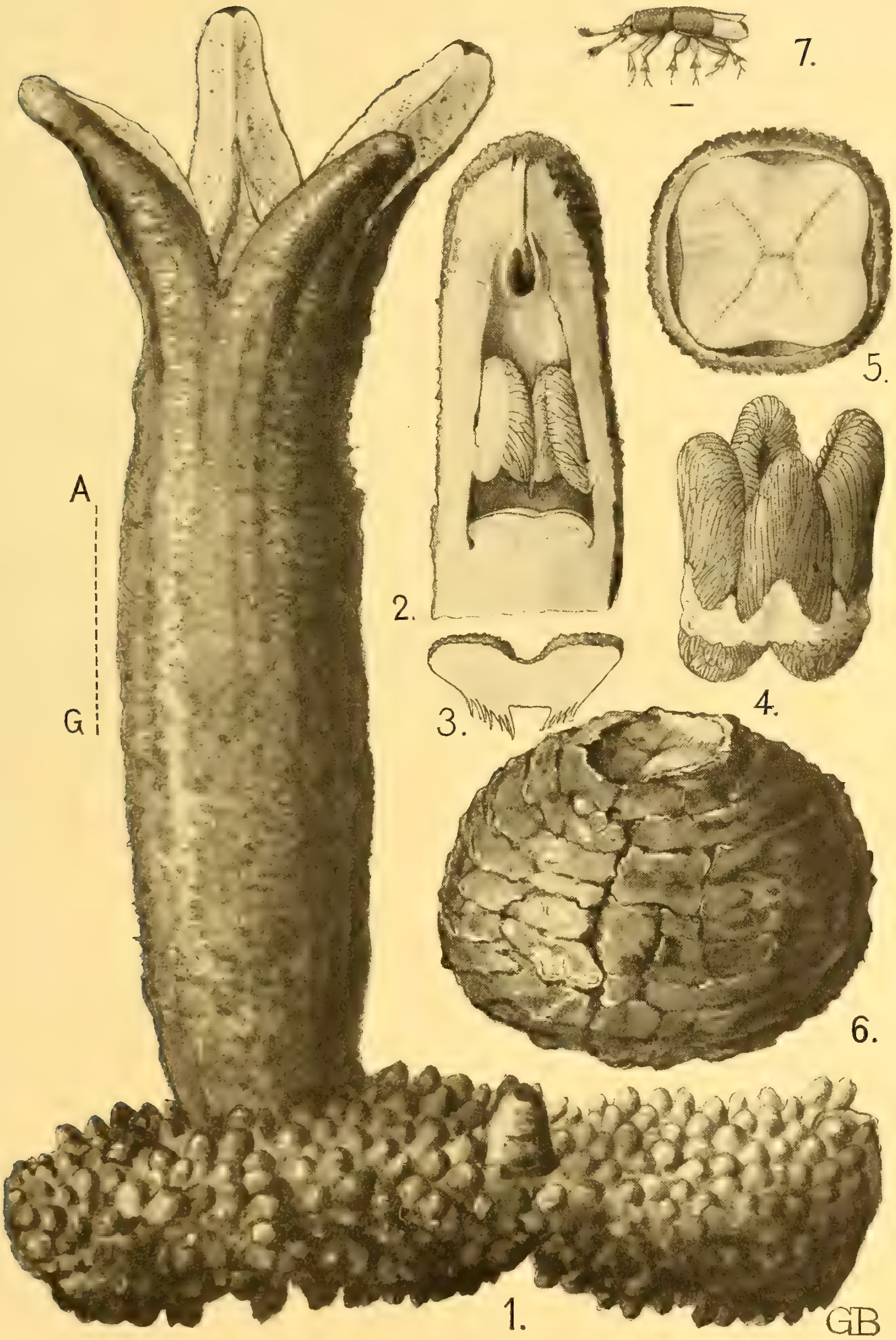


Fig. 82 *d.* *Hydnora Solmsiana* Dinter. 1. Plant, nat. size. 2. Segment of perianth, seen from within. 3. Transverse section through perianth-segment. 4. Androecium. The position of the ring of tissue by which it is attached to the perianth is indicated in fig. 1 by the letter A and the position of the gynaeceum by the letter G. 5. Gynaeceum, seen from above. 6. Fruit, nat. size. 7. Beetle from flower (*Carpophilus binotatus*). 3/1.

Fam. 16. Polygonaceae.

Herbs or rarely shrubs with swollen joints. Leaves alternate, dilated at base into a membranous, stem-clasping sheath (*ochrea*). (Plate 47, page 189.)

Flowers regular, bisexual or unisexual and then monoecious or dioecious. Perianth simple, either green or

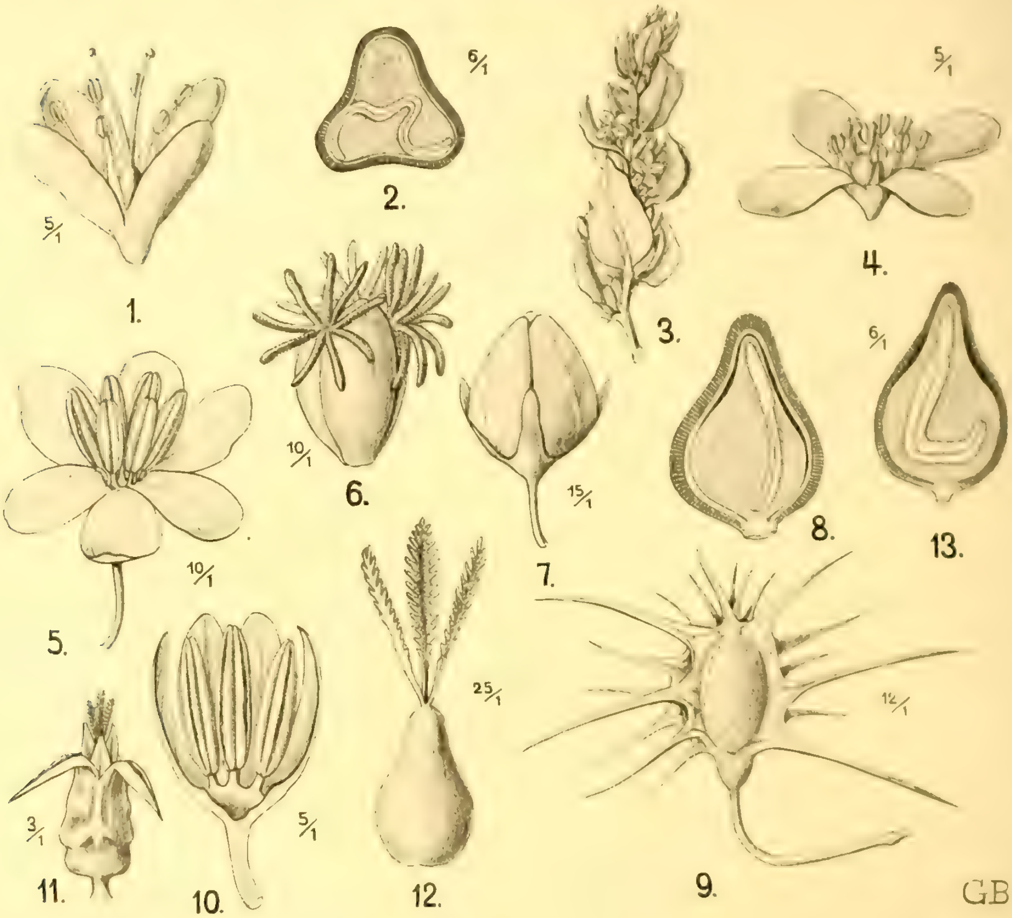


Fig. 83. Polygonaceae. 1-2. *Polygonum serrulatum* Lagasca 1. Flower. 5/1. 2. Fruit, transverse section. 6/1. 3-4. *P. atraphaxoides* Thunb. 3. Twig, in flower. 4. Flower. 5-8. *Rumex acetosella* L. 5. ♂ flower. 6. ♀ flower. 10/1. 7. Fruit with enlarged perianth. 8. Same in long. section. 9. *Rumex gariepensis* Meisn. Fruit. 12/1. 10-13. *Emex australis* Steinh. 10. ♂ flower in long. section. 5/1. 11. ♀ flower. 12. Pistil. 25/1. 13. Fruit, without the spiny perianth, in long. section. 6/1.

coloured, 3—6-parted, persistent, often enlarging with the fruit. Stamens 4—9, mostly 6—8; filaments filiform, anthers 2-celled. Ovary superior, 1-celled, ovule solitary, erect; stigmas 2—3. Fruit a nut with ample farinaceous endosperm; embryo inverted, straight or curved.

Over 600 species in various parts of the world, comparatively few in S. A., among them *Polygonum atraphaxoides* with mostly 4-merous flowers. (Fig. 83, Nos. 3, 4.)

Ecology. Flowers wind- or insect-pollinated. The fruitlets are adapted in various ways to dispersal by wind, water or animals by means of wings, spongy tissues and hooks or spines. In most cases it is the persistent perianth which becomes modified, sometimes the peduncle or the axis of the inflorescence.

Some species are cultivated on account of the farinaceous endosperm, viz. *Fagopyrum esculentum* (buckwheat), from Eastern Asia, others for ornamental purposes, *e.g.* *Rheum Collinsianum* and *Rh. nobile*; or as vegetables (rhubarb, the young leaf-stalks of several other species of *Rheum*). *Rh. officinale* and *Rh. palmatum* (China) yield the drug known as rhubarb-root (the rhizome).

Rumex Acetosella (*sheep sorrel, Steenbok-zuring*) and *Emex australis* (*Duiveltjes-doorn*) are troublesome weeds: the former may be combated by liming the soil, the latter, like the nearly allied *E. spinosa*, only by weeding. (Flor. Cap. v, 1, 459.)

SYNOPSIS OF GENERA.

A. Perianth herbaceous, greenish, 6-fid, in 2 whorls of 3 each; stamens 6; stigmas penicillate.

a. The 3 outer perianth-segments enlarging with the fruit, spiniferous at the apex and back. (Plate 47, E, page 191. Fig. 83.)
1 S. A. species, *E. australis*. 1. **Emex** *Neck.*

b. The 3 outer perianth-segments remaining small, the 3 inner segments enlarging, veiny, membranous, enclosing the fruit.
Over 100 species, 19 in S. A. (*Dock, zuring*). (Fig. 83.)
2. **Rumex** *L.*

B. Perianth coloured, 5-fid (1 spec. 4-fid); stamens 8; stigmas capitate.

a. Perianth-segments free; fruit mostly compressed or 3-cornered, not winged. (Plate 47, A, page 191.)
Over 150 species, 18 in S. A. 3. **Polýgonum** *L.*

b. Perianth-segments of fertile flower connate into a tube. Nuts mostly winged.
7 species. E and No. 4. **Oxýgonum** *Burch.*

Fam. 17. Chenopodiaceae.

(Plates 45, A—D, 46.) Flor. Cap. Vol. v, Sect. 1, 433.

Herbs or half-shrubs with alternate, exstipulate leaves and greenish or yellowish, inconspicuous flowers. Flowers bisexual or unisexual and then monoecious or dioecious.

Perianth herbaceous or occasionally absent, mostly 5-parted (rarely 4—2-parted), persistent, mostly enlarging with the fruit and enclosing it. Stamens as many as the perianth-segments, opposite them, inserted at their base, incurved in the bud. Pollen grains globose, with numerous pores (20—40). Ovary superior or nearly so, free, unilocular; ovule solitary, campylotropous, attached to a basal funiculus; styles 2—4. Fruit a nut, enclosed in the persistent perianth; pericarp membranous. Seed either with farinaceous perisperm (not endosperm) or without reserve-tissue. Embryo peripheric, clasping the perisperm, or, when this is absent, spiral or folded.

Ecology. Many species are ***halophytes***, occurring in the neighbourhood of the sea or in other saline localities, especially also in arid regions, where the soil is often rich in chlorides (common salt) and sulphates (Glauber's salt). The adaptations to their existence in such regions are numerous and often very elaborate. Various kinds of hairs occur on leaves and stems, often as a woolly layer (*Salsola Zeyheri*). Others produce inflated, bladder-like, pedicillate hairs, which contain a saline sap when young, but shrivel up later on, forming a white, powdery (mealy) layer on the leaf, thus removing the excess of saline matter from the tissues, while by the same device the leaves obtain protection against excessive transpiration (*Atriplex Halimus*). Others are succulents, where the excess of salt is removed with the old leaves, *e.g. Salsola aphylla* (*Ganna*). The wood of the shrubby species shows a remarkable anomaly, the fibrovascular bundles being scattered as in monocotyledonous stems or arranged in several circles.

(Plate 45 is facing page 186.)

Photo P. Marloth Werner & Winter Frankfort a/M

SALSOLA APHYLLA L. The **GANNA** bush.
The stunted shape of the shrublets is due to the nibbling of goats.
In the foreground an old thorntree (ACACIA HORRIDA).
Tanqua Karroo, at the base of the Little Roggeveld Mountains

Pollination is often effected by insects in spite of the inconspicuous nature of the flowers. The fruitlets are mostly dispersed by the wind, the persistent perianth being enlarged in various ways.

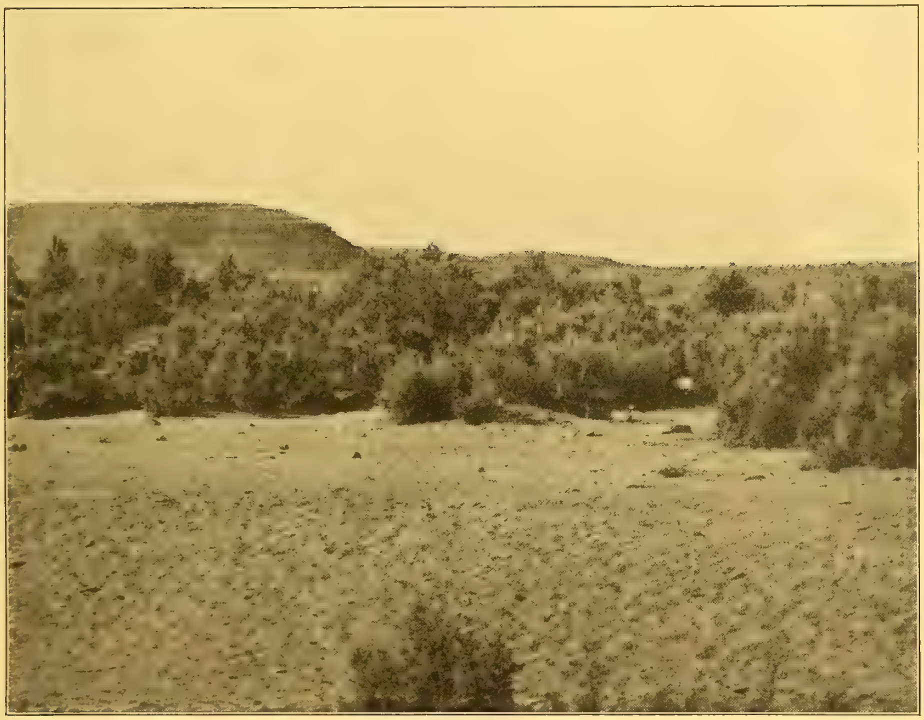


Fig. 84 *a*. *Salsola aphylla* L. f. The Ganna. Bed of the Dwyka river (Karoo).

There are over 500 species, especially in the temperate zones, several of them of the highest importance to man. *Beta vulgaris* var. *Rapa* is cultivated in several forms. One of these is the sugar-beet (annual production of sugar nearly 7 million tons); another is the red beetroot and a third the mangold (mangel-wurzel). *Spinacia oleracea* is the ordinary spinach plant. Of great importance to South Africa as fodder plants are *Salsola aphylla*, the *ganna* or *brakganna*, *S. Calluna*, the *rooi ganna* and *S. Zeyheri*, the *bloemkool-ganna* (Carnarvon etc.), and the *saltbush*, *Atriplex Halimus*. Recently some *Australian saltbushes*, viz. *A. nummularia*, *A. semibaccata* and *A. halimoides*, the latter two prostrate, herbaceous plants, have been artificially spread in the country. Some are common weeds, *e.g.* *Chenopodium murale* (*goosefoot*) and *Atriplex patula* (*melde*).

Fig. 84 *b*. Lagoon near Lüderitzbucht at high tide. *Salicornia natalensis* Bunge, intermingled with *Chenolea diffusa* Thunb. The grass is *Agropyrum distichum* Beauv.

KEY TO THE GENERA.

(See also Flor. Cap. Vol. v, Sect. 1, 433.)

A. **Cyclolobeae.**

Embryo annular or horseshoe-shaped, surrounding the copious perisperm. (In *Salicornia* conduplicate, without perisperm.) (Plate 45, A, 4.)

a. Stems not jointed, leafy. Leaves pedicellate, expanded, entire, deeply lobed or dentate.

I. Flowers bisexual, without supporting bracts.

1. Ovary depressed. Perianth-lobes not accrescent in fruit. Seed horizontally lenticular. Leaves mostly farinose, glandular.
About 60 species, 10 of them in S. A., probably all introduced (as weeds). Flor. Cap. 435.
1. **Chenopódium** *Tourn.*

2. Ovary globose. Perianth-lobes accrescent in fruit. Seed erect.
One introduced species. Flor. Cap. 440.
2. **Roubiéva** *Moq.*

II. Flowers unisexual, the ♀ bracteate, but without perianth. Seeds erect. (Plate 45, A, 2, 3, 4.)

1. Monoecious. Bracts of ♀ flowers small, not enlarging with the fruit. Leaves white, scurfy.

E. axyrioides (*hondebosje*), the only species is a low half-shrub of salty ground. Endemic. Flor. Cap. 441.

3. **Exomis** *Fenzl*

2. Monoecious or dioecious. Bracts of ♀ flowers enlarging with the fruit and enclosing it. Plants mostly "mealy." (Plate 45, A, B.)

About 120 species, 11 in S. A., mostly introduced. (Incl. *Obione* ex Harvey, Gen.) Flor. Cap. 442.

4. **Atriplex** *Tourn.*

b. Stems not jointed. Leaves linear or subterete, sessile.

I. Segments of fruiting perianth not dorsally winged. Flowers axillary. Styles 2. Leaves silky.

(*Ch. diffusa*, a widely spread seashore plant.) (Fig. 84 *b.*) (Syn. *Echinopsilon.*) Flor. Cap. 447.

5. **Chenólea** *Thunb.*

II. Segments of fruiting perianth dorsally winged; styles 2, filiform. Villous herbs or half-shrubs.

Several in S. A. Flor. Cap. 447.

6. **Kóchia** *Roth*

c. Stems or branches jointed, succulent. The flowers in the axils of fleshy, scale-like leaves. (Plate 45, D; Fig. 84 *b.*)

3 S. A. species, herbaceous or half shrubby. Flor. Cap. 448.

7. **Salicórnia** (*Tourn.*) *L.*

B. **Spirolobeae.**

Seeds without perisperm; embryo spiral. (Plate 45, C, 8.)

a. Bracts minute; fruiting perianth not dorsally winged.

Two S. A. species; one (*S. fruticosa*), the ***Inkbush***, a widely spread plant.

Flor. Cap. 450. 8. **Suaeda** *Forsk.*

b. Bracts as large as, or larger than, the perianth. Fruiting perianth hardened, with a broad horizontal wing.

(Plates 45, C and 46; Fig. 84 *a.*)

About 40 species, 5 in S. A. (Syn. *Caroxylon.*)

Flor. Cap. 451. 9. **Sálsola** *L.*

Plate 45.

Fam. 17. Chenopodiaceae.

A. *Atriplex Halimus* L. 1. Flowering twig; nat. size. 2. ♂ flower. 3. ♀ flower. 3/1. 4. Seed, long. section, showing the annular embryo and the central perisperm. 5. Fruit, winged. 2/1.

B. *Atriplex halimoides* Lindl. Fruit (naturally inflated). 3/1.

C. *Salsola aphylla* L. f. but figs. 1 and 4 from *S. Zeyheri* (Moq.) Schinz. 1. Flowering twig. 2. Leaf. 3/1. 3. Leaf in transverse section. 4. ♂ flower. 5. ♀ flower in long. section. 6. Fruit. 7. A single fruitlet. 8. Embryo. 10/1.

D. *Salicornia herbacea* L. 1. Twig. 2. ♂ flower. 20/1. 3. ♀ flower in long. section. 20/1. 4. Fruit. 3/1.

Fam. 18. Amarantaceae.

E. *Cyathula globulifera* Moq. 1. Twig in fruit. 2. Fruitlet with its bristles. 3. Seed. 4. Seed in long. section. 6/1. 5. Embryo. The burrs of this plant often adhere to wool.

F. *Achyranthes aspera* L. 1. Twig. 2. ♂ flower. 3. ♀ flower with its bracts. 4. Fruit. 9/1.

Fam. 18. Amarantaceae.

Herbs or shrublets with opposite or alternate, exstipulate leaves and small flowers, which are crowded together into capitate or capitate-spicate inflorescences (glomerules).

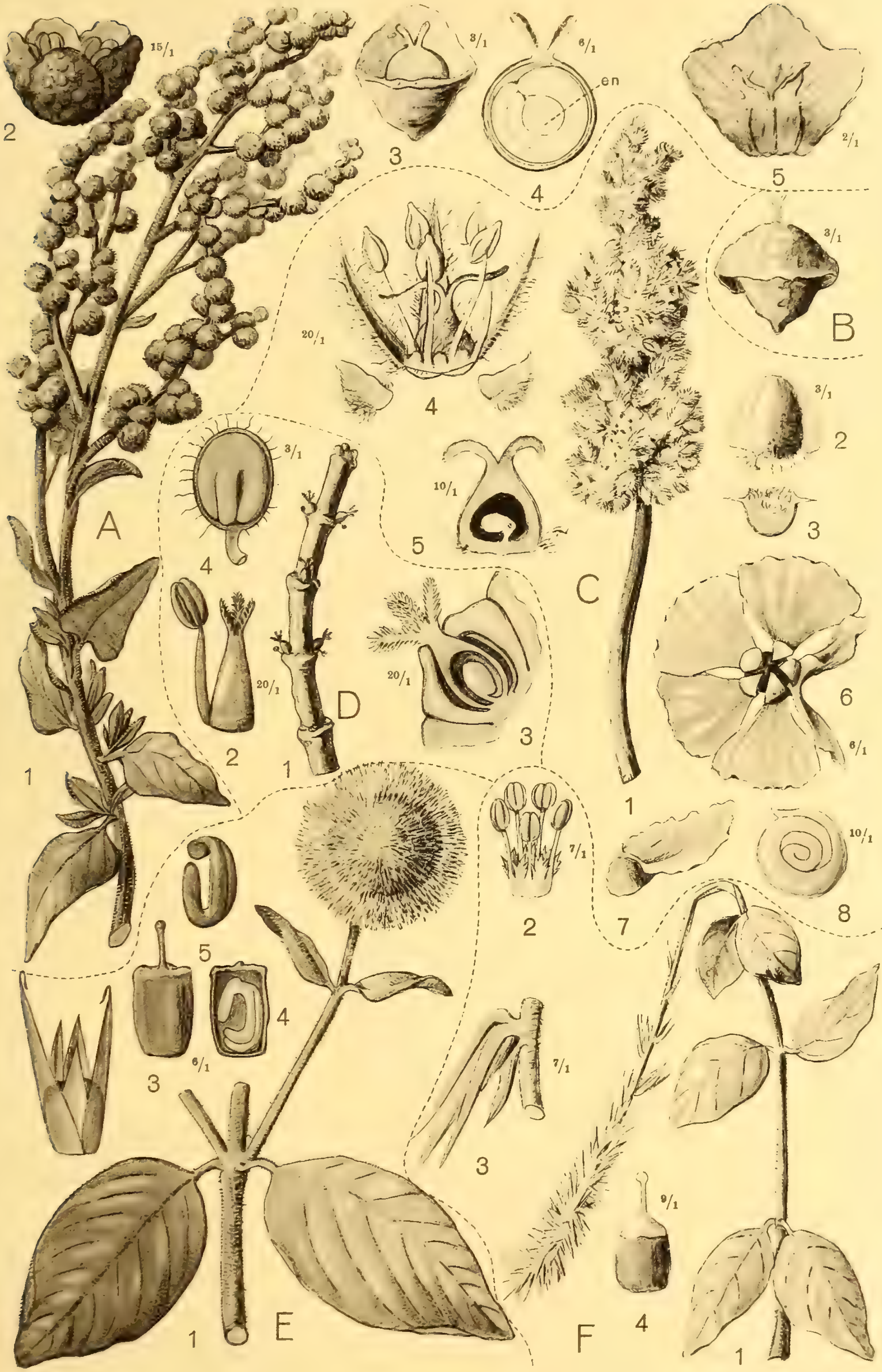
Flowers bisexual, regular, rarely monoecious (*Amarantus**) or dioecious (*Alternanthera*); perianth 4—5-parted or -cleft, the segments mostly dry and membranous. Stamens as many as the segments and opposite them, or fewer, the filaments more or less joined at their base into a short tube, with or without processes (staminodes) between them. Pollen grains globose with numerous pores. Ovary superior, 1-celled, free; ovules 1 or more, erect or suspended from funicles which rise from the base of the cavity. Fruit a nut-like utricle, either 1-seeded or many-seeded (*Celosieae*), mostly enclosed in the unaltered perianth-tube. Seed more or less rounded; embryo lateral, curving round the farinaceous perisperm.

This family is so closely related to Chenopodiaceae, that no sharp line can be drawn between them. As far as the South African species are concerned the membranous, often coloured (white or pink) perianth and their general habit afford sufficient means of distinction.

* From 'Αμαραντος, the Greek name of a plant that does not readily fade. The 'Αμαραντος of the ancients is, however, a plant quite different from our amaranths, viz. *Gnaphalium Stoechas*, a near ally of the everlastings.

(Plate 46 is facing page 182.)

CHENOPODIACEAE. AMARANTACEAE



Werner & Winter, Frankfort a/M

A: ATRIPLEX HALIMUS L. B: A. HALIMOIDES Lindl. C: SALSOLA APHYLLA Thunb.
D: SALICORNIA HERBACEA L. E: CYATHULA GLOBULIFERA Moq.
F: ACHYRANTHES ASPERA L.

Ecology. Although the flowers are mostly inconspicuous they appear to be visited by insects, while some are evidently anemophilous. The fruitlets of most species are easily carried about by the wind or passing animals, as the persistent perianth develops various kinds of wings, hairs or hooks, while in other cases the entire glomerule breaks away, and the hooks derived from the barren flowers secure the dispersal.

Owing to these excellent contrivances for transport and considerable resistancy against drought, various species of *Amarantus*, *Pupalia* and *Alternanthera** have become troublesome weeds. Others are cultivated in gardens for ornamental purposes, *e.g.* *Celosia argentea* var. *cristata* (the cockscomb) and *Gomphrena globosa* (the globe amaranth); also several species of *Alternanthera* on account of their variegated leaves.

KEY TO THE GENERA.

[Compare Flor. Cap. Vol. v, Sect. 1, 403.]

Tribe I. **Celosieae.**

Leaves alternate. Stamens 5; anthers 2-celled, each cell 2-locular. Ovary many-ovuled. Fruit mostly many-seeded (rarely 2 seeds only).

A. Staminal tube short, without appendages between the stamens.
1 species in S. A., *C. trigyna.* 1. **Celósia** *L.*
Flor. Cap. 404.

B. The staminal tube with 5 bifid petaloid appendages.
Endemic. 7 species. E, No.
2. **Hermbstáedtia** *Reichenb.*
Flor. Cap. 405.

Tribe II. **Amaranteae.**

Anthers 2-celled, each theca 2-locular; ovary 1-ovuled. Fruit 1-seeded.

A. Flowers unisexual. Stamens free, staminodes 0. Ovule erect, funicle short.
Several cosmopolitan species in S. A.
1 perhaps indigenous. 3. **Amarántus**† *L.*
Flor. Cap. 408.

* *Alternanthera sessilis* and *A. Achyrantha*, the "*amarantus weed.*" See Agric. Journ. (C. C.), Vol. 37, p. 267 (1910).

† The introduced species *Amarantus retroflexus* and *A. paniculatus*, as well as the indigenous *A. Thunbergii*, are known in the Transvaal under the names *pig weed* and *mistbreede*.

B. Filaments united into a cup. Ovule pendulous from a long funicle.

a. Flowers several in the axils of leaves (exc. some species of *Sericocoma*), some sterile.

I. Staminodes 0.

1. Flowers fertile and sterile in each cluster.

× *Leaves alternate, narrow. Fruit villous.*

2 species, 1 of them S. A. E, C, No.
S. remotiflora. 4. **Sericoréma** *Lopr.*
Flor. Cap. 412.

× × *Leaves opposite, broad.*

o *Fruit glabrous.*

2 species in S. A. E, Na. 11. **Pupália** *Juss.*
Flor. Cap. 422.

oo *Fruit hairy.*

1 species in S. W. A. *M. Bainesii.*
5. **Marcéllia** *Baill.*
Flor. Cap. 413.

2. Flowers all fertile. Leaves opposite or alternate.

1 endemic species. (Bredasdorp.)
L. Pfeilii. 6. **Leucospháera** *Gilg*
Flor. Cap. 413.

II. Staminodes present (exc. in 1 species of *Centema* and 1 of *Sericocoma*).

1. Fruit horned. Sterile flowers reduced to straight spines. Leaves opposite.

4 species in S.A. 7. **Cyphocárpa** *Lopr.*
Flor. Cap. 414.

2. Fruit not horned.

× *Sterile flowers reduced to straight spines or absent. Leaves alternate or opposite.*

2 species in S. A. C, W. 8. **Sericócoma** *Fenzl*
Flor. Cap. 416.

× × *Sterile flowers reduced to straight spines, thickened and united to the base of the fertile flower. Leaves opposite.*

2 species in S. A. T. D. 9. **Centéma** *Hook. fil.*
Flor. Cap. 418.

× × × *Sterile flowers reduced to hooked spines. Leaves opposite.* (Plate 45, E.)

6 species in S. A. E, C, Na, T.
10. **Cyáthula** *Lour.*
Flor. Cap. 419.

b. Flowers bisexual, solitary in the axils of leaves, bibracteolate.

I. Staminodes 0.

1 species, *P. africanum.* NE.

12. **Psilótrichum** *Blume*
Flor. Cap. 424.

II. Staminodes present.

1. Stems articulate.

1 endemic species. [Namib]. *A. Leubnitziae.*

13. **Arthráerua** *Schinz*
E. & P. III, 1 *a*, 109.

2. Stems not articulate.

× *Filaments connate at base only.*

o *Perianth-segments all or the inner only woolly or silky.*

§ *Perianth membranous. Leaves opposite or alternate.*

2 species in S. A. No, Na. 14. **Aerua** *Forsk.*
Flor. Cap. 425.

§§ *Perianth coriaceous. Leaves alternate.*

1 species in Trop. A. and S. W. A.
C. capitata. 15. **Calicoréma** *Hook. fil.*
Flor. Cap. 427.

oo *Perianth glabrous.*

2 species. E, Na, No.

16. **Achyrópsis** *Hook. fil.*
Flor. Cap. 429.

× × *Filaments connate into a long tube. Leaves opposite.*

2 species in S. A. (Plate 45, F.)

17. **Achyránthes** *L.*
Flor. Cap. 427.

Tribe III. Gomphreneae.

Anthers 1-celled. Ovary 1-ovuled.

A. Stigma capitate.

a. Fruit not compressed.

1 introduced species. 18. **Telanthéra** *Moq.*
Flor. Cap. 431.

b. Fruit much compressed, winged.

2 trop. species as weeds.

19. **Alternanthéra** *Forsk.*
Flor. Cap. 431.

B. Stigmas 2, linear. Fruit compressed.

1 trop. species, *G. globosa*, occasionally as a weed.
Cultivated in several varieties (Globe amaranth).

20. **Gomphréna** *L.*
Flor. Cap. 433.

Fam. 19. **Nyctaginaceae.**

(Plate 47, D.)

Herbs, shrubs or trees. Flowers often involucred, bisexual or polygamo-dioecious, regular; perianth simple, often corolloid, tubular, the lower part persistent. Stamens 1—5 (S. A.), filaments combined at their base into a hypogynous ring. Ovary superior, free, 1-celled; ovule 1, erect. Fruit enclosed within the hardened base of the perianth-tube. Embryo mostly with expanded cotyledons, which surround the perisperm. Flor. Cap. Vol. v, Sect. 1, 392.

Fig. 85. *Boerhaavia pentandra* Burch. Rootstock (incomplete), with young shoots (November). 1/4 nat. size.

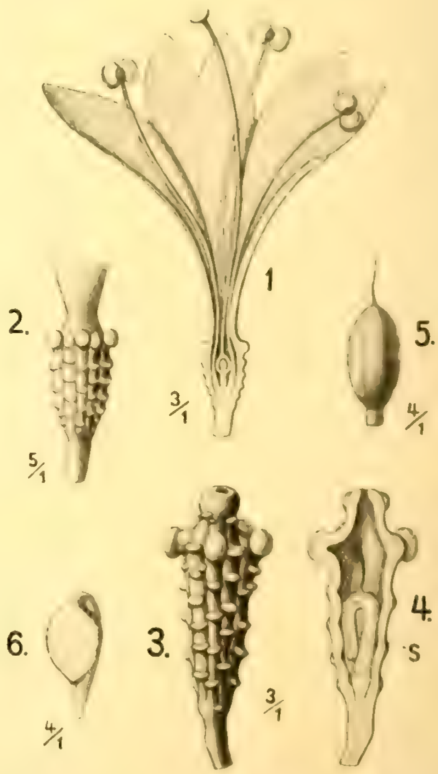


Fig. 86. *Boerhaavia pentandra* Burch. 1. Flower in long. section. 3/1. 2. Lower part of perianth. 5/1. 3. Fruit. 4. Fruiting calyx in long. section, the real fruit within. *s*. The embryo. 5. Seed. 4/1. 6. Embryo.

POLYGONACEAE NYCTAGINACEAE PHYTOLACCACEAE

Plate 47

A: Polygonum serrulatum *Lagasca* B: Phytolacca americana *L.*
C: P. heptandra *Retz* D: Boerhavia pentandra *Burch.*
E: Emex australis *Steinh.*

Several shrubs and herbaceous plants of this family are used for ornamental purposes, viz. *Bougainvillea spectabilis*, with brightly coloured involucral bracts (from Brazil), and two species of *Mirabilis*, viz. *M. Jalapa* and *M. longiflora* (Marvel of Peru, Four o'clock) with delicately tinted flowers, which open at night only and are withered the next morning (from South America).

KEY TO THE GENERA.

A. Herbaceous, deciduous in winter. Flowers bisexual.

a. Floral bracts large, connate. Erect herbs, with large tubers.
1 species (escaped from gardens). Na. T.
1. **Mirábilis** *L.*

b. Bracts small. Trailing herbs with woody rootstocks. (Plate 47, D.)
20 species, 5 in S. A. T. Na. No.
2. **Boerháavia** *Vaill.*

B. Shrubs. Flowers polygamo-dioecious.

a. Leaves fascicled.
1 species, *P. spinosum.* No.
3. **Phaeóptilum** *Radlk.*

b. Leaves alternate or opposite.
30 species, mostly American, 1 in Trop. and S. Afr.
4. **Pisónia** *L.*

Plate 47.

Fam. 16. Polygonaceae.

A. *Polygonum serrulatum* Lagasca 1. Short piece of plant with butterfly, *Pieris mesentina.* 2. Margin of leaf. 30/1.

E. *Emex australis* Steinh. Small piece of flowering plant, with fruits.

Fam. 19. Nyctaginaceae.

D. *Boerhaavia pentandra* Burch. [Syn. *B. Burchellii* Choisy] Small piece of flowering shoot and apex of rootstock.

(Note. The colour of the flower is in nature a purplish magenta, but that shade offers great difficulties to the artist as well as the lithographer.)

Fam. 20. Phytolaccaceae.

B. *Phytolacca americana* L. [Syn. *Ph. decandra* L.] 1. Flowering twig. 2. Flower. 6/1. 3. Fruiting spike. 4. Long. section of seed, showing the central perisperm. 4/1.

C. *Phytolacca heptandra* Retz. [Syn. *Ph. stricta* Hoffm.], with ripe fruit (nutlets), from the Transkei. Both species possess swollen roots like sweet potatoes, but they are poisonous.

Fam. 16. Polygonaceae.

The genus *Polygonum* is represented in South Africa by several introduced as well as indigenous species. Among the former is the ubiquitous *Polygonum aviculare* (***knotweed***, ***varkensgras***), which readily invades gardens and roads. It is able to thrive in the driest situations where almost all other plants perish, except perhaps *Alternanthera Achyrantha*, for like this American intruder it produces a very long tap root, which even in young plants, hardly a few weeks old, may measure 12 inches or more, while in old plants it descends to two or three feet. These plants are thus enabled to obtain their water supply from the deep-seated moisture and to flourish in the driest summer.

Polygonum serrulatum (***Duizendknoop***) is fairly frequent along all perennial rivers of the country and easily recognised by the serrate edges of its leaves. Otherwise it is somewhat similar to the introduced weed *P. Persicaria*.

Fam. 19. Nyctaginaceae.

Boerhaavia*.

All species possess a stout, deep-seated rootstock (Fig. 85), from which several branches rise to the surface of the ground. From them originate the thin trailing shoots which appear at the beginning of summer when the rains have soaked the soil. The largest species is *Boerhaavia pentandra*, which spreads on the ground or ascends in bushes, the shoots being three or more feet long. The flowers stand in umbel-like racemes and are bright coloured but very fugacious. The coloured part is not a corolla, but the limb of the simple perianth, while the persistent basal portion acts as a protection for the fruit and assists in its distribution. Being provided with numerous viscid knobs it is easily detached by passing animals and thus carried away.

Farmers look upon it as a good food for stock.

Phaeoptilum spinosum. This is a rigid, spiny shrub, 2 to 3 feet high, very conspicuous when bearing its numerous, mostly bright red fruits. Neither when in flower nor when fruiting would one at first glance recognise its relationship to *Boerhaavia* or *Bougainvillea*, for the cream-coloured flowers look, if not examined in detail, almost like those of some species of *Lycium*, and the four-winged fruits resemble those of some Combretaceae.

The shrub is recorded from Calvinia, and we have seen it on the Asbestos Hills near Griquatown as well as in the mountainous parts of Great Namaqualand.

* Named after Herm. Boerhaave, a famous physician and professor of botany at Leiden, 1668—1738. The city of Leiden erected a monument in his honour with his favourite motto:

"*Simplex sigillum veri.*"

Fam. 20. Phytolaccaceae.

(Plate 47, B, C.)

Herbs or shrubs with entire leaves and inconspicuous greenish or whitish flowers. Inflorescence racemose. Flowers bisexual or unisexual, regular; perianth simple, 5-parted. Stamens 5—∞. Ovary superior, different in the two genera. In *Microtea*, which is one of those anomalous genera that occupy an intermediate position, being nearly allied to Chenopodiaceae, the ovary consists of 2 completely connate carpels; in *Phytolacca* on the other hand, there are 6—15 more or less connate carpels, each one with 1 ovule attached to the ventral suture. Fruit of *Phytolacca* formed of several fleshy or nearly dry fruitlets, free or connate. Seeds with perisperm, which is surrounded by the curved embryo. (Plate 47, B, 4.)

TWO S. A. GENERA.

A. Carpels 2, united into a 1-celled, 1-ovuled ovary; styles 2, with entire or trifid stigmas.

4 S. A. species.

Syn. *Lophiocarpus* and *Wallinia* in Harv.

1. **Micrótea** *Sw.*

B. Carpels several, free or united into a several-celled ovary; styles 6 or more, free.

4 species in S. A. 2. **Phytolácca** *L.*

Phytolacca.

Two introduced species of this genus are well known throughout South Africa, viz. *Phytolacca americana*, the ***kermes bush***, ***karmozijnbos***, and *Ph. dioica*, the ***belombra tree***. The latter is a quick-growing, rather stout tree with large leaves, hence giving ample shade. The fruit is used for making jam and other preserves.

Phytolacca americana, on the other hand, is, although 5 to 8 feet high, really a bushy herb, which has become quite acclimatised here and there in the neighbourhood of homesteads or open glades of forests. The fruit, a spike of drupes or drupelets, contains a dark red juice, which is sometimes used for colouring foods or beverages (***vegetable kermes***). The fleshy roots are poisonous, but also used medicinally by the kaffirs.

Three indigenous species with dry fruitlets occur in the East and North.

Fam. 21. Aizoaceae.

(Plates 48—54 and 56.)

Herbs, half-shrubs or shrubs of various habit. Inflorescence generally cymose; occasionally flowers solitary. Flowers bisexual, regular. Perianth simple (pseudopetals in *Limeum*, *Orygia*, *Mesembrianthemum*), 4—5-parted; segments free or joined into a tube, often coloured on the inner side. Stamens 5 or by "dédoublement" more numerous, the groups alternating with the perianth- or calyx-segments. Ovary 2- or more-celled (exc. *Adenogramma*); ovules 2 or more in each cell (exc. genera 4, 5 and 6). Fruit a capsule or nut or nutlets, rarely pulpy as in a few species of *Mesembrianthemum*. Seeds with a peripheric embryo and central farinaceous perisperm.

The family is not easily defined, as some of its members approach Phytolaccaceae so closely, that certain authors* refer the connecting genera *Adenogramma*, *Polpoda*, *Limeum*, *Psammotropha* and *Giesekia* to that family, while Sonder† places them together with other Mollugineae in Caryophyllaceae. Whichever course is adopted, some genera will appear to occupy an abnormal position.

The genus *Mesembrianthemum*, at first sight, would not be called monochlamydeous, as its flowers possess numerous and very conspicuous petaloid organs (***pseudo-petals***). It has been shown, however, that these petaloid organs are genetically of the same origin as the stamens, having been derived from the same tissue which in other genera forms 5 or more stamens. The two sub-families are very different in habit, but show a gradual transition in their floral structure from a simple to a highly complex organisation.

* Pax, in Engl. Pflanzenfam. III, 1 *b*, p. 37.
† Sonder, Flor. Cap. I, 121.

KEY TO THE GENERA.

Subfam. I. **Molluginoideae** (Flor. Cap. 1, 136).

Perianth without a tube, the segments mostly free or partially cohering (*Coelanthum*). Ovary superior, 3—7-celled, ovules numerous in each cell. Herbs or dwarf undershrubs with mostly narrow leaves.

Tribe I. **Giesekieae.** Fruit of 2—5 separable nuts.

A. Petals 0. Ovary of 3—5 carpels. Nuts warted or crested, enclosed in the persistent perianth.

5 African species, 3 in S. A. 1. **Giesékia** *L.*
Flor. Cap. 1, 155.

B. Petals 3—5 (rarely wanting). Ovary of 2 plano-convex carpels.

a. Carpels flat, with a marginal wing.

Two endemic species. (*S. fenestrata* common C, No.)
2. **Semonvíllea** *Gay*
Flor. Cap. 1, 152.

b. Carpels hemispherical, not winged, dorsally pitted.

14 species, 10 in S. A., mostly eastern.
3. **Límeum** *L.*
Flor. Cap. 1, 152.

Tribe II. **Mollugineae.** Fruit a loculicidal capsule.

A. Pseudopetals 0.

a. Ovary 1-carpellary; 1-ovuled.

Endemic. 7 species.
4. **Adenográmma** *Reichb.*
Flor. Cap. 1, 149.

b. Ovary 3—5-celled, each cell with 1 ovule.

I. Calyx 5-parted, segments entire.

Endemic. 5 species dispersed.
5. **Psammótropha** *Eckl. & Zeyh.*
Flor. Cap. 1, 146.

II. Calyx 4-parted, segments fimbriate-lacerate.

One species (*P. capensis*), endemic on the Cape Peninsula.
6. **Pólpoda** *Presl.*
Flor. Cap. 1, 148.

c. Ovary 3—5-celled; each cell with 2 or more ovules.

I. Perianth-segments free.

1. Stigmas linear. Stipules obsolete.

× *Seeds without strophiole.*

4 species in the Karoo (*M. Cerviana*).
7. **Mollúgo** *L.*
Flor. Cap. 1, 137.

× × *Seeds with strophiole.*

2 species in S. A. 8. **Glínus** *Loefl.*
Flor. Cap. 1, 136.

2. Stigmas obovate or cuneate, fleshy.

× *Stipules multifid. Stamens* 3—5. *Disc cup-shaped.* (Plate 48.)
Endemic. 20 species (1 in St Helena).
9. **Pharnáceum** *L.*
Flor. Cap. I, 138.

× × *Stipules spathiform, entire. Disc* o. *Stamens* 3—5 *or many.*
Endemic. 4 species (C).
(*Hypertelis* in Flor. Cap. I, 144.)
10. **Hyperstélis** *E. Mey.*

II. Perianth funnel-shaped, 5-fid to the middle; segments petaloid. Stamens 5, short; stigmas 3.
Endemic. 2 species (W.).
[*Coelanthium* Sond. in Flor. Cap. I, 147.]
11. **Coelánthum** *E. Mey.*

B. Pseudopetals numerous, 15—30, linear or oval, shorter than the perianth-lobes, cohering below. Stamens many; stigmas 5.
1 species widely spread in Africa. 12. **Orýgia** *Forsk.*
Flor. Cap. I, 136.

Subfam. II. **Ficoideae** (Flor. Cap. II, 473 and 598).

Perianth-tube conical or bell-shaped.

Tribe I. **Sesuvieae.**

Ovary superior. Pseudopetals o. Capsule circumscissile. Leaves opposite.

A. Ovary 2—5-celled, each cell with numerous ovules.
2 widely spread species (W.).
(*Diplochonium* in Flor. Cap. II, 473.)
13. **Sesúvium** *L.*

B. Ovary 1—2-celled; cells mostly 1-ovuled; styles 2 or 1.
2 S. A. species (W. and C.). 14. **Triánthema** *L.*
Flor. Cap. II, 598.

Tribe II. **Aizooneae.**

Ovary superior. Pseudopetals o. Capsule loculicidal. Stipules o.

A. Stamens 5; ovary 3-celled.
Endemic. 1 species (C.). 15. **Plínthus** *Fenzl.*
Flor. Cap. II, 479.

B. Stamens 8—10; ovary 2—5-celled; cells 1-ovuled. (Plates 48 and 56; Fig. 90.)
Endemic. 20 species, dispersed. 16. **Galénia** *L.*
Flor. Cap. II, 473.

C. Stamens 10—40, 2-seriate; ovary 2-celled; cells 1-ovuled.
Endemic. 4 species (W.).
17. **Acrosánthes** *Eckl. & Zeyh.*
Flor. Cap. II, 471.

D. Stamens ∞, in bundles; ovary 5-celled; cells 2-ovuled. (Plate 48.)
8 S. A. species (C., W., No.). 18. **Aizóon** *L.*
Flor. Cap. II, 469.

Tribe III. **Mesembrianthemeae.**

Ovary inferior, 2—∞ -celled. Stamens ∞. Succulent herbs or undershrubs.

A. Pseudopetals 0. Fruit indehiscent, 1—9-celled and -seeded, often winged. Leaves alternate.

a. Stigmas equal.
27 species in S. A. (Plate 48.) 19. **Tetragónia** *L.*
Flor. Cap. II, 460.

b. Stigmas unequal; 2 long and papillose, 2 short and without papillae.
End. 1 species (*A. Schenckii*). G. Nam.
Bull. Herb. Boiss. V (1897) App. III, 79.
20. **Anisostigma** *Schinz*

B. Pseudopetals ∞, fruit a 5—20-celled capsule (rarely pulpy). Leaves mostly opposite.
21. **Mesembriánthemum** *Dill.*
Flor. Cap. II, 387.

Mesembrianthemum. Fig marigolds. Vijgebosjes.

(Plates 49—54.)

This is at present the second largest genus of South African plants, being surpassed only by *Erica*, which comprises 470 species [Flor. Cap. Vol. IV, Sect. I, 1910]; before long, however, it will probably be the largest. The heaths have been gathered continuously for centuries, and new species among them now turn up only from time to time, while every year adds considerably to the number of species of *Mesembrianthemum*. There are at present nearly 400 species described, but owing to the difficulty of drying and preserving the plants and their occurrence in arid and remote parts of the country, many are still unknown. Even in the well-explored districts of the South numerous new species have been found during the last few years; and the distant parts are likely to yield many more. As the interest in these singular and often fanciful members of our flora has lately been much revived, we may anticipate many additions during the next decade.

The genus is almost entirely South African, having its headquarters in the Karoo and the karroid plains and mountains of the North West. A considerable number cross the Orange river, or occur only beyond it in Great Namaqualand, and a few stragglers go through Bechuanaland and the Transvaal further north.

Fig. 87. *Mesembrianthemum rubro-lineatum* N. E. Br. Kew Bull. 1911, 82. An old plant (Griquatown). Showing the large roots. 1/2 nat. size.

Apart from South African species which have been carried to North Africa, southern Europe or other countries, *e.g.* Australia, by human agency, a few only occur beyond our limits. There are one or two endemic species in Australia, nearly allied to some at the Cape and probably derived from them, and a couple in eastern and northern Africa. One is endemic at St Helena.

Numerous species form wholesome food for all kinds of stock, *e.g.* the large-rooted *M. tuberosum* and *M. megarhizum*, the widely spread *M. spinosum* (Fig. 89) and the pretty *M. floribundum*. Of many others, which are too saline or too astringent to serve as food entirely, the flowering tops are eagerly eaten, and the genus is consequently as useful and important to the pastoral population of a large portion of Cape Colony as the grasses are to other districts and countries.

In many cases, however, the leaves are protected against the attacks of animals by bundles of raphides (Fig. 88), generally aggregated in special tubes, and often also by more or less numerous tannin-bearing idioblasts, *i.e.* large cells filled with a fluid rich in tannin (Fig. 88). These correspond in their function to the balsam cells of the aloe and the oil-receptacles of the buchu and other Rutaceae. Owing to their large size they are easily noticed as colourless spots within the green tissue.

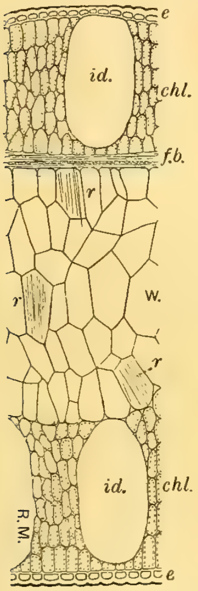


Fig. 88. *M. nobile* Haw. Long. section through leaf (1/5 of water-storing tissue only shown). *e.* Epidermis. *chl.* Palisade-cells with chlorophyll. *f.b.* Fibrovascular bundle. *w.* Water-storing tissue. *r.* Raphides. *id.* Idioblasts (large cells), filled with solution of tannin. 15/1.

How juicy and nutritious some of the Mesembrianthema are is shown by the analysis of the young shoots of *M. spinosum**.

	Water	Digestible carbohydrates	Proteids	Mineral matter	Fibre
Fresh	82·3	10·5	1·2	3·3	2·6 °/₀
Air dry	12·3	53·6	5·8	16·6	12·7

Some species of *Mesembrianthemum* possess toxic properties. *M. tortuosum*, the "*kauwgoed*" of the natives, produces a state of intoxication; it contains a powerful alkaloid, as was first shown by Mr Izaak Meiring (Worcester). According to Prof. C. Hartwich (Zürich), who recently named the alkaloid ***Mesembrin***, its chemical formula is $C_{16}H_{19}NO_4$ and its molecular weight 289·14.

When being dried the plant gives off a strong, almost pungent odour, hence we think it quite possible that this volatile body may contribute to the narcotic action of the drug.

* By Dr Ch. F. Juritz.

The roots of *M. acutipetalum* and *M. Mahoni*, called "*khadi*" by the natives of the Transvaal, are occasionally added to their kaffir beer. The latter species is looked upon as poisonous and has been found to contain a large amount of oxalates, corresponding to 3 % of oxalic acid, but no alkaloid.

Fig. 89. *Mesembrianthemum spinosum* L. 1/2 nat. size.

In eastern Cape Colony *M. stellatum*, called "*koerrimoer*" or "*kirimoer*," is employed for a similar purpose, apparently as a flavouring agent, corresponding to our hops; nowadays hops (imported) are often added to such beer.

M. micranthum (*asbos*) is burnt, and from the ash a lye (loog) is obtained for steeping the grapes when preparing raisins (Worcester district) or for soap making. Consequently also the plant is sometimes called *loog*.

Plate 48.

A: Galenia africana *L.* B: Tetragonia fruticosa *L.*
C: Pharnaceum cordifolium *L.* var. obovatum *Bolus.*
D: Aizoon paniculatum *L.* var. roseum.

Plate 48.

A. *Galenia africana* L. 1. Small twig. 2. Flower. 10/1.

B. *Tetragonia fruticosa* L. 1. Flowering twig, with bee (*Allodape*). 2. Flower, the two anterior segments of the perianth removed. 4/1.

C. *Pharnaceum cordifolium* L. var. *obovatum* Bolus 1. Small plant. 2. Whorl of leaves and stipules. 2/1.

D. *Aizoon paniculatum* L. var. *roseum*. 1. Piece of plant. 2. Flower, two perianth-segments removed. 5/1.

Galenia.

Galenia africana. (The **kraalbush**.) This plant is very common in the central and other karroid parts of South Africa, forming rounded, socially growing shrublets, 1 to 2 feet high. It is easily recognised, even at a distance, by its yellowish colour, which becomes more pronounced during the dry season.

Although not eaten by stock at ordinary times it forms a final stand-by during a drought, when sheep and goats nibble the thin branchlets. But even this drought-resisting plant is sometimes overpowered, as in the year 1903*. When the dry period lasts for several years, wide areas may be seen covered with thousands of its dead and bleached bushes. A year or two of normal rainfall, however, repairs the damage; millions of young plants will spring up and soon re-occupy the bare veld. (See Plate 56 opposite Plate 54.)

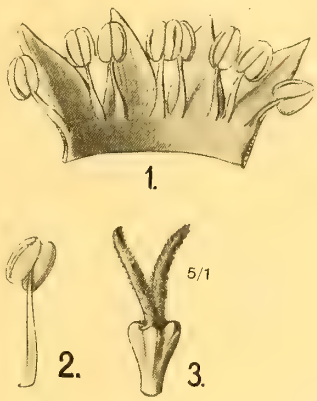


Fig. 90. *Galenia africana* L. 1. Perianth laid open. 2. Stamen. 3. Pistil. 5/1.

Tetragonia.

Tetragonia fruticosa. **Kinkelbosje.** Several species of this genus are succulent and juicy, forming good food for stock. Some have papulose leaves, glistening in the sun like the so-called **ice plants**, the epidermal cells having been transformed into little bladders filled with water which is gradually used up by the green tissue underneath.

Aizoon.

Aizoon paniculatum. The variety with red flowers is a pretty herb spreading on sandy ground in the Cape Flats, flowering in spring.

Pharnaceum.

Pharnaceum cordifolium var. *obovatum*. This plant which is looked upon as a distinct species by some authors, was omitted from the Flora Capensis, as pointed out by H. Bolus. It is fairly common in the Cape Flats.

An allied species with very narrow leaves, viz. *P. lineare*, is colonially known as "**Droedas kruiden**."

* Annual Rainfall (Period 1885/1894).

	Mean	Minimum	1903
Kenhardt	6·73 inch.	2·87 inch.	0·71 inch.
Prince Albert Road	5·67 „	3·35 „	0·79 „

Fig. 91 *a.* *Mesembrianthemum nobile* Haw. Photo. A. Fuller Nat. size.

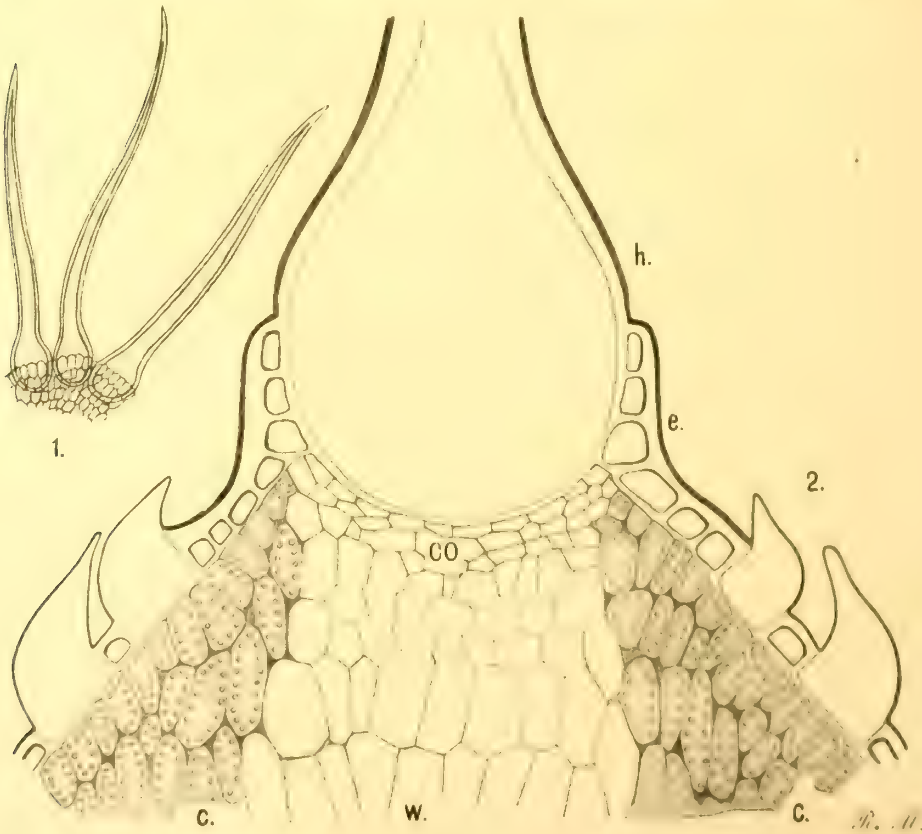


Fig. 91 *b.* *Mesembrianthemum densum* Haw. 1. Portion of apex of leaf with 3 of the apical hairs. 2. Long. section through apical hair. *h.* Hair. *e.* Epidermis. *c.* Cells with chlorophyll. *w.* Water tissue. *co.* Tissue which is later on turned into cork. (For fuller explanation of structure see page 202.)

Plate 49.

A: Mesembrianthemum obcordellum *Haw.*
B: M. calculus *Berger* C: M. densum *Haw.* D: M. ficiforme *Haw.*
E: M. tigrinum *Haw.* F: M. bilobum *Marl.* G: M. digitiforme *Thunb.*

Plate 49.

MESEMBRIANTHEMUM.

A. *M. obcordellum* Haw. 2. Long. section of a twig (corpusculum).
B. *M. calculus* Berger, from Van Rhynsdorp.
C. *M. densum* Haw., from the Karoo.
D. *M. ficiforme* Haw., from Worcester.
E. *M. tigrinum* Haw., from the Karoo.
F. *M. bilobum* Marl., from Little Namaqualand.
G. *M. digitiforme* Thunb., from Van Rhynsdorp.

MESEMBRIANTHEMUM. Section SPHAEROIDEA.

The plants of this section show a remarkable modification of their leaves. There are generally several shoots from a common root or crown, each one consisting of a short axis and a pair of leaves. The leaves are, however, so completely connate, that they form a single compact body (corpusculum), which encloses the flower bud (Plate 49, A, 2). When the flowering season arrives the bud forces its way out through a short slit at the apex of the flat body and finally opens above it, the ovary remaining hidden within (Fig. 93 A). After flowering the apical slit closes again and the further development of the fruit takes place in the corpusculum, while at the same time a young corpusculum originates alongside of the ripening fruit, both being supplied from the surrounding parent body with water and food until it is exhausted, its shrivelled remains forming a papery sheath around the new corpusculum. When the fruit is fully developed the stalk stretches itself and raises the seed vessel above the mass of the sheaths, thus enabling the seeds to be scattered more readily.

Four of the figured plants belong to this section, viz. *M. obcordellum*, *M. calculus* (named and described from the above illustration), *M. ficiforme* and *M. bilobum*.

M. tigrinum. This is the type of a group of species (*Ringentia*) with variously toothed and lobed leaves, from which the specific names have been formed, viz. *M. lupinum*, *caninum*, *murinum*, *ermininum* etc. The flowers of all these open late in the afternoon and generally close shortly after sunset.

M. ficiforme. Flowers fragrant, remaining open for several days and nights.

Mesembrianthemum digitiforme. The specimen figured is merely a twig of a lump as big as a child's head. The corpuscula are very juicy, being filled with a watery, slightly saline sap; hence they are readily eaten by herbivorous animals in times of drought (*fide* Mr W. SPILHAUS, who brought the entire plant from Van Rhynsdorp). The flowers are remarkably hardy, the petals being stiff and rigid and lasting about a fortnight without any visible change.

Cultivated specimens of this plant, as figured *e.g.* by BERGER, look so different that they may not represent the same species; but THUNBERG's original description in his Flora Capensis agrees so accurately with our plant, that the author had evidently written it on the spot.

Many other species, when cultivated under less extreme conditions than those they are accustomed to, even at Capetown, alter their habit of growth and colouring so completely, that one could not recognise the wild plant from the description of the cultivated one.

M. densum, *M. stellatum* and other species of the section Barbata bear at the apex of each leaf a ring of peculiarly constructed hairs. Each hair has a much inflated base, which is set in a strong protective cup; the bottom of this cup, which adjoins the water-tissue, is thin-walled and permeable to water as long as the leaf is young and growing, hence water absorbed from rain or dew by the hairs can pass into the tissue of the leaf, while in dry weather the exposed portion of the hair shrivels up and prevents loss of water from within (Fig. 91 *b* on page 200). On old leaves the hairs are dead, for the tissue immediately adjoining their base has become suberized, the plug of cork (*co*) thus formed preventing communication between the inner tissue and the hair.

When correcting the proof of this sheet we received a copy of a paper by Dr O. Oberstein, kindly sent by the author, on "Bau der Blattspitze der Mesembrianthema-Barbata." The author looks upon the hairs as organs of protection for the apex of the leaf against too excessive light, and on older leaves, where a layer of cork separates the basis of the hair from the water-tissue beneath, as an ornament or a protection against herbivorous animals.

The formation of the cork (marked *co* in Fig. 91 *b* and indicated, in its initial stage, by the thicker lines of the walls of the cells) rather supports our view, for in summer, when the power to absorb dew would be useless, as no dew occurs at that time in the Karoo, it is essential that the leaf should not lose any water through these apical hairs.

As branches and leaves of the plants of this group are spread out more or less horizontally (see our figure of *M. densum* and those of *M. stelligerum* and *M. bulbosum* in the author's paper cited) the apical hairs cannot afford any protection against light, especially not in *M. barbatum*, where the leaf pairs are more than an inch apart, even on the wild plants. Protection against insolation by means of hairs is, of course, of common occurrence, but they are always of ordinary shape and not of such an elaborated structure as in this case.

The theory of ornaments we need not discuss, and protection against grazing animals by such harmless hairs is out of the question.

Plate 50.

A: Mesembrianthemum edule *L.* B: M. acinaciforme *L.* (leaf).
C: M. criniflorum *Houtt.* D: M. aureum *L.*

Plate 50.

MESEMBRIANTHEMUM.

A. *M. edule* L. 1. Flower. 2. Section of leaf. 3. Ripe fruit, divided crossways.
B. *M. acinaciforme* L. Section of leaf.
C. *M. criniflorum* Houtt. From Cape Flats. Rose-coloured variety.
D. *M. aureum* L. From Worcester.

MESEMBRIANTHEMUM.

The flowers of *Mesembrianthemum*, although showing a great range of size, from a few millimetres to three inches in diameter, are of a very uniform structure, varying chiefly in the relative size of the parts. The colours are most brilliant, from the purest white to the deepest red, purple or yellow, in

Fig. 92. *Mesembrianthemum edule* L., with *Dimorphotheca pluvialis* and *Briza maxima*. Near Capetown. September. Photo. E. J. Steer

all possible shades. The brilliancy is due to a comparatively simple feature of their structure, every cell of the epidermis being a small optical apparatus, resembling a combination of a concave mirror with a prism of which the base (here the outer side of the cell) is convex. A fuller explanation of the optical phenomena involved is given under *Nerine* (Vol. IV, Plate 33), but while in the Nerine the cells of the epidermis are pear-shaped, not in section only but as a whole, they are here long and narrow like a wedge, and their apex is consequently not dome-shaped but formed like a rounded ridge (Plate 51, A, 2). As a result the light issuing from each cell does not form a luminous spot but a brilliant line, and this is the cause of the satin-like gloss of the petals of almost all species of *Mesembrianthemum.*

Mesembrianthemum edule occurs with yellow or purplish flowers, while those of the closely allied *M. acinaciforme* are always a deep purplish pink. Both differ also in the shape of their leaves (see figures of sections), and in the latter species there are always two floral bracts below the flower.

The stamens of this and some other species of *Mesembrianthemum* are irritable like those of *Opuntia*, bending inwards when touched by insects, *e.g.* bees, which visit these flowers.

Both species are very useful for the fixing of sandy soil along roads or embankments and even among dunes, provided that the wind cannot bury them with new sand. Their fruits are edible and known under the name **hottentot figs** or **Zuurvygen.** The numerous small seeds are embedded in a sweet pulp, which is slightly acidulous on account of malic acid. The fruit is, morphologically, a pulpy pome like a guava or pomegranate, and occurs only in this section of the genus, while all the other species possess capsular fruits. These capsules are highly hygroscopic, remaining closed when dry, contrary to the more general behaviour of capsular fruits, and opening their valves in rainy weather, just at a time when the seeds find favourable conditions for germination (Fig. 93, B).

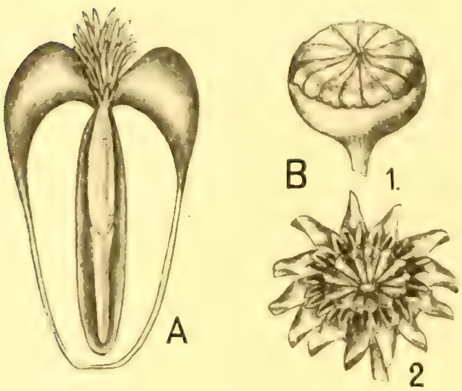


Fig. 93. A. *Mesembrianthemum bilobum* Marl. Corpusculum in long. section, the stalked ovary entire in the central cavity. B. *M. nobile* Haw. 1. Capsule in dry weather. 2. Same in wet weather.

The root of *M. edule* is used medicinally under the name **gaukum**.

Mesembrianthemum criniflorum. An annual species of the South West, developing its foliage during winter, flowering in spring and disappearing when the dry summer comes. The colour of the flowers varies considerably, being generally more purplish than in the variety represented, but always very brilliant.

Mesembrianthemum aureum. This small shrublet is a native of the western districts and one of the few species which are cultivated in Cape gardens. A rockery covered with this or the allied *M. aurantiacum* forms a most gorgeous sight in spring.

Plate 51.

A: Mesembrianthemum aurantiacum *Haw.* B: M. Hookeri *Berger*
C: M. mitratum *Marl.* D: M. Bolusii *Hook. fil.*

Plate 51.

MESEMBRIANTHEMUM.

A. *M. aurantiacum* Haw. 1. Small piece of plant. 2. Transverse section through petal. 250/1.

B. *M. Hookeri* Berger, from Windsorton. 1. Patch of plants in their natural locality. 2. Single plant with ripe capsule. 3. Long. section of flowering twig (corpusculum), with bud of young corpusculum.

C. *M. mitratum* Marl. (Trans. Roy. Soc. S. A., Vol. 1, 1910), from Little Namaqualand.

D. *M. Bolusii* Hook. fil. Plant in its natural locality, showing six leaves. 2. Young plant, the flat body formed by the enlarged cotyledons; in the centre the first pair of leaves.

Mesembrianthemum mitratum. This plant has a remarkable habit of growth, forming shrublets 1—2 feet high, the branches being apparently dead, but each one carrying a fleshy knob at its end. The knob really consists of two closely joined leaves, which include a bud. In spring the flower forces its way out through a slit at the side, and while the fruit is ripening, a new bud, of two similar leaves, forms alongside of it, absorbing the food material of the older leaves and then remaining dormant until the next season.

The plant was discovered by Mr G. ALSTON in the sandy desert belt near Port Nolloth.

Mesembrianthemum aurantiacum. A small trailing shrublet, but by its flowers one of the brightest species, occurring in several shades, from bright orange to deep magenta or maroon. The name *Mesembrianthemum* means midday flower, but there is a great diversity in the hour of the day or night at which the flowers open. Most species show their flowers in bright sunlight only, but others do so at night, like the fragrant *M. noctiflorum*, or towards evening like *M. Bolusii*, *M. tigrinum* and others of the section Ringentia. Most species close their flowers during dull weather and re-open them the next day in sunshine; but some do not close them at all, when once open, not even in rain, like *M. falcatum.* Some, like those of the latter species, last for 10 or more days, while others wither after a few hours flowering.

*Mesembrianthemum Hookeri**. This species of the section Sphaeroidea was figured by HOOKER (Bot. Mag. Tab. 6077) as *M. truncatellum*†; but it is evidently different from HAWORTH's original plant, hence its new name. It is one of the few plants with window leaves, being embedded in the soil and showing only the flat apex of the corpusculum. While the subterranean portion is delicately green, the apex is marked exactly like the ferrugineous soil and the pebbles surrounding it, thus providing one of the best illustrations of ***protective mimicry*** among plants.

We have sometimes searched for hours at localities where the plant was known to grow, without discovering it, so well does it harmonize with the surface of the ground. Our figure is only a modest attempt to represent the conditions as they exist in nature.

* See note on next page.

† The real *M. truncatellum* is not known at present.

Known from Griqualand West, the southern Transvaal and other parts along the Orange and Vaal, but as far as ascertained by the author, always in reddish or brown, ferrugineous, gravelly soil or among such pebbles.

The Dutch children call the plants "*toontjes*" (little toes) and eat them; they are also sought by herbivorous animals, when grass and other food is scarce, but being of the same colour and appearance as the ground, they have every chance of escaping discovery, especially at night time. Flowering in autumn.

Fig. 94. *Mesembrianthemum simulans* Marl. 1/2 nat. size. From Klipplaat. April.

M. Bolusii. This plant generally consists of a few pairs of leaves, each of them having the shape, colour and surface texture of a stone. In cultivation the colour becomes more greenish and the leaves longer. The flowers are bright golden and of considerable size, similar to those of *M. nobile* (Fig. 90), hence the plants are easily noticed during the flowering season (March—April).

Recorded only from the neighbourhood of the railway station Aberdeen Road, where also the somewhat similar species *M. simulans* occurs. Both are becoming rarer every year, as the goats search for them during the dry season.

Note to *M. Hookeri*: This species is also figured in Trans. Roy. Soc. S. A. (Vol. II, 369, 1912) under the name of *M. Lesliei* N. E. Br., and the chief difference is stated to be the smooth apex of the corpuscula. That difference, however, is merely one of season. When the summer rains have soaked the ground the plants become gorged with sap and have a smooth apex; but when left without water for a long time, the surface becomes quite shrivelled and covered with wrinkles. These raised ridges are caused by incrustations of brown granular masses in the subepidermal tissue of the apex, as explained and figured by us in a paper on "Die Schutzmittel der Pflanzen gegen übermässige Insolation," Ber. Deutsch. Bot. Ges. 1909.

We have gathered the plant in various seasons near Windsorton on the Vaal and near Griquatown on the Kaap Plateau, and compared it with specimens kindly sent by Mr Leslie from Vereeniging. There is considerable variation in size, but otherwise no difference.

Plate 52.

Mesembrianthemum rhopalophyllum *Schlechter et Diels*

Mesembrianthemum calcareum *Marl.*

Plate 52.

A. *Mesembrianthemum rhopalophyllum* Schlechter & Diels A plant with window leaves, in its natural locality in the sandy desert of the southern Namib near Lüderitzbucht.

B. *Mesembrianthemum calcareum* Marl., among fragments of lime tufa in its natural locality near Kimberley.

Mesembrianthemum rhopalophyllum. Our little landscape represents this remarkable plant in its natural habitat in the sandy deserts of the southern Namib near Pomona Island. The specimen in front is shown in natural size, one of the leaves being in vertical section. The leaves are club-shaped and consist, like those of other species, of a colourless epidermis, a thin layer of green tissue and a central mass of colourless water-storing cells, which are tightly packed against each other, almost without any intercellular spaces between them. The apex of the leaf possesses, however, no green tissue, but is colourless or greyish, and its epidermis adjoins the water-storing tissue.

The plant grows embedded in the sand, nothing but the flat, slightly convex apex of each leaf being visible, and even that is often covered with more or less sand according to locality. While the leaf itself is fresh green with a rather delicate skin, the exposed part is protected by a thick epidermis and cuticula, and possesses comparatively few stomata. It is through this portion, which has the function of a window, that the leaf receives its light, being thus illuminated from within. There are 5 to 10 or even more leaves to each plant, but nothing appears at the surface except these windows; they peep out of the sand like the eyes of the sand-lizard or the sand-viper, which often hide themselves there in a similar way.

When the flowering season arrives (August) one may see the delicate, white, glossy blooms even where no windows are visible; but they are there all the same, merely hidden by a little sand.

The subterranean mode of life which the plant has adopted affords it considerable protection against herbivorous animals, especially at night time, since it would be difficult for them to detect these little spots in a dim light. To the non-botanical reader it may be pointed out, that the window is an essential feature in this adaptation, for if the apex were provided with green tissue, this would absorb the light falling on it and the buried portion of the leaf would be colourless, or if green before it was buried, would become colourless like the underground shoot of a potato, and consequently unable to assimilate the food materials provided by air and soil.

There are a few other species of *Mesembrianthemum* with window leaves, *e.g. M. Hookeri* (Plate 51), *M. pseudotruncatellum* and *M. opticum*; a few species of *Haworthia*, *e.g. H. truncata*, *H. tesselata* (Vol. IV, Plate 22), and one of *Bulbine*, viz. *B. mesembrianthemoides* (Vol. IV, Plate 27), but as far as we have been able to ascertain no such plants are known from other countries.

The flowers are visited by a butterfly, the cosmopolitan *Vanessa Cardui* (the *painted lady*), which to our surprise was fairly numerous in the desert at that season of the year.

Mesembrianthemum calcareum. This species affords another striking example of protective mimicry among plants. The leaves form a dense rosette, and their surface, as far as exposed, is covered with irregular excrescences that look exactly like the whitish fragments of lime-tufa between which the plant grows. No artist could imitate the surface texture and colouring of the limestone more accurately than nature has done in this case*. It so happened on one occasion, that we had the good fortune to find this species and *M. Hookeri* on the same day, but the one only where there was nothing but limestone and the other only among the brownish soil and gravel of an ironstone belt, the similarity to their surroundings being perfect in both cases.

M. calcareum has been found by us in two localities, viz. at Alexandersfontein near Kimberley and on the Kaap plateau near Griquatown, in both cases tightly wedged in between the chips of lime-tufa and quite flush with the surface. It has also been received from Hanover (C. C.) by Dr Schönland of Grahamstown; hence it appears to be widely distributed. It is apparently the only plant in South Africa with such a rugged leaf-surface; in Central America a few species of *Anhalonium* occur, resembling it very much in this respect, *e.g.* *A. fissuratum* (Cactaceae).

* The lithographer, in his endeavour to show up the plants more distinctly than they appeared in the original painting, has given the stones surrounding them a purplish tone. In nature the plants match the colour of the limestone exactly, being equally white and grey with brown dust here and there.

MESEMBRIANTHEMUM ROSEUM Willd.

January On Table Mountain 2600 feet

Plate 53 A.

Mesembrianthemum roseum Willd.

Group on the northern side of Table Mountain.

Flowers bright rose-coloured and very glossy, opening during the forenoon and closing about an hour before sunset.

Plate 53 B.

1. *Mesembrianthemum junceum* Haw.
In a plain near Vanrhynsdorp.
Some of the bushes are dead, owing to a drought.

2. Karoo near Laingsburg.
M. spinosum L. and *M. calamiforme* L.

Photo by A. Rogers

MESEMBRIANTHEMUM JUNCEUM Haw.

Near Van Rhynsdorp. In the background the Matsikamma, a mountain with a capping of Table Mountain sandstone.

Photo. by R. Marloth.

Werner & Winter, Frankfort a/M

MESEMBRIANTHEMUM SPINOSUM L. and **M. CALAMIFORME** L.

Karroo near Laingsburg

R. Marloth Werner & Winter, Frankfort a/M.

CLIFF WITH LICHENS AND SUCCULENTS.
North Side of Table Mountain.
MESEMBRIANTHEMUM VERRUCULOIDES Sond. and COTYLEDON ORBICULATA L.
January 2000 feet

Plate 54.

Cliff on northern side of Table Mountain.
Mesembrianthemum verruculoides Sond. and
Cotyledon orbiculata L., the latter in flower.
The rocks (sandstone) are covered with lichens (*Pertusaria lactea* Nyl.).

Plate 56.

Entrance to the Ceres-Karoo.

Galenia africana L.

Here and there, *e.g.* near the boy, a few clumps of *Cotyledon orbiculata* L.

At the foot of the hills flows the Doorn river, with a few small karri-trees (*Rhus lancea*) on its banks, all larger trees having been cut down. The hills consist of Wittebergen quartzite and bear in their upper parts Proteas and other members of the Cape Flora.

Photo. R Marloth.

Werner & Winter, Frankfort a/M.

THE BOKKEVELD KARROO

GALENIA AFRICANA L.

In the background Karroopoort and the Zwarteruggens.

Plate 55.

A: Portulacaria afra *Jacq.* B: Anacampseros filamentosa *Sims*
C: A. ustulata *E. Mey.* D: A. papyracea *E. Mey.* E: A. telephiastrum *DC.*

Plate 55.

(Plate 56 is facing Plate 54.)

A. *Portulacaria afra* Jacq. 1. Flowering twig. 2. Flower, in long. section. 6/1.
B. *Anacampseros filamentosa* (Haw.) Sims 1. Small plant. 2. Leaf and stipules.
C. *A. ustulata* E. Mey. 1. Plant (nat. size). 2. Leaf with the stipule of the next higher leaf adhering to it (two views). 2/1.
D. *A. papyracea* E. Mey. 1. Plant with ripe capsules, one full of seeds and one empty. 2. Leaf with neighbouring stipule. 3. Leaf and stipule in long. section. 20/1.
E. *A. Telephiastrum* DC. 1. Flowering plant with visiting bee (*Allodape quadrata*). 2. Flower laid open, two petals removed. 3. Ovary, long. section. 5/1. 4. Capsule, enclosed in persistent calyx. 5. Capsule, the pericarp splitting. 6. Capsule without the pericarp. 7. Capsule, open. 8. Seed. 3/1. 9. Tip of axillary stipule. 20/1.

Portulacaria.

Portulacaria afra (the **spekboom**) grows socially in the south eastern Karoo, extending right through to Kingwilliamstown; it is also reported from the Eastern Transvaal. It often covers whole hills or mountain slopes with its fresh verdure, which forms a pleasant contrast to the surrounding dull coloured vegetation. In the Addobush it is arborescent, up to 20 feet high, often forming dense thickets. The juicy leaves are a wholesome food for all classes of stock as well as for wild animals including buffaloes and elephants; hence farms with plenty of spekboom need not fear an ordinary drought.

"Providence meant to spoil our farmers in placing the spekboom on the hills of the Karoo," wrote MacOwan in one of his articles on the fodder plants of the country.

Ceraria.

C. namaquensis (Sond.) Pears. & Steph. (*P. namaquensis* Sond.), although till recently included in *Portulacaria*, is very different in habit and foliage from *P. afra*, forming compact, rounded bushes, 3—6 feet high, with woody stems and very small leathery leaves.

Sections of the bark are employed by the natives of Namaqualand for joining the ends of two sticks when they require a longer rod than is to be had naturally for obtaining bee's honey from high cliffs. The fresh bark is withdrawn from its wood as a complete tube, and this is slipped over the sticks in the same way as a chemist joins two glass tubes by means of a piece of rubber tubing. When drying the bark contracts and makes a solid joint. Colonial name "**hotnotsriem**" (strap of the hottentot).

Anacampseros.

This genus includes two groups of species of very different habit, viz. the two sub-genera *Telephiastrum* and *Avonia*. The difference is principally in the stipules, which are fimbriate or formed of hairs in *Telephiastrum*, while they are membranaceous and several times larger than the tiny leaves in *Avonia*. In the latter section they are tightly pressed against the stem, each one covering the leaf next above it; hence they overlap like the scales of a fish, and nothing of the real leaves is visible from without. (C, 2 and D, 3.)

These specially developed stipules serve several purposes. In the first instance they afford good protection to the somewhat delicate leaves against the rays of the sun, diffusing the light before it reaches the green tissue, while at the same time they retard the transpiration of the leaves considerably.

They are of further advantage to the plants in enabling them to absorb rain and dew. All species of *Anacampseros*, and specially those of the section *Avonia*, inhabit some of the most arid parts of South Africa, where the annual rainfall, on an average, does not amount to four inches, and where years occur with less than one inch. But even in those districts nights with dew are not rare, at least not in winter, and the power to absorb and utilise it must be a great help to these dwellers in the desert.

They also show a striking similarity to their surroundings, and are consequently good examples of ***protective mimicry*** among plants. *A. ustulata*, which occurs on the ordinary grey or yellowish shales of the Karoo, is dull coloured, while *A. papyracea* and *A. albissima*, which are pure white, have been found only on fields of white milky quartz, and are consequently detected only with difficulty between the pebbles or in the fissures of the rock. When found all are readily eaten by grazing animals.

A. ustulata is called the ***moerplantje***, as farmers use it for preparing a kind of yeast which is employed in the baking of a favourite kind of pastry, viz. "moer-bolletjes." It is also used in the brewing of beer by the natives. Whether the herb really adds to the efficiency of the yeast has not been ascertained as yet.

In the section *Telephiastrum* the absorption of dew is effected, although in a less copious way, by the fringe-like stipules.

Anacampseros Telephiastrum is fairly frequent in all parts of the Karoo, including the Robertson Karoo from Worcester westwards.

Anacampseros ustulata has a wide range, occurring also on the Nieuwveld, while *A. quinaria* is known only from Little Namaqualand.

A. papyracea occurs in the Ladismith and Prince Albert districts.

Fam. 22. Portulacaceae.

(Plate 55, facing page 209.)

Herbs or shrubs with entire, mostly fleshy leaves. Flowers bisexual (except *Ceraria*), regular; perianth double; calyx formed of 2 (S. A.) strongly imbricate, deciduous sepals. Corolla formed of 5 (4—6) free or connate, very deciduous petals. Stamens opposite the petals, mostly more numerous. Ovary superior (in *Portulaca* half-inferior), 1-celled; styles 2—3; ovules 1—∞, on a central basal placenta. Fruit a capsule, mostly valvate, or indehiscent (*Portulacaria*, *Ceraria*), in the latter cases 1-seeded, otherwise seeds ∞; embryo peripheric, curving round the farinaceous perisperm, or nearly straight (*Anacampseros*).

Ecology. The flowers of *Anacampseros* (Sect. *Telephiastrum*) are showy (pink), but very fugacious, opening only for a few hours (afternoon) in bright sunlight. Those of *A. papyracea* and the other members of the section *Avonia* are cleistogamous, for, although provided with large rose-coloured petals, they very rarely emerge from between the papery stipules of the apical leaves, but seed regularly all the same, being evidently ***self-pollinated***. Those of the other species are visited by various flies and bees.

Portulaca oleracea is a common weed. *Purslane; postelein; varkenskost.*

KEY TO THE GENERA.

A. Ovary superior.

a. Ovules ∞ ; capsule ∞ -seeded, splitting lengthways.

I. Seeds wingless; embryo circular.
Several S. A. species (E., No.). Flor. Cap. II, 385.
1. **Talínum** *Adans.*

II. Seeds winged; embryo nearly straight.
Endemic. 12 species. Flor. Cap. II, 382.
2. **Anacámpseros** *L.*

b. Ovary 1-ovuled.

I. Flowers bisexual. Fruit a winged nutlet, 1-seeded.
Endemic. 1* species (*P. afra*) SE.
Flor. Cap. II, 385.
3. **Portulacária** *Jacq.*

II. Plant dioecious. Fruit (when ripe), fleshy, not winged.
3 species. Shrubs. Nam.
4. **Ceraria** *Pears. & Stephens*

B. Ovary half-inferior. Capsule membranous, circumscissile.
3 species in S. A. (Flor. Cap. II, 381.)
5. **Portuláca** *L.*

* Prof. H. H. W. Pearson and Miss E. L. Stephens have removed *P. namaquensis* Sond. from this genus to the newly established genus *Ceraria*. Annals S. A. Museum, Vol. IX, 32 (1912).

Fam. 23. Caryophyllaceae.

(Plate 57.)

Herbs, rarely dwarf undershrubs, with entire, mostly opposite leaves. Flowers bisexual, regular; perianth double or the corolla sometimes 0; calyx 4—5-cleft or -parted, persistent; petals 4—5, entire or 2-fid, free. Stamens mostly 10, in 2 rows, rarely 5 or 4. Ovary free, 1-celled or incompletely 2—5-celled in the lower part; styles 2—5, spreading or connate; ovules 2—∞, rising from a basal central placenta. Fruit a many-seeded capsule or a nut (Paronychieae). Embryo peripheric, curving round the farinaceous perisperm.

Ecology. The flowers are mostly entomophilous. Several species with showy flowers (*Dianthus*, *Silene*) are visited by butterflies, or, if closed during the day, like some species of *Silene*, by moths; those with small flowers like *Stellaria*, by flies. The seeds of several species or genera are winged; others are equally easily dispersed by the wind, owing to their small size, hence some introduced species have become common weeds in gardens and fields, *e.g.* *Stellaria media* (*chickweed*), *Silene gallica* (*gunpowder weed*).

The pink and the carnation (*Dianthus Caryophyllus* L. from the Mediterranean) are cultivated in many varieties as garden flowers. *Spergula arvensis* (spurry) is occasionally cultivated in sandy soil as a fodder plant. Flor. Cap. 1, 120.

The family as here defined includes **Paronychieae** of Harvey's Genera, described under **Illecebraceae** in Flor. Cap. Vol. v, 1, 398.

KEY TO THE GENERA.

I. Subfam. Alsinoideae.

Sepals 4—5, free; petals and stamens hypogynous; petals not clawed.

Series A. Fruit a capsule, opening with teeth.

Tribe I. **Alsineae.** Stipules 0. Petals 2-fid, styles free.

A. Styles 3. Capsule globose. (Plate 57.)
1 European species (*St. media*).
Flor. Cap. 1, 130. 1. **Stellária** *L.*

B. Styles 5, rarely less, opposite the sepals. Capsule cylindrical.
Several S. A. species, others as weeds. Flor. Cap. 1, 130.
2. **Cerástium** *Dill.*

Tribe II. **Sperguleae.**

Stipules membranous. Petals entire; styles free.

A. Styles 5; petals white.
1 introduced species, *Sp. arvensis.*
Flor. Cap. 1, 135.
3. **Spérgula** *L.*

B. Styles 3; petals pink or purple.
3 widely diffused species, in brackish soil.
(Syn. *Lepigonum* in Flor. Cap. 1, 134.)
4. **Sperguläria** *Presl.*

Tribe III. **Polycarpeae.**

Stipules membranous. Styles connate below.

A. Petals 5, deeply 2- or 4-parted.
30, mostly S. American species, 1 of them, *D. cordata*, found at our South Coast.
Flor. Cap. 1, 135.
5. **Drymária** *Willd.*

B. Petals entire.

a. Sepals membrane-edged, sharply keeled.
P. tetraphyllum, a cosmopolitan weed.
Flor. Cap. 1, 133.
6. **Polycárpon** *Loefl.*

b. Sepals membranous, not keeled.
P. corymbosa Lam., widely spread in warm countries.
Flor. Cap. 1, 133.
7. **Polycarpáea** *Lam.*

Series B. Fruit indehiscent.

Tribe IV. **Paronychieae (Illecebraceae).**

Perianth simple or double. Style 1, entire or 2—3-fid. Fruit a minute nut enclosed in the persistent perianth. Stipules scarious.

A. Perianth simple, urceolate. Ovules 2—∞. Leaves subverticillate.
1 species (*P. campestris*) E. and No.
Flor. Cap. 1, 133 and v, 1, 399.
8. **Pollíchia** *Soland.*

B. Ovule 1.

a. Perianth double; petals 5. Leaves alternate.
2 species in S. A. widely spread.
Flor. Cap. 1, 132 and v, 1, 401.
9. **Corrigíola** *L.*

b. Petals 0. Leaves opposite.
The European *H. hirsuta* widely spread.
Flor. Cap. 1, 132 and v, 1, 399.
10. **Herniária** *Tourn.*

Tribe V. **Sclerantheae.**

Perianth simple, of 5 obtuse lobes; styles 2, filiform. Fruit a utricle, enclosed in the thickened perianth-tube. Stipules 0.
S. annuus, a cosmopolitan species as a weed.
Flor. Cap. v, 1, 401.
11. **Sclerânthus** *L.*

II. Subfam. Silenoideae.

Calyx tubular, 4—5-toothed; petals and stamens hypogynous, often supported, together with the ovary, by the lengthened axis (gynophore, thecaphore); petals clawed. Stipules 0.

A. Styles 5; calyx nude at base, its segments elongated, leafy.
A. Githago, in grain-lands, introduced as a weed.
Corncockle; ***Kornroos***. Flor. Cap. 1, 129.
12. **Agrostémma** *L.*

B. Styles 3; calyx nude at base, 5-toothed. Capsule supported by a thecaphore and opening by 6 teeth. (Plate 57.)
Over 300 species, of which about 14 in S. A., several of them endemic. Flor. Cap. 1, 125.
13. **Siléne** *L.*

C. Styles 2; calyx bracteate at base. Capsule opening by 4 teeth. (Plate 57.)
Over 200 species, mostly Mediterranean, 13 in S. A.
Flor. Cap. 1, 122.
14. **Diánthus** *L.*

Plate 57.

A: Silene undulata *Ait.* **B**: S. gallica *L.* **C**: S. Burchellii *Otth.*
D: Dianthus scaber *Thunb.* **E**: Cerastium capense *Sond.*
F: Stellaria media *Cyrill.*

Plate 57.

A. *Silene undulata* Ait. 1. Small piece of plant in flower, with hawk moth, *Chaerocampa cajus.* 2. Flower spread out, the calyx pulled down. 3. Petal with appendage (corona). 4. Ripe capsule, showing the thecaphore. 5. Piece of stem, enlarged, showing glandular hairs.
B. *Silene gallica* L. 1. Plant. 2. Capsule and seeds.
C. *Silene Burchellii* Otth
D. *Dianthus scaber* Thunb.
E. *Cerastium capense* Sond. 1. Plant. 2. Flower. 2/1.
F. *Stellaria media* Cyrill., the **chickweed.** 1. Plant 2. Flower. 2/1.

Silene.

Silene undulata. Perennial, glandularly pubescent and aromatic, the stems branching, 1—3 feet high, especially when growing among bushes; the leaves broadly lanceolate with more or less undulate margins. Flowers white or flushed with pink, opening at night but also in diffused daylight. The plant is very similar to the European *Silene noctiflora*, but differs from it by its undulate leaves and the much shorter thecaphore.

The flowers are visited by various kinds of hawkmoths, *e.g. Chaerocampa cajus*, as figured on plate. The caterpillar of this moth lives on the leaves of the white arum (*Zantedeschia*)

Found in south western Cape Colony only, while the nearly allied *Silene capensis* is more widely spread. The latter possesses an unusually wide range of altitude, being known from the plains as well as some of our highest mountains, viz. the Zwartebergen, where Mr George Travers-Jackson found it on the summit of the Toverkop. (7200 feet.)

Silene Burchellii. This differs from the preceding species by its linear or linear lanceolate leaves, the smaller flowers and the different calyx and thecaphore, the petals being deeply bifid and flesh-coloured. The calyx is clavate, 10-ribbed and sprinkled over with numerous red dots (glands). A variable and widely distributed plant, flowering in spring.

Silene gallica, the **gunpowder weed**, is an annual. Frequent on waste lands and cultivated grounds.

Dianthus. To this genus belong the pinks and carnations, which in their many garden varieties are principally derived from two European species, viz. *D. Caryophyllus* and *D. barbatus.* Several of our South African species form large tufts with numerous flowers, and would be equally suitable for the production of more showy garden plants if improved by cultivation and hybridising.

Dianthus scaber (**Wild pink**; **Anjelier**). This is a comparatively small species, and although nowhere common, it has a wide distribution, occurring in rocky situations from Capetown to the Orange river.

Cerastium capense is nearly allied to the common European *C. arvense*, its ancestors having been probably introduced by migratory birds. It is not confined to cultivated lands, but occurs on hills and mountains often far away from human habitations, while *Stellaria media*, also a member of this family and quite ubiquitous, is a weed of cultivation here as at home (**Sterre muur**).

Fam. 24. **Nymphaeaceae.**

(Plate 58; Figs. 95, 96.)

Aquatic herbs with fleshy rhizomes. Leaves entire, mostly floating on the surface of the water. Flowers large, solitary, on long peduncles, bisexual. Sepals and petals ∞, showing a gradual transition into stamens. Stamens ∞ in several whorls, anthers opening longitudinally.

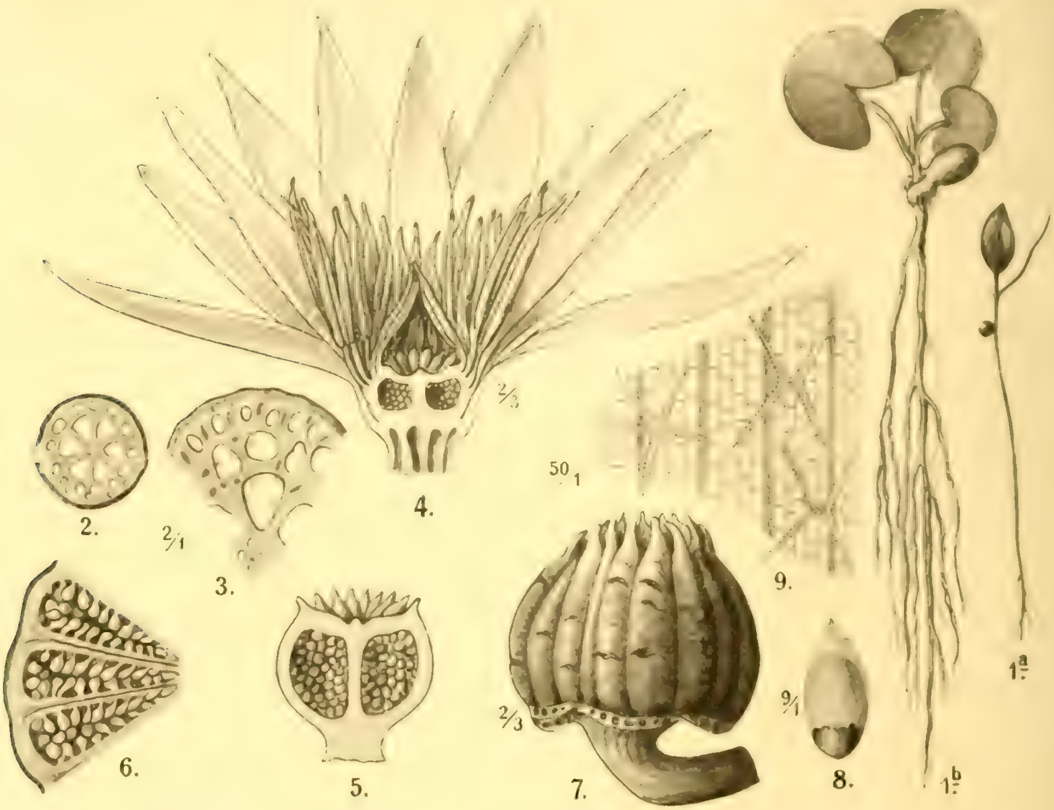


Fig. 95. *Nymphaea stellata* Willd. 1 *a*. Young seedling. (Note the linear cotyledons.) 1 *b*. Young plant. 2. Transverse section of stem. 3. Portion of same enlarged. 2/1. 4. Flower in long. section. (Note that the air channels of the stem terminate abruptly below the flower.) 5. Long. section of receptacle. 1/1. 6. Transverse section of portion of pistil. 5/2. 7. Fruit, after removal of the persistent sepals. 2/3. 8. Seed. 9/1. 9. Tissue of stem, with stellate sclerotic cells. 50/1.

Carpels several, inserted on the inner side of a fleshy receptacle. Ovules numerous. Fruit a fleshy pseudo-capsule, formed by the receptacle and finally opening by decay. Seeds numerous in each compartment, with a hard shell and a membranous arillus. Perisperm as well as endosperm present. Flor. Cap. 1, 13.

Photo by R. Marloth.

Werner & Winter, Frankfort %M.

VLEI IN THE CAPE FLATS

NYMPHAEA STELLATA Willd. TYPHA AUSTRALIS Schum.

Early morning, hence the flowers of the water lily not yet open

The family contains some of the most famous ornamental plants.

Victoria regia, which inhabits shallow rivers of the Amazon valley, possesses leaves up to 2 yards and flowers 16 to 20 inches in diameter.

Nelumbo nucifera, the Indian lotos, has rosy flowers; its seeds are used as food like those of the *Victoria*.

Fig. 96. *Nymphaea stellata* Willd. in the Vlei near Retreat. With *Typha australis* and *Cladium Mariscus*. The shore of the lake occupied by plantations of *Acacia saligna*.

Nymphaea Lotus, the white lotos of the ancient Egyptians*, sometimes called "lotus," opens its delicate, pure white flowers only for a few hours at night.

Nymphaea stellata, the blue lotos, which is equally often represented on Egyptian monuments and sometimes described as a separate species, viz. *N. coerulea*, has a wide range, occurring in India as well as Africa.

* "When the Nile floods the lands many lilies appear which are called '*lotos*' by the Egyptians. The fruit resembles the head of a poppy, and the seeds are ground and baked into bread." HERODOTUS.

This is the only species of water-lily (*plomb*) within our limits*. It inhabits permanent vleis, ponds and calm pools along rivers, bearing sweet scented, mostly blue, but occasionally purple flowers. They open only in sunshine, closing again at night and re-opening next morning when the sun is fairly high. This movement is effected by the sepals, for if these be cut away when spread out, the flowers cannot close again. They do not float on the surface of the water like those of the European water-lily (*N. alba*), but stand upright about a foot above the surface. Pedicels and peduncles are traversed by spacious air-channels, and the tissue contains numerous stellate sclerotic cells, which are a means of defence against snails like the raphides of the sorrels. After flowering, owing to the escape of some of the air in its cavities, the receptacle becomes submerged, and the fruit develops underneath the water. When ripe the walls of the fruit decay, and the pseudo-capsule breaks up, thus liberating the seeds. As each seed is enclosed in the inflated, membranous arillus, it floats on the water and is carried about until the air escapes, finally sinking to the bottom. If the water be not too deep, the seed germinates at once, producing at first only linear leaves without a blade. In very shallow water even the first leaves develop a floating blade. (Fig. 95, 1.)

The only S. A. genus (2 species in S. A.). **Nympháea** *L.*

Fam. 25. Ceratophyllaceae.

Submerged aquatic herbs. Leaves in whorls, simply or repeatedly furcate. Flowers in the axils of the leaves, whitish, monoecious; ♂ flowers with about 12 segments and 12—16 stamens, the anthers with a 2-pointed connective. ♀ flowers with 9—10 segments. Carpel 1, 1-celled, 1-ovuled; style long, subulate; ovule orthotropous with 1 integument. Fruit a nut. Seed with a thin endosperm and 2 large cotyledons.

The only genus (3 species, 1 extending to S. A.). **Ceratophýllum** *L.*

* Wood & Evans, Natal Plants, Vol. 1, t. 33, is apparently *N. madagascariensis.*

Ceratophyllum (*Hornwort*) is the only genus of plants which, apart from Najadaceae, bears permanently submerged flowers (*hydrophilous*). When the anthers have reached the stage of dehiscence, they are forced out of the flower, and, rising towards the surface of the water, scatter their pollen among the interwoven masses of leaves and stems, thus enabling it to reach the female flowers. The stigma of the ♀ flower does not possess any papillae, but

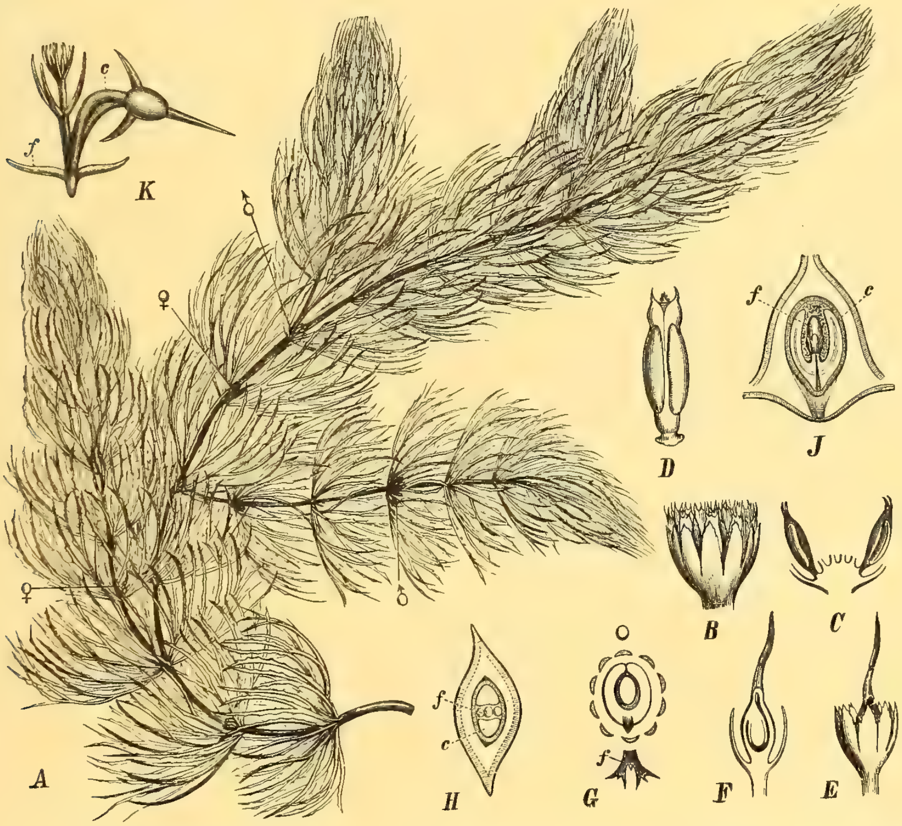


Fig. 97. *Ceratophyllum demersum* L. *A*. Plant with ♂ and ♀ flowers. *B*. ♂ flower. *C*. ♂ flower in long. section. *D*. Stamen, back view. *E*. ♀ flower with perianth. *F*. Long. section of pistil. *G*. Diagram of ♀ flower. *f*. Bract. *H*. Transverse section through fruit. *J*. Median long. section through fruit, the spines omitted. *c*. One of the cotyledons. *f*. First pair of leaves standing at right angles to the cotyledons. *K*. Germination of fruit. (From Engler and Prantl)

the under side of the curved style is viscid and thus capable of retaining the pollen grains.

The fruit floats on the water for a short time and, finally sinking to the bottom, becomes anchored by means of hooked appendages. On germination it produces roots, but these soon deteriorate, and the plants float at or near the surface of the water. *C. demersum*, widely spread, occurs in Natal.

Fam. 26. Ranunculaceae.

(Plates 59—61.)

Herbs or (Clematideae) climbing shrubs. Flowers bisexual. Sepals 3—∞, mostly 5, free, deciduous, green or petaloid. Petals 5—15, often wanting, free, hypogynous, in 1 or more whorls. Stamens ∞, hypogynous, free; anthers adnate. Pistil apocarpous, superior; carpels ∞ *, 1- or few-ovuled. Fruit an etaerio of achenes or drupelets. Seeds with oily endosperm; the embryo minute.

Over 1200 species, mostly in the northern hemisphere, comparatively few in South Africa. All South African species contain acrid or poisonous substances; hence they are avoided by grazing animals. Flor. Cap. 1, 1.

KEY TO THE GENERA.

A. Shrubs, climbing by means of the leaves. Leaves opposite. Achenes with a feathery tail. (Plate 59; Fig. 98.)
6 species in S. A., many others.
Flor. Cap. 1, 1. 1. **Clématis** *L.*

B. Herbs with alternate, cauline or radical leaves.

a. Sepals coloured; petals 0.

I. Inflorescence compound. Sepals 4—5, shorter than the stamens.
2 species in S. A. E, No.
Flor. Cap. 1, 3. 2. **Thalíctrum** *Tourn.*

II. Peduncle mostly 1-flowered. Sepals ∞, longer than the stamens. Achenes dry, tailed. (Plates 59, 61, B.)
4 S. A. species, on the mountains of the South and East. Flor. Cap. 1, 3.
3. **Anemóne** *L.*

b. Sepals green. Petals present.

I. Sepals 5; petals ∞, nearly concolorous with the sepals. Drupelets. (Plate 60.)
Endemic, 10 species.
Flor. Cap. 1, 4. 4. **Knowltónia** *Salisb.*

II. Sepals 3—5. Petals 5—10, coloured. Achenes dry, mostly beaked. (Plates 60, 61, A.)
10 species in S. A., some introduced.
Flor. Cap. 1, 5. 5. **Ranúnculus** *L.*

* *Thalictrum rhynchocarpum* mostly with 1 carpel.

Plate 59.

A: Anemone capensis *Lam.* B: Clematis brachiata *Thunb.*

Plate 59.

A. *Anemone capensis* Lam. 1. Flower and leaf. 2. Receptacle with ripe fruits (some removed) (etaerio of achenes).

B. *Clematis brachiata* Thunb. 1. Flowering twig with visiting bee. 2. Diagram (after Eichler). 3. Receptacle and ripe fruitlets (tailed achenes).

Anemone.

Like *Ranunculus* the genus *Anemone* is far more largely developed in the northern hemisphere than in the southern, extending from North America through Europe and Siberia right into Japan. There are three species in South Africa, each one with its own fairly well-limited area, viz. *A. capensis*, frequent in the South West, but rarer further east, *A. caffra* in the South East, and the beautiful *A. Fanninii* on the Drakensbergen.

A. capensis (***Anemoon***). Rootstock deep and stout, producing one or more shoots every year. Leaves biternate, sometimes with linear segments; scape 1—2 feet high according to locality, with one or, on vigorous plants, two flowers which appear in spring. Fruit an etaerio of tailed and bearded achenes. [See also plate 61, which faces page 222.]

In rainy weather and at night the flowers are drooping and closed, but in sunshine they soon open and stand upright.

This is one of the most beautiful species of the whole genus, the handsome leaves and the delicately rose-coloured, silky flowers exceeding all others in size and gracefulness. Unfortunately it does not lend itself readily to cultivation, growing only in localities which, although not wet, never get quite dry. Such conditions exist on the south western mountains, where the southern winds and their clouds bring sufficient moisture even in summer; hence we do not find the plant in the plains nor further north, and it does not thrive in the gardens of the Cape, where, on the other hand, the less particular Japanese white anemone flowers profusely every autumn.

Clematis.

C. brachiata. Climbing by means of its petioles, which, on coming into contact with a support, soon form one or two coils around it. The plant flowers freely, and as its flowers, although not big, are fragrant it is often grown on trellises and verandahs here and in Europe. In the woods it covers large shrubs or even trees with its delicately cream-coloured flowers, and later on, with its feather heads (***Traveller's joy***). There are a few other species in South Africa, some of them very showy, like *C. Stanleyi*, a shrubby plant 3—4 feet high, with silvery white foliage and pure white flowers, occasionally tinged with pink, more than 2 inches in diameter. (Transvaal, Natal, Rhodesia.) (Fig. 98.)

Fig. 98. *Clematis Stanleyi* Hook. Veld near Johannesburg. Photo. by A. Graham Cook

Ranunculus.

The genus *Ranunculus* has its headquarters in the northern hemisphere, but like a considerable number of other northern genera it is also represented in South Africa, not only by introduced but also by some indigenous and endemic species. One must assume that these have originated from some northern forms introduced by migratory birds during former geological periods.

Ranunculus pinnatus, one of the smaller species of ***buttercups*** (***boterbloem***) of European, or at any rate of northern origin, is now fairly frequent in wet spots throughout South Africa. The hairy variety (*R. pubescens*) goes under the name of "***kankerblaren.***" The equally ubiquitous *R. aquatilis*, which has white flowers, is often found in vleis and ponds.

The indigenous *R. Cooperi*, with beautiful large leaves, occurs on the banks of mountain streams in Natal. (Plate 61, A.)

Knowltonia*. (Plate 60, facing page 223.)

Here as in *Ranunculus* the flowers are complete, although there is little difference in the colours of the calyx and corolla. Sepals 5; petals 5 or 10 or more, green like the sepals or slightly paler. Fruitlets with a juicy mesocarp, forming an etaerio of drupelets of the same nature as that of the blackberry, but poisonous. The genus is sometimes included in *Anemone*.

There are 10 species, mostly endemic in the South West and South, one in the Transvaal.

* Named after Th. Knowlton, a director of the formerly famous Botanic Garden at Eltham. Died 1781.

Photo. E. Dyke

A

Photo R. Marloth.

B

Werner & Winter, Frankfort a/M

A. **RANUNCULUS COOPERI** Oliver
On the banks of a mountain stream in Natal
January 5000 feet

B. **ANEMONE CAPENSIS** Lam.
With BRACHYSIPHON FUCATUS (on left) and LEUCADENDRON DECORUM
October Table Mountain 3000 feet

Plate 60.

A: Ranunculus pinnatus *Poir.* **B:** Knowltonia vesicatoria *Sims*

Plate 60.

[Plate 61 is facing page 222.]

A. Ranunculus pinnatus Poir. 1. Flowering plant. 2. Thalamus with stamens and pistils, long. section. 2/1. 3. Achene, long. section, showing the minute embryo at its base. 6/1.

B. *Knowltonia vesicatoria* Sims 1. Rootstock, leaf (small) and inflorescence. 2. Fruiting capitula, one of them with ripe fruitlets. 3. Long. section of drupelet with minute embryo.

Knowltonia vesicatoria. Rootstock creeping; leaves radical, large, on young plants ternate, on older ones bi- and tri-ternate, leathery, dark green, finely serrate or sometimes entire. Peduncles 1—2 feet high, bearing one or more superposed umbels, the rays mostly simple, flowers one inch in diameter, yellowish green; fruitlets oblong, shining black.

Common in woods and shady ravines of the coast districts, flowering in spring and summer. (Plates 60 and 12.)

The leaves contain an acrid substance like many other members of the family. They are sometimes applied to the skin for producing blisters, hence their colonial name "*brandblaren.*" Even the juice of the ripe drupes is pungent; it would be interesting to know if any animal eats them.

Fam. 27. Menispermaceae (S. A.).

(Plate 62; Fig. 99.)

Shrubs, mostly climbing, rarely erect, with simple, exstipulate leaves. Flowers dioecious. Sepals 1—9. Petals 1, 2, 3 or 6. Stamens 3—15, free or connate. Carpels 3—∞, free, each with 1 ovule. Fruit consisting of 1 or several drupes; drupe 1-seeded, with a fleshy or coriaceous exocarp and a hard endocarp.

About 250 species, most of them in tropical regions, a few only in South Africa. Flor. Cap. 1, 9.

KEY TO THE GENERA.

A. Sepals 6—9; petals 5 or more.

a. Sepals free.

I. Endocarp straight.

1. Fruit glabrous.

3 species, 1 in Na. D. (*D. caffrum.*)

1. **Desmonéma** *Miers*

2. Fruit ellipsoid, strigose. Leaves cordate, mostly 5-lobed.

2 African species, 1 ext. to Natal (*J. palmata*). (*Jateorhiza.*)

2. **Jatrorrhíza** *Miers*

II. Endocarp curved.

1. Sepals 9. Stamens about 15, sub-connate.
7 species; 1 at D. (*A. triplinervia*).
3. **Anisócycla** *Baill.*

2. Sepals 6. Stamens 6.
11 species; 1 at D. (*C. hirsutus*). 4. **Cócculus** *DC.*

b. The three inner sepals connate. Stamens 18.
2 species; 1 at D. (*E. delagoense*). 5. **Epínetrum** *Hiern*

B. Sepals less than 6 in the ♀ flower (S. A.).

a. Sepals and petals in ♀ flower 3—4. Leaves peltate.
32 species; 1 T., Na. Flor. Cap. 1, 10.
6. **Stephánia** *Lour.*
Incl. *Homocnemia.*

b. Sepals and petals in ♀ flower 2. Leaves not peltate. (Plate 62.)
4 species in S. A. Flor. Cap. 1, 11.
7. **Antizóma** *Miers*

c. Sepals in ♀ flower 1; petals 2, often connate. Leaves often peltate.
21 species, 6 in S. A. Flor. Cap. 1, 10.
8. **Cissámpelos** *L.*

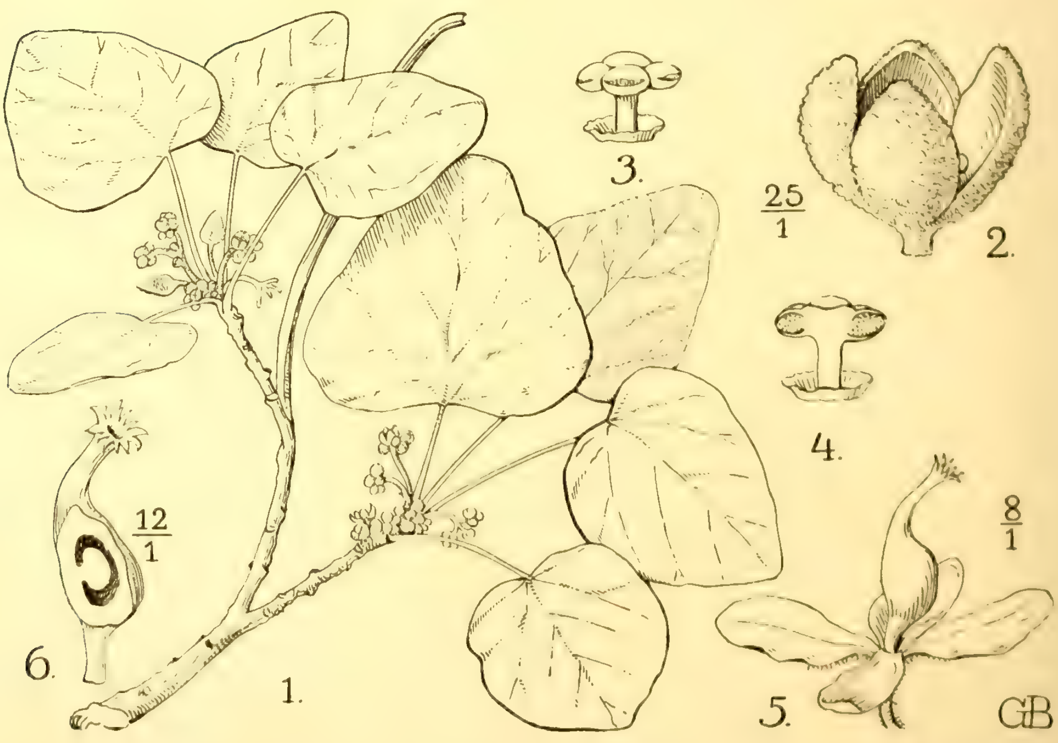


Fig. 99. *Antizoma capensis* (L. fil.) Diels 1. Twig of ♂ plant. 2. ♂ flower. 3. Staminal tube. 4. Staminal tube in long. section. 5. ♀ flower. 6. Pistil in long. section. (*Cissampelos capensis* in Flor. Cap. 1, 11.)

Fam. 28. Anonaceae.

(Plate 62.)

Trees, shrubs or woody climbers. Flowers (S. A.) bisexual. Sepals 3, free or united at the base. Petals 6, hypogynous, in 2 whorls. Stamens ∞, hypogynous, free, linear, with 2 adnate anther cells, the connective dilated. Carpels ∞, free or connate, inserted on a more or less convex receptacle, 1- or more-ovuled. Seeds with ruminate albumen (S. A.).

Trees with simple and quite entire leaves, the parenchyma of all parts, including the flowers, with oil-cells.

About 800 species, mostly in the tropics, very few in South Africa.

Several species are cultivated in tropical and sub-tropical countries, among them *Anona reticulata*, *the custard apple* and *Anona squamosa*, *the sugar apple* (sweet sop).

KEY TO THE GENERA.

A. Carpels free.

a. Fruitlets free.

I. Petals imbricate. Climbers.
1 species. *U. caffra.* Na. D.
Flor. Cap. 1, 8. — 1. **Uvária** *L.*

II. Petals valvate.

1. Petals unequal, the outer larger than the inner ones. Peduncles not hooked.
1 species. *P. caffra* [*Guatteria*]. Na. D.
Flor. Cap. 1, 9. — 2. **Popówia** *Endl.*

2. Petals subequal. Peduncles hard, hooked. Climbers.
1 species. *A. Monteiroae.* Na. D. — 3. **Artabótrys** *R. Br.*

b. Fruitlets connate.
1 species. Na. Tr. (Plate 62.) — 4. **Anóna** *L.*

B. Carpels connate. Petals unequal, the inner ones clawed.
1 species. D. — 5. **Monodóra** *Dun.*

Fam. 29. **Lauraceae.**

(Plate 62; Figs. 100, 101.)

Trees or, as the Cassytheae, parasitical herbs. Flowers usually bisexual. Perianth 4—6 cleft. Stamens usually in 3 whorls; anthers of the outer whorl introrse, of the inner whorl extrorse, 2—4-celled, each cell opening by a persistent valve. Carpel 1, free, unilocular, with 1 anatropous ovule. Fruit fleshy, a drupe (*Ocotea*) or pseudodrupe. Seed exalbuminous, the cotyledons large, usually plano-convex.

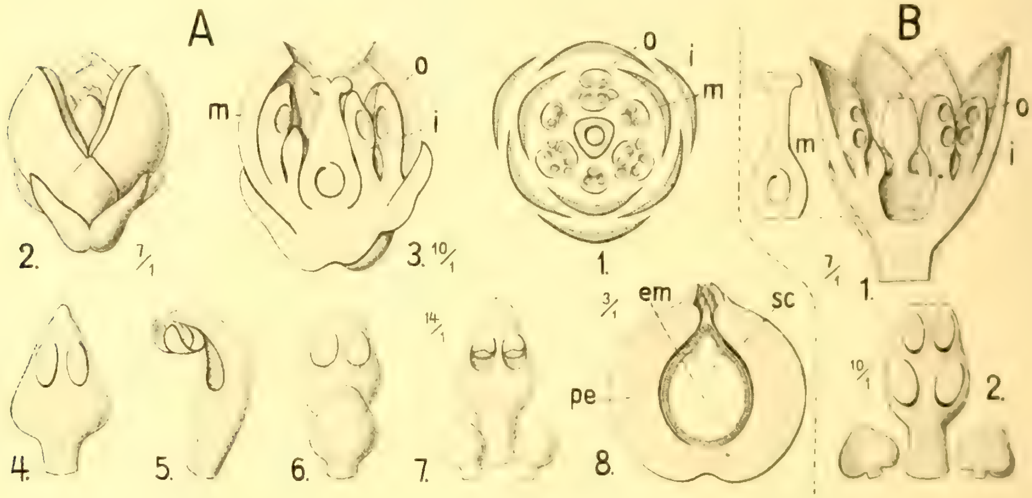


Fig. 100. Lauraceae. A. *Cassytha ciliolata* Nees 1. Diagram of flower. *o.* Stamen of outer whorl. *m.* Stamen of middle whorl. *i.* Stamen of inner whorl. 2. Flower with bracts. 7/1. 3. Flower in long. section. 10/1. 4 and 5. Stamen of outer whorl. 6. Stamen of middle whorl. 7. Stamen of inner whorl. 8. Long. section of fruit (pseudodrupe). *pe.* Succulent perianth. *sc.* Sclerenchyma (pericarp). *em.* Embryo. B. *Ocotea bullata* E. Mey. 1. Flower in long. section: to left the ovary. 7/1. 2. Stamen of inner whorl with basal glands. 10/1.

Various species of this family are cultivated on account of the aromatic oils which they contain, *e.g.* cinnamon, camphor, laurel, while others yield delicious fruits, *e.g.* *Persea gratissima*, the so-called "avocado pear*."

Leaves without stipules, mostly alternate; bark and leaves of the arborescent species with oil-cells or slime-tubes. About 1000 species in the warmer parts of the globe, but only 10 in South Africa. Flor. Cap. v, 1, 493.

* Name a corruption of the Mexican "aguacate."

Plate 62.

A: Cissampelos capensis *Thunb.*
B: Anona senegalensis *Pers.* var.: rhodesiaca *Engl. et Diels*
C: Cassytha ciliolata *Meissn.* D: Ocotea bullata *E. Mey.*

The laurel, *Laurus nobilis*, is often grown in South African gardens (bay leaves), and the camphor tree, *Cinnamomum Camphora*, forms beautiful avenues on some of the old farms in the Stellenbosch district.

KEY TO THE GENERA.

A. Trees.

a. Anthers 4-celled, with 4 valves.
About 200 species, 1 in S. A. (Plate 62; Fig. 100, B.)
Syn. *Oreodaphne* (*in Harv.*) 1. **Ocotéa** *Aubl.*

b. Anthers 2-celled, with 2 valves.
6 species in S. A. 2. **Cryptocárya** *R. Br.*

B. Parasitic herbs, leafless.
3 species in S. A. (Plate 62; Fig. 100, A.)
3. **Cássytha** *L.*

Plate 62.

Fam. 27. **Menispermaceae.**

A. *Antizoma capensis* (L. fil.) Diels [*Cissampelos capensis* Thunb.]
1. Female twig with flowers and fruit. 2. Male twig. 3. Seed. 2/1.

Fam. 28. **Anonaceae.**

B. *Anona senegalensis* Pers. var. *rhodesiaca* Engl. & Diels 1. Flowering twig with one leaf. 2. Section through receptacle with stamens and carpels. 2/1. 3. Stamen. 4/1. 4. Carpel, side view. 5. Carpel, back view. 6/1. 6. Ripe fruit, section. 7. Seed. 8. Section through seed, showing the arillus, the ruminated endosperm and the small embryo.

Fam. 29. **Lauraceae.**

C. *Cassytha ciliolata* Nees (*C. capensis* Meisn.) with flowers and fruits, parasitic on a shrub of *Psoralea aphylla*.
D. *Ocotea bullata* E. Mey. 1. Flowering twig. 2. Fruit. 3. Seed in long. section.

MENISPERMACEAE (page 223).

Antizoma capensis. This plant is usually included in the genus *Cissampelos*, apparently owing to an oversight, for although the description in the Flora Capensis (Vol. 1, p. 10) states that there is only one petal, we have always found two (see Fig. 99), hence we agree with Diels who refers this species to the genus *Antizoma*.

The plant is a shrubby twiner, growing in bushy places in various parts of South Africa. Dioecious; the male shrubs appear to be far more numerous than the others. Fruit a yellow drupe with a flat stone.

As in most climbers the wood of the stem and root is traversed by numerous large air channels which wind about in a very irregular way.

The root is largely used by the colonists as a blood purifier instead of sarsaparilla and goes under the name "*davidjes wortel*."

ANONACEAE.

Anona senegalensis, **Wild custard apple.** Several Anonas come within our limits, the more frequent one being the variety of *A. senegalensis* distinguished as "*rhodesiaca*" by ENGLER and DIELS. It occurs throughout Central Africa and extends southwards as far as Natal. The fruit, a compound pseudocarp, is rather small, not much bigger than a good-sized walnut, and contains only a little orange-coloured but strongly aromatic pulp, in which the black seeds are embedded. In the tropics the plant forms good-sized bushes, but at its southern limit it is only about a foot high, being too often destroyed by veld fires.

LAURACEAE.

Fig. 101. *Cassytha ciliolata* Nees, on young oak. Stellenbosch.

LAURACEAE.

The two plants chosen as representatives of the *Lauraceae* are so different in their appearance, that one would not suspect their close relationship. We find, however, not rarely that those members of a natural group which have adopted a parasitic mode of life degenerate, and therefore differ considerably from the others; as the connecting links are generally missing, the origin of the deviated group often remains obscure.

Cassytha. There are three species in South Africa, viz. the widely spread *Cassytha filiformis*, which extends through the entire length of the continent, and occurs also in Asia, America and Australia; *C. ciliolata* which is more common in the South, and *C. pondoensis*, only known from Pondoland.

The pulp of the fruit is eaten by birds, and the seed thus carried to some distance; it germinates on the ground, but as soon as the little stem comes into contact with a living plant, be that herb or shrub, it attacks it by means of its suckers, the root shrivelling up. Once established in this way it spreads from bush to bush, and even by pieces the parasite will be transferred to clean plants. Occasionally it multiplies to such an extent, that large shrubs or trees succumb to its attacks; we have seen shrubs of *Rhus*, silver trees and oaks killed by the *Cassytha*. (Fig. 101.)

This plant is sometimes erroneously called a dodder, but it is not related to the real dodder in any way, the latter, *Cuscuta*, belonging to Convolvulaceae, which will be treated in the third volume of this work. While the dodder of the lucerne and clover is a dangerous intruder on account of the large number of small seeds which it produces, and cannot be eradicated without considerable trouble and expense, the *Cassytha* is easily dealt with and may be kept in check by a little attention, even if once established in a field.

Ocotea.

This genus of about 200 species, mostly South American, has only one representative in South Africa, viz. *Ocotea bullata*, the *stinkwood*. The vernacular name refers to the strong smell which the fresh wood emits. There appears to be a second species in Natal.

The tree occurs in all natural forests and wooded ravines of the South and North, but is absent from the Eastern Province, re-appearing in Natal and the Zoutpansberg; it is replaced in Eastern Africa by *O. usambarensis*, the only species in Tropical Africa. At the Knysna it forms large trees which supply a most beautiful wood, highly valued for elegant furniture and cart building; hence, where not protected, all good-sized trees have been cut down. In the ravines of Table Mountain all stems down to a diameter of six inches have been felled, and nothing is left besides a few gnarled trunks and young saplings, the latter almost always with large, beautiful, glossy, dark green leaves. In the Grootvadersbosch near Swellendam the trees are as fine as at the Knysna.

The leaves always possess two or more bulging spots near their base, hence the specific name of the plant. Such inflated spots of the lamina of a leaf are called ***domatia*** or ***acaro-domatia***, and are, at any rate on young leaves, inhabited by various kinds of mites (*acari*). The presence of the acari appears to enable other arachnids to thrive there as well; among others we have observed some small, green, quite translucent spiders on the under side of the leaves.

The fruit is set in a curious cup resembling the cupule of an acorn, but of different morphological origin, as it is formed from the receptacle (base of the calyx), while the real fruit is the drupe contained in it. When ripe the pericarp of the fruit becomes almost black. In the genus *Cryptocarya* the cupule encloses the fruit completely, becoming somewhat pulpy like the pericarp, thus forming a pseudodrupe.

Fam. 30. **Monimiaceae** (S. A.).

Trees with opposite leaves. Dioecious. Flowers racemose, with small, scale-like sepals; petals 0. Male flower with ∞ stamens. Female flower with an annular disc; ovary 1-celled, 1-ovuled, with a sessile, subpeltate stigma. Fruit a pseudodrupe. Seed with copious albumen.

The only S. A. genus. 1 species in S. A., 1 in Trop. Afr. and one in Madagascar. Flor. Cap. v, 1, 492.

Xýmalos *Baill.*

Xymalos monospora (Harv.) Baill.

The name is an anagram of *Xylosma* (Bixaceae), in which genus HARVEY [Thes. II, pl. 181] originally placed the plant. It differs, however, too considerably from that genus, and later authors have removed it to Monimiaceae.

No species of *Xylosma* is known within our limits.

A tree 50—70 feet high, abundant in dense parts of the Eastern, Natal and Transvaal forests. Its colonial name is "*Lemoenhout, wild lemon.*" Fruits $\frac{1}{2}$ inch long, bright red. Racemes often produced in clusters from the old, leafless wood.

"It is reserved in all conservancies, and as it endures enormous forest fires without being killed, gaunt and burned, but still living specimens of this tree are often the only remnants left in Kafir gardens to show where the forest has once stood." (SIM, Forest Flora, p. 288. Plate 121.)

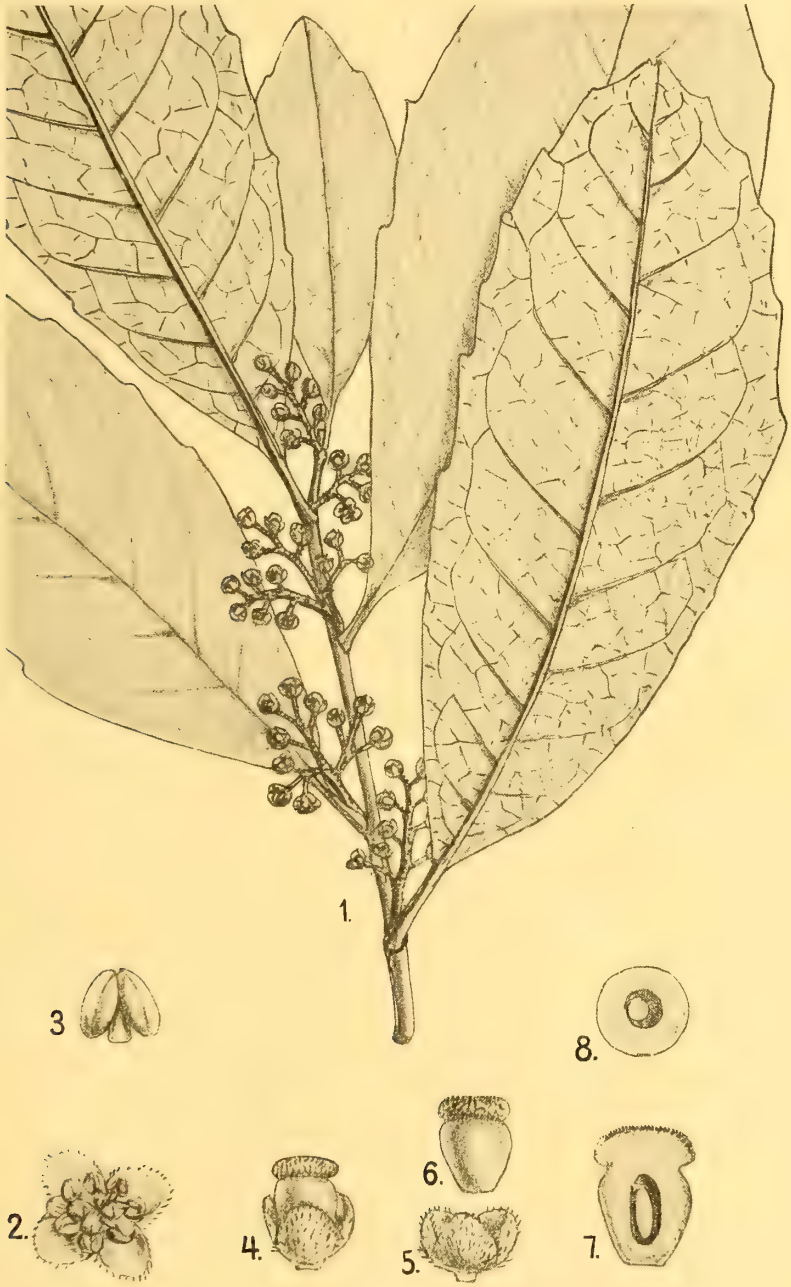


Fig. 102. *Xymalos monospora* (Harv.) Baill. 1. Flowering twig. 2. ♂ flower, artificially opened. 3/1. 3. Stamen. 6/1. 4. ♀ flower. 6/1. 5. Calyx of ♀ flower. 6. Pistil. 7. Ovary in long. section. 10/1. 8. Ovary in transverse section. (From Harvey, Thes., tab. 181; one leaf of each pair absent and the disc of the ♀ flower not shown.)

Fam. 31. Papaveraceae.

(Plate 63.)

Annual herbs (S. A.) with alternate leaves. Flowers bisexual. Sepals 2, deciduous. Petals 4. Stamens 6—∞. Carpels 2—16, connate into a unilocular ovary. Fruit 1-celled, with parietal ovules. Seeds ∞ or 1, albumen oily, embryo small.

About 180 species in the temperate and warmer zones.

The family, as accepted here, consists of 2 subfamilies, viz. Papaveroideae and Fumarioideae. Stems and leaves of *Papaver* and *Argemone* possess much-branched laticiferous tubes filled with a white or, as in the latter case, yellowish latex. In some species this contains narcotic substances, *e.g. P. somniferum*, the common poppy, from certain varieties of which opium is obtained (Asia Minor, India).

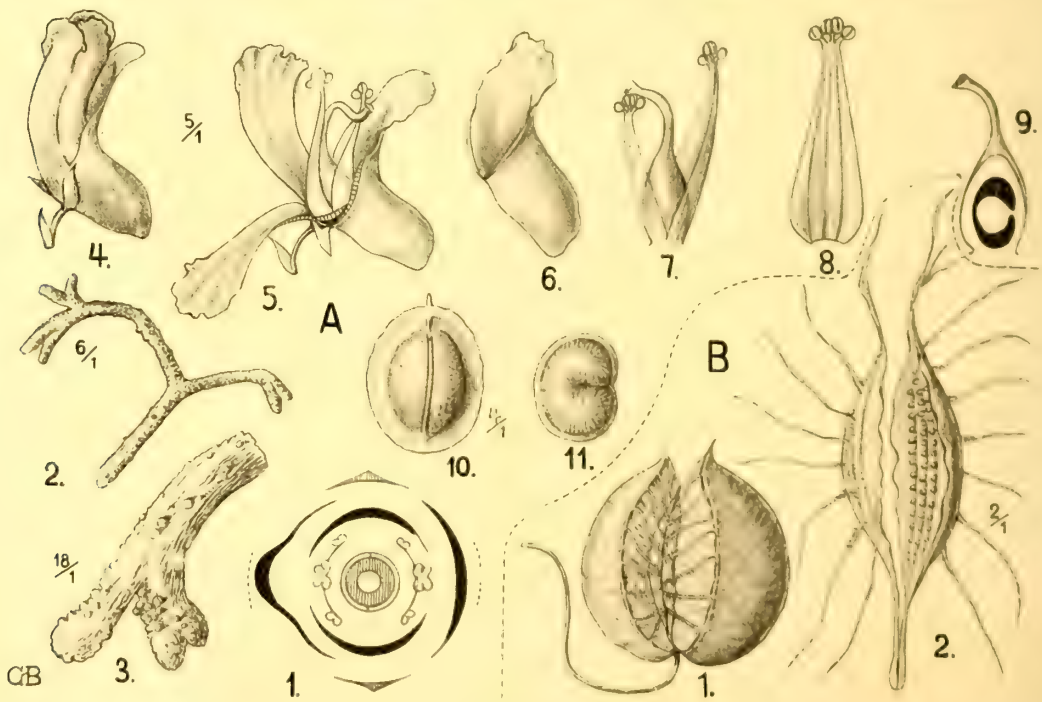


Fig. 103. Papaveraceae. A. *Fumaria Mundtii* Spreng. 1. Diagram. 2. Piece of tendril. 6/1. 3. Apex of tendril, showing papillae of perception. 18/1. 4. Flower. 5. Flower opened; one sepal and 1 lateral petal removed. 6. The spurred petal. 7. Stamens and pistil. 8. One bundle of stamens. 9. Pistil in long. section. 10. Fruit (nut). 4/1. 11. Seed. B. *Cysticapnos africana* Gaertn. 1. Capsule dehiscing, with central false partition (replum), formed by the detached inner ovarial wall (endocarp), and bearing the placentae at its margin, the mesocarp being spongy. 2. Replum with seeds and suspending threads. 2/1.

KEY TO THE GENERA.

A. Papaveroideae. Erect herbs. Petals equal. Stamens ∞.

a. Stigma forming a disc on the apex of the ovary.
40 species, 1 in S. A. (Plate 63.)
Flor. Cap. 1, 15. 1. **Papáver** *L.*

b. Stigmatic surfaces placed between the conniving style branches.
1 American species as a common weed. (Plate 63.)
2. **Argemóne** *L.*

B. Fumarioideae. Climbing herbs. Petals unequal, one or both of the outer saccate at base, the 2 inner callous at the apex. Stamens 6.

a. Fruit a many-seeded capsule.

I. Capsule lanceolate, compressed.
4 S. A. species. Flor. Cap. 1, 16. 3. **Corýdalis** *DC.*

II. Capsule bladdery, globose.
1 endemic species. (Fig. 103, B.) Flor. Cap. 1, 16.
4. **Cysticápnos** *Boerh.*

b. Fruit 1-seeded, indehiscent.

I. Fruit subglobose, with or without a wing.
(Plate 63 and Fig. 103, A.) Flor. Cap. 1, 18.
[Incl. *Discocapnos.*] 3 sp. in S. A. 5. **Fumária** (*Tourn.*) *L.*

II. Fruit triangular.
1 species. *T. curvipes.* End., W. 6. **Trigonocápnos** *Schlechter*

Fam. 32. Capparidaceae.

(Plates 63, 65.)

Herbs, shrubs or trees. Leaves often with stipules. Flowers racemose or solitary, bisexual, mostly zygomorphic. Sepals 4, sometimes connate. Petals 4 (rarely 0), clawed, often unequal. Stamens 4, 6, 8 or many, often inserted on an ***androphore.*** Carpels connate, the ovary supported by a ***gynophore***, ∞-ovuled. Fruit a capsule or berry; seeds kidney-shaped. Embryo incurved. (Fig. 104.)

Over 300 species in the warmer countries.

The family includes few plants of economic importance, *e.g. Capparis spinosa*, a shrub of the Mediterranean countries; its flower-buds are the capers of commerce. Several South African representatives of the genus, *e.g. C. oleoides*, are locally employed for the same purpose.

The root of *Capparis oleoides* (*witstam*), is sweetish and used by the colonists as a substitute for coffee. (Fig. 105.)

Some species of *Capparis* and of the nearly allied genus *Boscia* form dwarf trees in the central and northern districts (Fig. 105). *Boscia* bears a profusion of small, greenish flowers, and those of *B. foetida* (*stink bush*) emit a very evil odour. The fruit is nearly globular, its pulp sweetish and oily, but the seeds contain a pungent principle. Natives often use the pulp as food.

The young foliage of *Capparis* is often devoured by the caterpillars of *Pieris mesentina* (Plate 47), a butterfly very similar to the common European *Pieris brassicae**.

Several species of *Cleome* and *Polanisia*, *e.g.* *P. lutea*, produce showy spikes of flowers and are cultivated in European gardens but rarely here.

Capparis hereroensis is one of the few plants capable of existing on the sand dunes of the western litoral (Namib), but only in the neighbourhood of underground watercourses, even if the water should be brackish and at a considerable depth. In its power to thrive under such extreme conditions it resembles the *naras* (*Acanthosycios horrida*), but unlike this it possesses bright green leaves and consequently attracts the eye of the traveller from a distance. The pale yellow flowers are an inch in diameter, and the fruits resemble small melons. Mules and camels feed on it, but horses cannot do so.

An unusual mode of raising itself above the surrounding bushes is adopted by *Capparis Gueinzii* (Caffraria, Natal). The robust, upright main-shoots produce, at certain intervals, two opposite branches which gradually curve round towards each other until they meet, thus embracing any shrub or tree that might be near by. The growth of these arms stops when they meet, and the pair next above them repeats the process. The species is consequently an "embracing scrambler." (From information by Dr F. C. Kolbe.)

* The larvae of the various species of *Pieris* generally feed on plants of the family Cruciferae and Capparidaceae, probably on account of some compounds of allyl and sulphur which these plants contain.

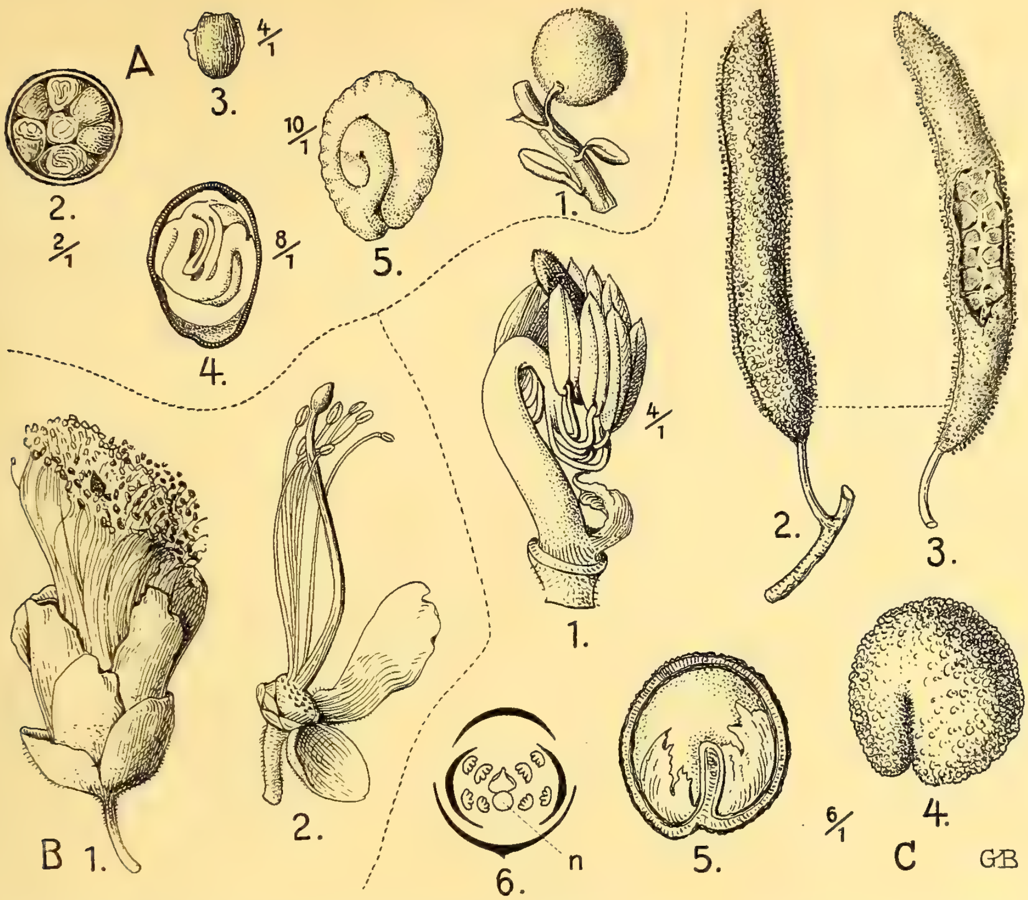


Fig. 104. Capparidaceae. A. *Capparis oleoides* Burch. 1. Fruit. 2. Transverse section of fruit. 3. Seed. 4. Seed, opened. 8/1. 5. Embryo. 10/1. B. *Capparis tomentosa* Gilg 1. Flower. 2. Receptacle with 1 sepal, 1 petal, a few stamens and stipitate ovary. C. *Cadaba juncea* (L.) Benth. & Hook. fil. 1. Androecium and gynoecium with nectary. 4/1. 2. Fruit. 3. Fruit, partly opened. 4. Seed. 6/1. 5. Seed in long. section. 6. Diagram. *n.* Nectary.

KEY TO THE GENERA.

A. Aromatic herbs, with glandular clammy hairs. Fruit a capsule, dehiscing with valves.

a. Stamens 4 or 6, without androphore.
10 species in S. A.
Flor. Cap. 1, 55. 1. **Cleóme** *L.*

b. Stamens 8—32, androphore small.
6 species in S. A. Incl. *Dianthera* and *Tetratelia.*
Flor. Cap. 1, 56. 2. **Polanísia** *Raf.*

c. Androphore elongate.
Syn. *Pedicellaria* Schrank
Flor. Cap. 1, 55.
1 species, *G. pentaphylla.* No. 3. **Gynandropsis** *DC.*

B. Shrubs or trees with leathery leaves. Fruit with a somewhat fleshy or oily pulp, indehiscent.

a. Sepals free or nearly so.

I. Stamens ∞.

1. Petals 4. (Figs. 104, 105.)
12 species in S. A.
Flor. Cap. 1, 61. 4. **Cápparis** (*Tourn.*) *L.*

2. Petals 0.
5 species in S. A. No. (Fig. 106.)
Flor. Cap. 1, 60. 5. **Bóscia** *Lam.*

II. Stamens 4—8 (S. A.). (Plates 63, 65.)
2 S. A. species. Incl. *Schepperia.*
Flor. Cap. 1, 59. 6. **Cadába** *Forsk.*

b. Calyx tubular.
10 species in S. A.
Syn. *Niebuhria.* Flor. Cap. 1, 60. 7. **Máerua** *Forsk.*

Fig. 105. *Capparis oleoides* Burch. near Griquatown, among shrubs of *Rhigozum obovatum.*

Plate 63

A: Cadaba juncea *Harv.* B: Papaver aculeatum *Thunb.*
C: Fumaria Mundtii *Spreng.* D: Argemone mexicana *L.*

Plate 63.

Fam. 31. **Papaveraceae.**

B. *Papaver aculeatum* Thunb. 1. Small plant. 2. Capsule filled with seeds. 2/1. 3. Seed. 30/1. 4. Seed in long. section. 30/1.
C. *Fumaria Mundtii* Spreng.
D. *Argemone mexicana* L. Capsule and seeds.

Fam. 32. **Capparidaceae.**

A. *Cadaba juncea* Harv. 1. Flowering twig. 2. Capsules, ripe. 3. Seeds, one with and one without the oily fruit pulp. (Also Plate 65, opposite page 242.)

Papaver aculeatum (*Wild poppy*). While there are numerous species of poppy in Europe and Asia, one only occurs in South Africa. It is frequent in the eastern and northern districts extending into the Tropics. The flowers are a brilliant scarlet-orange, difficult to describe and to render.

Argemone mexicana (*Mexican poppy*) is an introduced weed, now, owing to the profusion of seeds which each plant produces, of universal occurrence in all the warmer and drier parts of the country. There are often one hundred seeds in a single capsule, and as a moderate sized plant will bear 20 or 30 capsules, a large one perhaps two or three times that number, the weed has been spread by wind and water to such an extent that it is now a real pest, especially along rivers and on irrigated lands. Where care is taken before it is too late, the plant may be kept in check, as we have seen done on several farms in the Kimberley and other districts. The capsule of *Argemone* opens in quite a different way from that of the poppies (Figs. B 2 and D).

Fumaria. The flowers appear at first sight so different from those of the poppy that one often treats it and the allied genera, viz. *Corydalis* etc. as a distinct family, viz. Fumariaceae. The parts correspond, however, so exactly to each other, that it appears preferable not to separate these genera from Papaveraceae.

F. Mundtii. This is sometimes separated from *Fumaria* as a distinct genus, viz. *Discocapnos* (Flor. Cap. 1, 18), the difference being in the little fruits, which are simply globular in *F. officinalis*, the common *fumitory* (*duiven kervel*), but provided with a flat margin in our plant. While our fumitory, although slightly different in its foliage from the European form, is probably of recent introduction, that means to say brought here since the occupation of the country by the white race, the sub-genera *Discocapnos* and *Phacocapnos* (*Corydalis*), which are endemic here, must have originated at a more remote period from ancestors introduced then but now extinct.

There are quite a considerable number of parallel cases in our flora, of which a few may be mentioned here, viz. *Cerastium capense*, *Papaver aculeatum*, *Geum capense*, *Epilobium*, *Viola*, *Stachys*, *Scabiosa africana*, *Hieracium capense*, etc.

Annual, frequent among shrubs of the South West, appearing in winter and flowering in spring, disappearing after fruiting.

Cadaba juncea. This shrub is widely spread from the south coast (Zwartkops) northwards right into Tropical Africa. Only the very young twigs bear a few narrow leaves, the adult branches being leafless. The shrub is a scrambler, reaching a considerable height, viz. 10 feet or more, by insinuating itself between other shrubs and using them as a support; without such aid it is only a couple of feet high and then mostly eaten down into a compact mass by goats and sheep, which nibble off all the thinner branches. The flowers produce an abundant supply of nectar, which attracts bees as well as sun birds (see Plate 65). The fruit is a kind of pulpy capsule, the pulp being rather dry but rich in oil. The ovary and later on the capsule are thickly studded with stalked glands that secrete a sticky film of varnish. This probably serves as a means of distribution for the seed-vessels, which thereby adhere to the bodies of birds when they attempt to eat the oily pulp. Called by the colonists "*zwart storm*."

In Great Namaqualand a variety with yellow flowers and bare fruits occurs (*Cadaba juncea*, var. *nuda* Marl.).

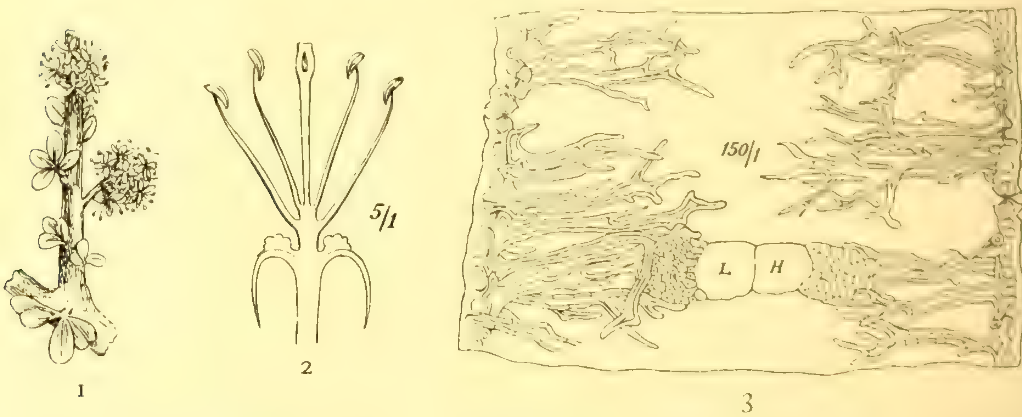


Fig. 106. *Boscia foetida* Schinz 1. Twig. 1/1. 2. Diagrammatic long. section of flower. 3. Transverse section through leaf. 150/1. (After Pestalozzi)

The leaves of several genera, *e.g. Capparis* and *Boscia*, often contain numerous, simple or branched, sclerotic cells. Usually they extend from the epidermis to the centre of the mesophyll (green tissue), thus forming an elaborate frame work, which prevents the collapsing of the leaf in times of extreme dryness of the air. The leaves of *Boscia foetida* (Fig. 106) are isolateral in structure, probably on account of their more or less vertical position, and the sclerotic cells occur on both sides, but most other species have bifacial leaves, with the stomata only on the lower side and the sclerotic cells mostly attached to the upper epidermis.

Plate 64.

A: Brachycarpaea varians *DC.* **B:** Heliophila pilosa *Lam.*
C: H pusilla *L. f.* **D:** Nasturtium officinale *R. Br.*

Plate 64.

A. *Brachycarpaea varians* DC. 1. Small piece of flowering plant. 2. Silicula, containing one seed in each compartment.

B. *Heliophila pilosa* Lam., with bee. Medium sized plant. 2. Ripe fruit (siliqua) of *H. callosa*. 3. Seed, long. section. 3/1. *c*. Cotyledons. *r*. Radicle.

C. *Heliophila pusilla* L. fil. Nat. size.

D. *Nasturtium officinale* L. **Water cress.** 1. Flowering plant. 2. Flower, one sepal and two petals removed. 6/1. 3. Flower in long. section, without sepals and petals. 8/1. *g*. Nectariferous gland. 4. Seed, long. section. 8/1.

Brachycarpaea.

This genus consists of two species only, both confined to the western districts, where quite a number of Cruciferae are endemic. *Brachycarpaea varians* is a compact showy half-shrub, one or two feet high, often quite covered with its pale or deep lilac-coloured flowers.

Heliophila.

This is the largest S. A. genus of the family, containing over 60 species, most of them possessing light blue or white, very fugacious flowers. Some species are annuals, others perennials and some half-shrubby. The tiny *H. pusilla* is as common on fallow grain lands or in the open veld as in Europe the ubiquitous *Erophila verna* (Whitlow grass). The shape of the fruit varies considerably within the genus (see Figs. B and C).

One half-shrubby species, *H. scandens*, is a climber which sometimes covers bushes and hedges with its white flowers. (Natal.)

Nasturtium.

The name *Nasturtium* is unfortunately often employed for a very different plant, viz. *Tropaeolum majus*, a much favoured garden flower, which is cultivated in many varieties. This, however, belongs to Tropaeolaceae, which are nearly allied to Geraniaceae and the sorrels. The mistake has probably arisen from the similarity of their vernacular names, the *Tropaeolum* being sometimes called "Indian cress" or "cresse des capucins."

Nasturtium officinale (**Water cress, waterkers**). This herb is now at home in all temperate regions, having been spread partly by human agency and partly by migratory birds, especially water fowl, which transport the seeds of water plants with the mud that adheres to their feet and feathers.

To those who like water cress a word of warning may not be out of place, for if any contaminated water should find its way into the pond that supplies the herb, the germs of disease may easily be brought into the house of the unsuspecting buyer. No water cress should be used the origin of which is not above suspicion.

It is interesting to note how the plant has been modified since its introduction into South Africa, for while it possesses a strong taste, almost as sharp as mustard seed, when growing wild in Europe, *e.g.* in the Black Forest, it is quite mild here.

Fam. 33. **Cruciferae.**

(Plate 64.)

Herbs or small half-shrubs with alternate leaves and racemose flowers. Flowers bisexual. Sepals 4. Petals 4, cruciate. Stamens 6, rarely less, tetradynamous, the 2 lateral shorter, the anterior and posterior pairs longer. Ovary usually bilocular with parietal placentae, which, by meeting in the centre, form a false dissepiment. Fruit usually bilocular, dehiscing by 2 valves from below upwards, rarely 1-celled and indehiscent. Seeds pendulous, numerous, or rarely solitary; albumen o.

About 1200 species in the temperate and colder regions. Mostly annual or biennial herbs, but in the largest S. A. genus, viz. *Heliophila*, a number of perennial, half-shrubby species occur.

Fig. 107. *Heliophila pilosa* Lam. Diagram. g. Nectariferous gland.

The number of useful plants of this family is very considerable. Cabbage, cauliflower, Brussels sprouts, kale, kohlrabi, turnips, rape, mustard and radish are some of the most commonly cultivated kinds, while stocks and wallflowers are not less favoured garden plants. Some annuals are troublesome weeds, like *Raphanus Raphanistrum* (*charlock, ramanas*) which invades grain lands, and the *shepherd's purse* in gardens (*herderstasje*).

Of South African species none are of special value for domestic use, but quite a number deserve more attention on account of their deep blue or purplish flowers.

It is remarkable that the western coast districts possess several monotypic and endemic genera, viz. *Chamira*, *Cycloptychis*, *Palmstruckia*, *Schlechteria* and *Carponema*.

The characters for the subdivision of the family taken from the seeds afford good means of classification, but the arrangement according to the shape of the fruit is more convenient, although this separates allied genera and splits even a genus (*Heliophila*). For the convenience of the student we give both lists.

I. **Siliquosae***.

Capsule several times longer than broad, opening with valves from below upwards: *Matthiola*, *Nasturtium*, *Sisymbrium*, *Brassica*, *Sinapis*, *Carponema*, *Heliophila* (partly).

II. **Siliculosae.**

Fruit short and broad, dehiscing, or 1-seeded and indehiscent. *Alyssum*, *Heliophila* (partly), *Lepidium*, *Capsella*, *Senebiera*, *Brachycarpaea*, *Cycloptychis*, *Palmstruckia*, *Schlechteria*.

III. **Nucamentaceae.**

Fruit indehiscent, separating into several 1-seeded segments. *Raphanus*.

KEY TO THE GENERA.

A. Cotyledons flat.

a. Edges of the cotyledons directed towards the radicle (accumbent) o=. See Plate 64, D.

I. Fruit subterete.

1. Two of the sepals saccate at base.
   1 S. A. species. C, No.
   Flor. Cap. 1, 20. 1. **Matthíola** *R. Br.*

2. Sepals equal at base. (Plate 64, D.)
   1 endemic species and 1 cosmopolitan (water cress).
   Flor. Cap. 1, 21. 2. **Nastúrtium** *(L.) R. Br.*

II. Fruit linear, the valves flat.

1. Capsule linear-elongate, narrow. Valves not elastic.
   2 species in S. A.
   Flor. Cap. 1, 22 (incl. *Turritis*). 3. **Arabis** *L.*

2. Capsule acute at each end. Valves dehiscing elastically.
   2 widely spread species in S. A., one *C. africana*.
   Flor. Cap. 1, 23. 4. **Cardámine** (*Tourn.*) *L.*

III. Fruit oval.

1. Sepals not petaloid.
   2 species in S. A. Flor. Cap. 1, 23. 5. **Alýssum** (*Tourn.*) *L.*

2. Sepals petaloid.
   1 endemic species. Ca. 6. **Schlechtéria** *Bolus*

IV. Fruit 2-edged or 4-angled, with keeled valves.
   1 species, a weed. Flor. Cap. 1, 22. 7. **Barbaréa** *R. Br.*

* *Siliqua*, the capsule of Cruciferae, if it is dehiscent and longer than broad. *Silicula*, dehiscent or indehiscent, but always at least as broad as long.

b. Radicle appressed to the back of a cotyledon (incumbent) o ‖ .

I. Fruit subterete.

9 species in S. A. Flor. Cap. 1, 24. 8. **Sisýmbrium** (*Tourn.*) *L.*

II. Fruit broad.

1. Fruit didymous. Stamens 2, 4 or 6. Flor. Cap. 1, 27.

4 species in S. A., mostly weeds on roadsides. 9. **Senebiéra** *DC.*

2. Fruit not didymous.

× *Fruit ovate or subcordate.* Flor. Cap. 1, 28.

10 species in S. A. (*e.g.* Cape cress). 10. **Lepídium** *L.*

× × *Fruit triangular.*

1 species as a weed, *C. bursa-pastoris.*

Flor. Cap. 1, 31. 11. **Capsélla** *Medik.*

B. Cotyledons plicate and enfolding the radicle in their groove. o)).

a. Fruit with a flat beak.

1 S. A. species. Flor. Cap. 1, 32. 12. **Sinápis** *L.*

b. Fruit with a cylindrical or conical beak.

3 species in S. A. Flor. Cap. 1, 31. 13. **Brássica** (*Tourn.*) *L.*

c. Fruit moniliform, separating into several 1-seeded segments.

1 species as a common weed. 14. **Ráphanus** (*Tourn.*) *L.*

C. Cotyledons linear, spirally convolute or folded twice (Plate 64, B, 3).

a. Seeds several in each cell.

I. Fruit dehiscent.

1. Calyx not spurred. (Plate 64, B.)

87 species, end. Flor. Cap. 1, 35. 15. **Heliόphila** (*Burm.*) *L.*

2. Calyx spurred.

1 end. sp. (*C. cornuta*). Flor. Cap. 1, 32. 16. **Chamíra** *Thunb.*

II. Fruit indehiscent.

1 endemic species (*C. filiforme*). Cape Flats.

Flor. Cap. 1, 35. 17. **Carponéma** *Eckl. & Zeyh.*

b. Seed 1 in each cell.

I. Valves of the fruit ventricose. (Plate 64, A.)

2 end. sp. W. and Ca. Flor. Cap. 1, 33. 18. **Brachycarpáea** *DC.*

II. Valves of the fruit flat.

2 end. sp. Flor. Cap. 1, 34. 19. **Cyclóptychis** *E. Mey.*

c. Seed 1.

1 end. sp. C. Nam. Flor. Cap. 1, 35. 20. **Palmstrúckia** *Sond.*

Plate 65 *a*.

The scrub consists of *Gymnosporia buxifolia* (*Celastrus buxifolius* in Flor. Cap. 1, 459), a shrub common from Capetown to Natal (see Celastraceae, Vol. II). Among it was growing *Pelargonium inquinans* (see plate in Vol. II) and the *Cadaba*, which, being protected against the goats by the impenetrable hedge of the *Gymnosporia*, had spread its delicate, virgate shoots in various directions.

The photograph shows the black, long-tailed sugar-bird (*Promerops cafer* ♀) sitting on a branch of the *Cadaba* in front of a bunch of flowers.

Photo. P. Marloth

A

Photo. K. Dinter.

B

Werner & Winter, Frankfort a/M.

A. **CADABA JUNCEA** (L.) Benth. et Hook.
With visiting sunbird (Promerops cafer). The scrub formed by GYMNOSPORIA BUXIFOLIA (L.) Szysz.
Addo bush July

B. **MORINGA OVALIFOLIA** Dtr. et Berg.
Great Namaqualand

Fam. 34. Resedaceae.

Herbs (S. A.) with alternate, stipulate leaves. Flowers bisexual. Sepals 2—5. Petals 2 (S. A.). Stamens 3—10. Carpels 2, 4 or 6, connate, but the styles

Fig. 108. *Oligomeris capensis* Harv. 1. Small plant. 2. Flower. 8/1. 3. Androecium with the opened ovary. 4. Fruit. 6/1. 5. Diagram. *p.* Petals.

free; ovary 1-celled; placentae parietal; ovules numerous. Fruit a gaping capsule, 4-horned. Seeds numerous; albumen 0; embryo curved.

A small family of 6 genera with about 60 species. The largest genus is *Reseda* with racemose flowers, which differ from those of *Oligomeris* by possessing 4—7 petals and a conspicuous disc and gynophore.

Reseda odorata (*mignonette*) from North Africa is a well-known garden plant, while *R. luteola* (*Weld, yellow weed*) is occasionally found wild. Flor. Cap. 1, 63.

The only S. A. genus. **Oligómeris** *Cambess.*

Flowers with 2 petals, the ovary sessile.

Four endemic S. A. species and one other widely spread in the Mediterranean countries, Asia Minor and California.

Oligomeris capensis occurs in all the drier districts south as well as north of the Orange river. (Fig. 108.)

Fam. 35. Moringaceae.

(Plate 65 and Fig. 109.)

Trees with deciduous, pinnate leaves. Flowers bisexual. Sepals 5. Petals 5. Stamens 5, staminodes 5, perigynous, inserted on the margin of a concave receptacle. Pistil borne on a short gynophore, 1-celled, with 3 parietal placentae; ovules ∞, pendulous, anatropous. Fruit a pod-like capsule, 1-celled, 3-valved. Seeds attached in the centre of the valves and separated by a spongy tissue, large, amply winged, exalbuminous, with fleshy cotyledons.

The only genus. **Moringa*** *Juss.*

The family consists of one genus only, of 4 species (Africa, Asia). One of them, viz. *Moringa pterygosperma* is cultivated in Tropical countries, the roots being employed like horseradish, while *M. arabica* yields oil from its seeds.

The only S. A. species, *M. ovalifolia*, was recently found by us in the Tsarris mountains, Great Namaqualand. It is a tree 10—20 feet high, with a curiously swollen stem and a whitish, shining bark. Flowers small, white. Growing in rocky situations, shedding its leaves in winter, the new foliage appearing at the beginning of summer (November). Recorded by Dinter from Okahandja and other districts of Hereroland. Fig. 109 and Plate 65.

* The name is derived from the Indian designation of the cultivated *M. pterygosperma*, often quoted as *M. oleifera*.

Fig. 109. *Moringa ovalifolia* Dinter & Berger 1. Twig with ripe capsule. 2. Flower. 2/1. 3. Pistil in long. section. 3/1. 4. Piece of capsule, opened; showing two seeds. 5. Seeds. 6. Embryo. 15/1.

LITERATURE

GENERAL WORKS OF REFERENCE.

BENTHAM, G. & HOOKER, J. D. Genera Plantarum. 3 vols. 1862—1880.

ENGLER, A. & PRANTL, K. Die Natürlichen Pflanzenfamilien. 16 vols. 1889—1897. With 2 supplements, incl. the year 1904.

INDEX KEWENSIS, 2 vols. and Supplementum I, incl. the year 1895.
" " Supplementum II. 1895—1900.
" " " III. 1901—1905.

KUNTZE, O. Revisio generum plantarum secundum leges nomenclaturae internationales. 3 vols. Leipzig, 1891—1893.

INTERNATIONAL RULES of Botanical Nomenclature. 2nd edit. (Brussels congress) Jena, 1912.

ENGLER, A. Das Pflanzenreich. (In course of publication.)
Of the families treated in this volume have appeared: Rafflesiaceae and Hydnoraceae (Heft 5); Myrsinaceae (9); Phytolaccaceae (39); Menispermaceae (46).

Some more important books and papers on Systematic Botany dealing with South Africa.*

ALGAE.

GROVES, H. & J. On Characeae from the Cape Peninsula, collected by Major WOLLEY-DOD. (1 plate.) Journ. Linn. Soc. Bot. Vol. 37. July, 1906.

HARVEY, W. H. Nereis Australis (Algae of the Southern Ocean). With 50 coloured plates, drawn and lithographed by Harvey. London, 1847.

KARSTEN, G. Das Phytoplankton des Antarktischen Meeres. (With 19 Plates, quarto.) Ergebn. Deutsch. Tiefsee-Exp. Band II, 2. Jena, 1906.

WEST, G. S. Fresh-water Algae collected by H. H. W. PEARSON in S. W. Africa, 1908—1911. Annals S. A. Museum, Vol. IX. 1912.

WILLE, N. Ueber einige von J. MENYHARDT in Südafrika gesammelte Süsswasser-Algen. Oesterr. Botan. Zeitschrift 1903. No. 3.

EUMYCETES.

FRIES, E. Fungi Natalenses, collected by J. A. WAHLBERGH. Ex actis Academ. Scient. Holmianae. Stockholm, 1848.

KALCHBRENNER, K. Phalloidei novi vel minus cogniti. Budapest, 1880.

LLOYD, C. G. Synopsis of the known Phalloids. Cincinnati, 1909.

LICHENES.

MASSALONGO, A. B. Lichenes Capenses. Coll. by Wawra. Estr. del vol. x del Ist. Ven. di Scienze. With 8 coloured plates. Venice, 1861.

STITZENBERGER, E. Lichenaea Africana. Verhandl. Naturw. Ges. St. Gallen. 1890—1895.

STIRTON, JAMES. Additions to the Lichen Flora of South Africa. Trans. Glasgow Soc. of Field Naturalists. Part v, 1877.

* Further references are given in: MACOWAN & BOLUS, Catalogue of printed books and papers relating to South Africa (Botany). Trans. S. A. Phil. Soc. Vol. II, 1882.

HEPATICAE.

MITTEN, WM. List of Hepaticae collected by the Rev. A. E. EATON at the Cape of Good Hope. With 2 plates. Journ. Linn. Soc. Bot. XVI, 1877.

PEARSON, W. H. Hepaticae natalenses a clarissima domina HELENA BERTELSEN missae. With 12 plates. In Kristiania Videnskabs-Selskabs Forh. 1886. No. 3. Kristiania, 1886.

—— Hepaticae Knysnanae sive Hepaticarum in regione capensi "Knysna" a HANS IVERSEN lectarum Revisio. With 6 plates. L. c. No. 9. Kristiania, 1887.

MUSCI.

HARVEY, W. H. Thesaurus Capensis, Vol. I, Plate No. 100.

MÜLLER, C. Contributiones ad Bryologiam austro-afram. Hedwigia, Vol. XXXVIII, 1899.

SHAW, J. Catalogue of the mosses of Cape Colony. Cape Monthly Mag. Dec. 1878.

WAGER, H. A. Some new S. A. mosses. Trans. Roy. Soc. S. A. Vol. III, 1913.

PTERIDOPHYTA.

SIM, T. R. Ferns of South Africa. With 150 plates. 1892.

—— Recent information concerning S. A. ferns and their distribution. Addr. and Papers read at the joint meeting of the Brit. and S. A. Assoc. Adv. Sc. With 3 figures. Vol. III, 502. South Africa, 1905, and in Trans. S. A. Phil. Soc. Vol. XVI, 1906.

BURTT-DAVY, J. & GIBBS, CRAWLEY. The families, genera and species of Pteridophyta of the Transvaal. Rep. S. A. Assoc. Adv. Sc. Bloemfontein, 1909.

GYMNOSPERMAE.

HOOKER, J. D. On *Welwitschia*, a new genus of Gnetaceae. Trans. Linn. Soc. Lond. Vol. 24, 1863.

MARLOTH, R. Eine neue Kap-Cypresse (with fig.). Engl. Bot. Jahrb. Vol. 36, 1905.

MASTERS, M. T. Notes on the genus *Widdringtonia*. Journ. Linn. Soc. Vol. 37, 1905.

MIQUEL, F. A. W. Prodromus systematis Cycadearum. Amsterdam, 1861.

PEARSON, H. H. W. Notes on S. A. Cycads. Trans. S. A. Phil. Soc. Vol. XVI, 1906.

—— Some observations on *Welwitschia mirabilis*. Phil. Trans. Roy. Soc. of London, Series B, Vol. 198, 1906.

—— Further observations on *Welwitschia*. L. c. Vol. 200, 1909.

REGEL, E. Generum et specierum Cycadearum Revisio. Petersburg, 1876.

SAXTON, W. H. Preliminary account of the ovule, gametophyte and embryo of *Widdringtonia cupressoides*. Bot. Gaz. Vol. 48, 1909.

—— Contributions to the Life History of *Widdringtonia cupressoides*. With 3 plates. Bot. Gaz. Vol. 50, 1910.

ANGIOSPERMAE (Monochlamydeae).

Flora Capensis. Based on the system of Bentham and Hooker's Genera Plantarum.

[Vols. I—III by Harvey and Sonder; the others by various authors, edited by Sir Wm. Thiselton-Dyer.]

Vol. I. Thalamiflorae and part of Calyciflorae. 1859—1860.
" II. Leguminosae—Loranthaceae. 1861—1862.
" III. Rubiaceae—Campanulaceae. 1864—1865.
" IV, Sect. 1. Vacciniaceae—Gentianaceae. 1905—1909.
" IV, " 2. Hydrophyllaceae—Pedalineae. 1904.
" V, " 1. Acanthaceae—Proteaceae. 1909—1913.
" V, " 2. Euphorbiaceae, &c. (In preparation.)
" V, " 3. Hydrocharideae—Scitamineae. 1912—1913.
" VI. Haemodoraceae—Liliaceae. 1896—1897.
" VII. Pontederiaceae—Gramineae. 1897—1900.

Numerous additional species and genera of S. A. plants have been described or figured in various serial publications, especially in :

Annals of the South African Museum. Capetown.
Botanical Magazine. London.
Bulletin de l'herbier Boissier. Geneva.
De Wildeman, E. Icones selectae Horti Thenensis. (From the Herb. of the garden of M. van den Bossche at Tirlemont, Belgium.) 6 vols. 1899—1909.
—— Plantae novae vel minus cognitae Herbarii Horti Thenensis. Vol. I, 1904—1907, and 2 parts of Vol. II.
Engler, A. Botan. Jahrbücher für Systematik und Pflanzengeographie.
—— Beiträge zur Flora Afrikas.
—— Monographien Afrik. Pflanzenfamilien. 8 vols. 1898—1904.
Icones Plantarum. London.
Journal of Botany. London.
Journal of the Linnean Society (Botany). London.
Kew Gardens, Bulletin of miscellaneous information.
Records of the Albany Museum. Grahamstown.
Schinz, H. Beiträge zur Afrikanischen Flora. Genf und Zürich.
Trans. S. A. Philosophical Society. Capetown. Vols. 1—18, 1877—1909.
Trans. Roy. Soc. of South Africa. Capetown. Vols. 1—3, 1910—1913.

Books and Papers.

Berger, A. Mesembrianthemen und Portulacaceen. With 67 figures. Stuttgart, 1908.

Bolus, H. & Wolley-Dod, A. H. List of the Flowering Plants and Ferns of the Cape Peninsula. Trans. S. A. Phil. Soc. Vol. XIV, 1904.

Burtt-Davy, J. & Mrs R. Pott-Leendertz. First checklist of the Flowering Plants and Ferns of the Transvaal and Swaziland. Pretoria, 1912.

DINTER, K. Deutsch Südwest-Afrika. Leipzig, 1909.

ENGLER, A. Plantae Marlothianae. With 6 plates. Engler's Jahrb, Vol. X, 1 and 2; Vol. XI, 4, 1888.

—— Die Pflanzenwelt Afrikas, Vol. I (2 parts). With 20 plates, 5 maps, 400 figures. Leipzig, 1910. (General account of the vegetation.)

—— „ „ Vol. II, with 16 plates and 316 figures. 1908. (Pteridophyta, Gymnospermae, Monocotyledones.)

HARVEY, W. H. Thesaurus Capensis. 2 vols, with 200 plates. Dublin, 1859—1863.

—— The Genera of S. A. plants. 2nd edition, edited by J. D. HOOKER. London and Capetown, 1868.

MARLOTH, R. Das Kapland. 28 plates, 8 maps. Quarto. Jena, 1908.

OBERSTEIN, O. Über den Bau der Blattspitzen der *Mesembrianthema-Barbata*. Beih. Bot. Centralbl. XXIX, Abt. I, 1912.

PESTALOZZI, A. Die Gattung *Boscia*. Bull. de l'Herbier Boissier. Tome VI, App. III. With 14 plates. Geneva, 1898. Also in Mitteilung. Bot. Mus. Zürich, Vol. VII.

SCHÖNLAND, S. List of the Flowering Plants found in the districts of Albany and Bathurst. Records Albany Museum, Vol. II. Grahamstown, 1907.

SIM, T. R. Sketch of the Flora of Kaffraria. Capetown, 1894.

—— The Forests and Forest Flora of Cape Colony. With 160 plates. Quarto. Aberdeen, 1907.

—— The Forest Flora and Forest Resources of Portuguese East Africa. With 100 plates. Quarto. Aberdeen, 1909.

THONNER, FRANZ. Die Blütenpflanzen Afrikas. With 150 plates. Berlin, 1908.

WOOD, J. MEDLEY. Revised list of the Flora of Natal. Trans. S. A. Phil. Soc. Vol. XVIII, 1908.

—— Supplements to the preceding paper. (Apocynaceae—Asclepiadaceae and additions.) Trans. Roy. Soc. S. A. Vol. I, 1910 and III, 1913.

WOOD, J. MEDLEY & EVANS, M. S. Natal Plants. 5 Vols. with 100 plates each. Durban, 1899—1908.

ZAHLBRUCKNER, A. Plantae Pentherianae. Annalen K. K. Nat. Histor. Hofmuseums. Wien, 1901—1905.

ABBREVIATIONS EMPLOYED IN THE KEYS.

C. C. Cape Colony.
Ca. Cape region (South west. C. C.).
C. Central region (Karoo and Karroid Plateau).
D. Delagoa Bay and district.
E. Eastern Cape Colony.
F. Forests of the South Coast.
K. Karoo.
Kal. Kalahari.
Na. Natal.
Nam. Namaqualand.
Nam. (L.) Little Namaqualand.
Nam. (G.) Great Namaqualand.
No. North of Orange river.
N.E. North Eastern Cape Colony and Orange Free State.
N.W. North western C. C.
S. W. A. South Western Africa north of Orange river.
T. Transvaal.
W. Western coast districts.

FLOWERING PLANTS (VOL. I).

INDEX OF GENERA AND SPECIES*.

Synonyms are printed in italics. Introduced plants in spaced type.
Foreign plants in spaced type and without the author's name.
Plants mentioned incidentally only are in italics and without the author's name.

* Index of Thallophytes see page 37; Archegoniatae, page 84.

NOTE. In a few cases the spelling of a name in the text or on a plate differs from that in the index. The latter is then the correct form.

NAMES OF ANIMALS

AVES

LEPIDOPTERA

COLEOPTERA

HYMENOPTERA

HEMIPTERA

COLEMBOLA 161

GENERAL INDEX

Popular names of S. A. plants in black type.

ADDENDA.

I. To page 96, third paragraph:

The reference to Dr Rattray's observations was based on a resumé of his paper submitted at the meeting of the Royal Society of South Africa on April 16th, 1913. The paper* has now been published in full, and on reading it we find that, although the name of the insect observed by the author on the flowers of *Encephalartos Altensteinii* and *E. villosus* is given as *Phloeophagus hispidus* [Cossoninae], the description shows that it is *Antliarhinus zamiae* (Plate 15) [Antliarhinae]. This simplifies the position very much.

The evidence for the entomophilous nature of these Cycadaceae consequently stands as follows:

1. *Phloeophagus hispidus* and *P. ebeninus* were collected by Miss Pegler on ♂ plants of *E. villosus*, and Prof. Pearson thought it not unlikely that these weevils were concerned in the transport of the pollen to the ♀ cones. (H. H. W. Pearson, Trans. S.A. Phil. Soc. xvi, 348 (1906).)

2. *Derelomus languidus* was subsequently collected by Miss Pegler on both sexes of *E. villosus*. (See page 96.)

3. *Antliarhinus zamiae*, which regularly infests the seeds of both species (see pages 96 and 99), was observed by Rattray in large numbers (♂ and ♀) on the male cones of both species, and the female insect a few days later within the ♀ cones in the open spaces between the ovules.

4. The same insect, called at that time *Curculio zamiae*, was found by Thunberg (1773) in the seeds of *E. caffer* (Thunb. Flora Cap. p. 430).

It is therefore obvious that, although *Antliarhinus* destroys a good many seeds of these Cycadaceae, their pollination principally depends upon its presence. The case is quite similar to that of the Yucca-moth (*Pronuba*).

* G. Rattray, Notes on the pollination of some S. A. Cycads. Trans. Roy. Soc. South Africa. Vol. iii, 259 (1913).

The fact that *Antliarhinus* (3 species) represents a very isolated group, which has been found so far only in the eastern parts of the Cape Colony, and that its life-history is so intimately interwoven with that of the genus *Encephalartos* indicates that these insects must be also of ancient origin.

II. To page 183: *Atriplex Halimus* is also called ***Brak vaalbos*** or ***Vaalbrak***.

THE SUPPLEMENTARY VOLUME (V) WILL CONTAIN

1. A synopsis of the genera of South African Angiosperms.
2. An alphabetical index of the genera of S. A. Angiosperms.
3. A map with explanatory notes on the phyto-geographical regions of South Africa.
4. An index of English and Dutch names of South African plants.

TO THE READER

The author will be grateful for any information concerning the names, uses, distribution, habits, biological features etc., of S. A. plants, whether treated in this volume or not. All additions or corrections of importance will be included in the supplement.

Photographs of South African trees, shrubs, flowers etc. are specially welcome and would be bought or accepted in exchange.

Living plants of all succulents for cultivation are specially solicited, *e.g.* species of *Mesembrianthemum*, *Anacampseros*, *Crassula*, *Cotyledon*, *Euphorbia*, *Pelargonium*, *Pachypodium*, *Stapelia* and other asclepiads, *Kleinia* and similar composites, *Aloe* and allied genera etc., as much has to be learned concerning their distribution and biology.

CAPETOWN
P.O. Box 359.

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ERRATA.

p. 94 line 18 for *Fig. 63* read *Fig. 64*.
p. 97 ,, 5 from bottom for *Fig. 64* read *Fig. 63*.
p. 132 fig. 74. The twig A represents *M. cordifolia*.
p. 136 line 26 for *Apocrypha* read *Apocrypta*.
p. 177 ,, 3 from bottom for *Arnoldii* read *Arnoldi*.
p. 180 ,, 3 for *page* 189 read *page* 192.
p. 204 ,, 19 for *zuurvygen* read *zuurvijgen*.
p. 206 ,, 12 for *Fig.* 90 read *Fig.* 91 *a*.