

THE  
BOTANY OF BIHAR AND  
ORISSA

BY  
H. H. HAINES, C.I.E., F.C.H., F.L.S.  
LATE CONSERVATOR OF FORESTS, BIHAR AND ORISSA

VOLUME I

REPRINTED UNDER THE AUTHORITY  
OF THE GOVERNMENT OF INDIA

BOTANICAL SURVEY OF INDIA  
CALCUTTA

Reprinted Edition 1961.

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By

GOVERNMENT OF INDIA.

Printed by  
P. C. Ray  
At Sri Gouranga Press Private Ltd.,  
5, Chintamani Das Lane,  
Calcutta - 9.

THE  
BOTANY OF BIHAR AND  
ORISSA

AN ACCOUNT OF ALL THE KNOWN INDIGENOUS  
PLANTS OF THE PROVINCE AND OF THE  
MOST IMPORTANT OR MOST COMMONLY  
CULTIVATED EXOTIC ONES

*WITH MAPS AND INTRODUCTION*

BY

H. H. HAINES, C.I.E., F.C.H., F.L.S.

*Late Conservator of Forests, Bihar and Orissa*

IN SIX PARTS

PART I

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### DATES OF PUBLICATIONS

Part I, pp. i—x and pp. 1—199	...	...	1925
Part II, pp. 1—224	...	...	1921
Part III, pp. 225—418	...	...	1922
Part IV, pp. 419—754	...	...	1922
Part V, pp. 755—1058	...	...	1924
Part VI, pp. 1059—1350	...	...	1924

#### CORRESPONDING CHANGES IN PAGINATION in the Reprinted Edition.

- Pp. 1—199 correspond to pp. 1—192 (Vol. 1).
- Pp. 1—224 correspond to pp. 1—233 (Vol. 1).
- Pp. 225—418 correspond to pp. 235—437 (Vol. 2).
- Pp. 419—754 correspond to pp. 439—791 (Vol. 2).
- Pp. 755—1058 correspond to pp. 793—1106 (Vol. 2 & 3).
- Pp. 1059—1350 correspond to pp. 1107—1372 (Vol. 3).

To  
SIR EDWARD ALBERT GATT, K.C.S.I., C.I.E., I.C.S.

LIEUTENANT-GOVERNOR OF BIHAR AND ORISSA

(1915-1920)

WITHOUT WHOSE ENCOURAGEMENT THIS WORK COULD  
NOT HAVE BEEN WRITTEN,  
IT IS RESPECTFULLY INSCRIBED WITH GRATITUDE  
AND AFFECTION

## PREFACE

AN apology is necessary for the sub-title of this book, as large groups of plants of which very little is known in Bihar and Orissa, viz. the algæ (including *Characeæ*), fungi and *Muscineæ*, have not been touched upon. Among the higher plants very much still remains to be done before the botany of the province can be regarded as worked out, even in the very narrow sense of all the species being known. The basis of the book is my own notes and collections,\* and the duties of a forest officer in India leave so little time for the pursuit of botany that not only have interesting plants been frequently observed which there has been no time to collect, but often specimens collected have become useless, and had to be thrown away while awaiting opportunity for examination or drying. In some cases, especially on my only visits to special localities, such as the Mayurbhanj Mountains and the Orissa delta, the quantity of drying paper carried has proved insufficient to cope with the new material. Finally, some districts, including many of the native states, have not been botanized at all. There is, therefore, plenty of even ordinary field work remaining to be done by those who take an interest in the natural history of plants, and for anyone with a settled residence and a garden, where doubtful species and varieties could be cultivated and watched, the field is practically unworked. Perhaps the largest collector of herbs in the province has been C. B. Clarke, who, in addition to good specimens, has frequently supplied accurate drawings and valuable notes. Clarke collected chiefly (so far as our province is concerned) in Chota Nagpur. He more especially appears to have turned his attention to the rice field flora. Next to Clarke in the extent of his collections in the province was the distinguished biologist Buchanan-Hamilton. In 1801-02 he went by river to Patna, and then marched through Saran and Tirhut to Nepal,† but of more importance than this was his long residence in our Northern tract, commencing in 1809 and continuing with short breaks to 1812-13, during which time he was engaged in the statistical survey of Purneah, Bhagalpur (as it then was), Monghir (or Monghyr, Mungger of his MS.), Patna and Shahabad. The collections of Buchanan-Hamilton, which include woody plants as well as herbs, are well represented in the Wallichian Herbarium at Kew, where I have had the opportunity of consulting them, though want of time prevented my going through them systematically until I had nearly completed the Flora. A complete set of Hamilton's collections from 1807-1814 are said to be represented in the Herbarium, but this seems scarcely credible, as, with the exception of the Monghyr

\* The sign ! after a locality, without the addition of a collector's name, indicates specimens seen by me *in situ*.

† "Sketch of the life of Francis Hamilton (once Buchanan)" by Sir D. Prain in the *Annals of the Royal Botanic Garden, Calcutta*.

district and the country around Nathpur, the flora of the Bihar and Orissa districts is poorly represented, and of numerous plants alluded to in the manuscripts there are often no specimens.\* The results, therefore, of this examination have been disappointing. They have been shown in Appendix I. The manuscripts of Hamilton are in the India Office Library, but interesting as they are, the plants mentioned are for the most part under their vernacular names. Occasionally the technical name is given, or they are referred to the species described in Rhede's *Hortus Malabaricus*, or other data are given which sufficiently determine the species. But as the value of a provincial flora is greatly discounted by being spread over a large number of years, I have not thought that the advantage to be gained by identifying all these references would be commensurate with the time which would have to be spent on them. In the case of Monghir, of which the flora is most completely described, and of which I myself have not close acquaintance, the gist of Hamilton's account is given in the Introduction. The important collection from Manbhum of the late Rev. Dr. Campbell I particularly noticed in the *Forest Flora of Chota Nagpur*, and I have not been able further to visit it, though many duplicates of Campbell's in the Kew and Calcutta Herbaria have been made use of. A small collection, but containing nevertheless some records not found elsewhere, was made in the province by Sir J. D. Hooker. Hooker entered it at the boundary of Burdwan and Manbhum, and marched along the Grand Trunk Road, ascending Parasnath *en route*, through parts of Manbhum, Hazaribagh and Gaya to the Sou. He then passed over the Kymore Hills (Shahabad district) and dropped down the Ganges to Caragola ghat (in a boat, so that very few specimens are available from this part of the route). He then proceeded through Purneah, leaving the province at Titalyah, for his celebrated Himalayan tour. The collections of Kurz were made chiefly along the Ganges and in Behar—an unfortunately vague term which has been used in various senses, and used to include the northern half of Chota Nagpur as well as most of the area between Chota Nagpur and the Ganges, as in the map attached to the *Flora Indica* of Hooker and Thomson.† Where Behar is given on the tickets of specimens collected by Kurz or others without further information being available it is so mentioned in the Flora, otherwise the term has not been used. In this connection it might be observed that the word "Orissa" as used in botanical works does not necessarily refer to the Orissa as at present understood. The term as used by Hooker and Roxburgh included all

\* To take a concrete instance, Hamilton's No. 2093. "*Phyllanthus sanphalia*," which was collected in Monghyr and has been seen by Col. Gage at Edinburgh, is not in the Wallichian Herbarium.

† The province of "Bahar" (Behar) in the *Description of Hindostan* by Walter Hamilton (1820) embraced the province of Bihar and Orissa as now constituted without Purneah, Singbhum, Sambalpur, or any part of Orissa. Then again there was also a district of "Bihar" which also fluctuated in area, at one time embracing all of what is now known as Gaya, as well as parts of Shahabad, Patna and a piece of the old district of Ramgarh (now in Hazaribagh). Buchanan-Hamilton's account of Bihar and the city of Patna is applicable to the present Gaya and Patna.

Madras north of the Godavari, and it appears in a few cases to have been used in this wider sense in *Bengal Plants*, some of the specimens recorded as being from Orissa having been collected by Cleghorn and others south of the present political boundary. Gamble and Wood, who collected in Chota Nagpur, Lace, who collected in Orissa, Hope in Behar, Griffith in Sambalpur, Hieronymus in Champaran, and the Rev. Father Cardon, who collected orchids in Chota Nagpur, are among other botanists whose collections from our province are represented to a smaller extent in the herbaria at Kew and Calcutta. There are also a few specimens collected by Thomson, Anderson and Prain, but a considerable number of specimens, chiefly grasses, were collected by Nusker and Mokim—collectors sent out by Prain while Director of the Botanical Survey. These were chiefly from the Santal Parganas, Monghyr and Gaya. With the exception of Gamble and Lace, and to some extent Hamilton, the botanists mentioned above chiefly confined their attention to the more cultivated parts of the province. Both duties and inclination have led the author into the wilder and least cultivated regions. Camping wherever possible within the forest itself, and when the evening's office work would permit, walking out again after the labours of the day with a rifle as sole companion, his opportunities for nature study have been of a kind complementary to those of most of his predecessors in the botanical field, and there is scarcely an indigenous species of tree or shrub described in the Flora which he has not personally noted in its own habitat. On the other hand the writer's herbarium is exceedingly deficient in the flora of the open country and in that of the jheels and tanks, as well as in epiphytic orchids, the collection of which entailed more time than could be given. In addition to tours in all the Government forests of the province, the author has visited, either on special duty, or on behalf of private owners, or during short periods of leave, the forests of Champaran, a small part of Shahabad, part of the remaining jungles of Purificah and of Gaya, many of the states of Orissa, and the mangrove swamps of the Mahanadi delta. Before leaving India he spent some five months examining the collections in the Sibpur Herbarium at Calcutta.

Adverting shortly to the scheme of the book: in the body of the Flora, for the convenience of those accustomed to the usual English systematic works, the *Genera Plantarum* has been mostly followed in the sequence of the families of the Angiosperms. In the Introduction there is an alternative system of classification, supposedly more natural, and also descriptions of the larger groups as well as a general compactus of families. This classification is based on various authorities (especially Jussieu, De Candolle, Lindley, Endlicher, Hooker, Arber, Parkin and Scott), and is an elaboration of that in the *Forest Flora of Chota Nagpur*, which it has been understood has been found useful, and assists students, in some cases, to determine the family of a plant whose affinities are less obvious from the arrangement in the Flora.

There has been no attempt at uniformity in the description. These vary in detail according to the necessities of the case, and the treatment of species is very unequal. In general an endeavour has been



made to adopt the arrangement used by Sir J. D. Hooker in his *Students' Flora of the British Islands*, giving first a brief description of the species, then its habitat, and finally fuller details and its uses (if any).

The work being primarily intended for the use of forest officers, it may be asked why it includes all herbaceous plants. In the *Flora of Chota Nagpur* only herbaceous plants of known economic value were described. Experience has shown that this is not a satisfactory arrangement. A forest officer has numerous inquiries addressed to him as to the possibility of obtaining this or that plant in his district. If he does not find it in the provincial flora he may not know whether it occurs or not, and whether a vernacular name only is given for his guidance in the indent, he may send something quite different to what is intended. Or it may happen that the economic value of the plant is a new discovery, and therefore, although it may occur in considerable abundance, it will not have been described. I need only quote recent demands for *Chenopodium ambrosoides* (which occurs), for Belladonna and for Henbane (neither of which occur), for *Dhatura* (of which some species occur), and for *Gymnema sylvestris* (which occurs). If the plant be one of a genus of which two or more species occur, it is very essential that *each* be fully described, or the wrong species may be collected. This consideration brings one to the relative uses of a book arranged on the key system only, and one with more complete descriptions. The first, when written by a professional botanist, is very useful to botanists, and also more handy, but for the majority of people who take an interest in plants, whose technical knowledge is more restricted, fuller descriptions of species are essential to prevent errors in identifications. Such errors are exceedingly likely to occur when the plant whose identity it is sought to establish has not before been recorded from the province, and is therefore not in the key—a circumstance likely to be of frequent occurrence in the present state of our knowledge of Indian provincial floras. The above are merely utilitarian reasons for endeavouring to include as many of the indigenous plants as possible in the Flora, but I venture to think that those who study plants merely for the love of them and what they teach are as worthy of consideration as the practical man. For these an insignificant, otherwise useless plant is as much worthy to be known and named as economically the most important. Finally, it frequently happens that a botanist or forester wishes to identify a plant which is not in flower, or otherwise in a condition showing the particular characters for which the key is adapted. In these cases as many characters as possible are necessary for his purpose, both in descriptions of the larger groups and the species.

The work in the Calcutta Herbarium, carried on in a bad state of health, would not have been possible had it not been for the very great kindness of Col. Gage, the then Director of the Botanical Survey, who not only gave me assistance in the Herbarium itself, but placed his own residence in the gardens at my disposal, thus obviating a tiresome daily journey to and from the Herbarium and Calcutta. My thanks are also due to Mr. C. C. Calder, the Keeper of the Herbarium during

the same period. During the four years employed in writing the Flora, since my return to England, I have repeatedly had to consult the great Herbarium and Library at Kew, and acknowledge with much gratitude the facilities for study given to me by Sir D. Prain and Dr. Hill, successively Directors of the Royal Gardens, and by Dr. Stapf and Mr. Cotton, successive Keepers of the Herbarium and Library. I am indebted to Sir D. Prain also in another way. His book on *Bengal Plants* covers, in addition to the present province of Bengal, the greater part of the ground traversed by the present work, and has served especially as a most useful guide for the existence of specimens in the Sibpur Herbarium, thus decreasing my own labours in searching for records, and indicating the existence of many which might otherwise have escaped my necessarily hurried inspection. To Messrs. Wright, Dunn, Hutchinson and Turrill, of the Kew staff, thanks are due for ever-ready help, and particularly to Mr. Skan for assistance in matters pertaining to the Library. To Mr. Gamble I am indebted, as usual, for the loan of specimens, and I have also had the advantage of the first two parts of his splendid *Flora of Madras*. Since completing part of this Flora, Mr. B. Chatterjee, of the Forest Department, has kindly sent a few specimens from Angul and the Gantal Parganas. One or two of these are new records for the district, and, as in the case of other collectors, where known, his name appears in italics after the name of the district in the localities for the species concerned.

For the preparation of the Index to the Flora grateful thanks are tendered to my niece Miss Sylvia Haines and her sisters.

My final acknowledgments strike a chord of sadness. Both those forest officers who took the most interest in the production of this work, and sent specimens from the tributary states of Orissa have passed away. Mr. A. N. Grieve and Mr. G. M. Cooper, both young and energetic officers, fell victims to fever and overwork in the course of their professional duties. My old friend Dr. Campbell, to whom I am indebted for so much help and sympathy, also died shortly before I left India.

Wimborne,  
Dorset;  
20 Feb., 1925.

H. H. HAINES.

## PREFACE TO REPRINTED EDITION

When the Botanical Survey of India was reorganised in 1954, the Government of India decided on the advice of the eminent Botanists of the country that the important Floras of the country which had gone out of print should be reprinted in order to provide immediate facilities of work on Systematic Botany of Phanerogams by students and Botanists of the country. The reprints are now being issued accordingly.

One particular point needs a special mention here. The Government of India, while recognising fully the need for bringing the Floras of the country up-to-date after a thorough revision, cannot overlook the fact that such a work is possible only on an extensive and thorough exploration of the regions already explored or hitherto under-explored and a proper rating of the information thus obtained with the materials in the already published Floras. The present effort, is therefore, the starting point in the greater project of the review of the Floras of our country. It is hoped that these publications would then meet the long-felt requirement of the Botanists of the country.

Owing to the necessity to conform to certain printing stipulations and using the same size of paper for all the reprinted Floras, the paginations in the reprinted volumes differ from that of the original. But the correspondingly corrected index would, it is hoped, enable reference without inconvenience. Some of the printing mistakes in the original Floras have been corrected in this edition.

The present reprinted edition is being published in three volumes. The corrections mentioned in the corrigenda of the original volume have been incorporated in the text of the present edition.

Calcutta, 1961

J. C. SEN GUPTA  
Chief Botanist  
Botanical Survey of India

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# INTRODUCTION.

## CHAPTER I.

### AREA AND BOUNDARIES.

1. The boundaries of the province of Bihar and Orissa are only to a small extent natural, *e.g.*, the crests of the Sameshwar Hills on the Nepal frontier in latitude  $27^{\circ} 30'$  bounding the area on the extreme north-west, the Ganges and its tributaries the Gogra and Karamnasa for a short distance on the west, and the waters of the Bay of Bengal on the south-east. The remaining boundaries (shown on the attached map), with the exception of other short lengths of river (the longest perhaps being the Kanhar on the west of Palamau), and the crests of hill ranges for short distances, are artificial. The extreme south latitude is  $19^{\circ} 2' N$ . The total area is 111,829 sq. miles, or over one and a quarter times that of Great Britain.

## CHAPTER II.

### TOPOGRAPHY AND GEOLOGY.\*

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\* For the geology I have made much use of Vredenburg's *Summary of the Geology of India* (1910), and also the various memoirs of the Geological Survey, especially papers by Ball. I have also consulted Martin Duncan's *Abstract of the Geology of India*, prepared for the use of students at Cooper's Hill College, and also the geological chapters in the *Gazetteers* of the province. A detailed text-book on the Geology of India is still a desideratum, but I understand this is under preparation by E. W. Vredenburg. At the time of Medlicott and Blandford's *Abstract of the Geology of India* very little of our province had been geologically examined, and considerable areas still remain to be examined.

## GENERAL.

2. Very few of the older administrators or writers on India appear to have appreciated, or even realized, the great natural beauties and the absorbing interest of the manifold natural objects with which the country once abounded, and which, alas, partly through their apathy, it has now mostly lost. What the Creator gave in these respects might have been to a great extent saved, and even have been accompanied by material as well as spiritual profit.\* Now that they are gone they are to a great extent irretrievable. So far as the records show, the dominating ideas were the spread of agriculture, increase of population and the development of the country from a revenue point of view. Not only was the æsthetic view wanting, but even Europeans sometimes appeared to regard with a horror, quite inconceivable to the present writer, what is unfeelingly referred to as dismal waste or jungle, which is but one way of expressing the glorious harmony of forest-covered hills with their wealth of natural animal and plant life—a harmony impossible where man's works are concerned. Even the utilitarian aspects of the forests were discovered too late to save a sufficiency of them for those direct and indirect benefits which they confer.

3. The greater part of the Gangetic Plain had long before the advent of Europeans lost almost all pretence to natural beauty, but much of the Central and Southern tracts still retained some portion of wild nature, though but a vestige of their primeval loveliness.

Walter Hamilton, who (1820) included Sambalpur, Angul, and many of what are now the feudatory States of Orissa in his "Gondwana Province", described the latter as "consisting of wild and wooded countries affording little or no revenue or supplies. rugged and mountainous and overrun with thick jungle, no army of any considerable number or equipment could penetrate them."

4. Singbhum, Mahurbhanj, Kconjhur, Balasore, Cuttack and Khurda (Puri) were included in his "Orissa Province." Of these districts also he remarks: "The interior of this province remains in a very savage state, being composed of rugged hills, uninhabited jungles, and deep water-courses, surrounded by pathless deserts, forests, or valleys, and pervaded by a pestilential atmosphere the high lands are infested with wild beasts. . . the rivers and waters swarm with fish, reptiles and alligators (*sic*); the plains and jungles with winged vermin."

5. Even Buchanan-Hamilton, a botanist and zoologist, is so obsessed with the usual official view as to complain of any part of a district lapsing to a state of nature—an attitude, no doubt corresponding with that of the majority of hard-headed Britons, though the Wordsworthian view would appear more appropriate to a naturalist. He does, however, raise a strong protest against the reckless waste of natural resources going on in his time. In his account of the southern part of Bhagalpur (the Monghyr district, etc.), he says: "The causes assigned for the stunted condition of the forests are: (1) Burning. Every year in spring the whole forests are burned. (2) Resin tapping. (3) Extraction of Catechu, even roots being dug up. (4) Rearing of Tasar. (5) Cultivation

\* Some of the Indian poets seem to have fully perceived this.

(jhuming) by the hill tribes. (6) Cutting of timber. (7) Want of economy in cutting fuel. The havoc that is now wrought by every one using the first tree that suits his purpose is vastly greater than I could have imagined. I shall take the liberty, on account of the magnitude of the evil, of earnestly again recommending the subject to the consideration of government."

6. In the *Statistical Reporter* for January, 1876, an article appeared on the "Natural Productions of the Karrukpur Hills." It is stated that "the utter absence of all forest conservancy has long ago caused the disappearance of all the giants of the forest, and even when the East Indian Railway was commenced, the contractors for sleepers found a lease of these hills on moderate terms a losing speculation." Sal trees fit for sleepers were even then few and far between. The same writer (from internal evidence; no name is appended), in this periodical for March, 1877, in an article entitled "The Forest Flora of Monghyr," again refers to the reckless waste of natural resources in that district. He says: "The most casual observer will at once detect the ravages made by the agency of man. Not only is the woodman's axe never at rest, and the underwood consumed as firewood, but cows, sheep and goats, in locust-like swarms, are let loose in the woods, until the wonder is that any green thing survives. Indeed, near the towns of Monghyr, Jamalpur and Sheikpura, a clean sweep has been already effected . . . only a few stinging-nettles and crotons have been competent to hold their own against the fierce hunger of the animals. Notwithstanding, however, the denudation which goes on, Monghyr is still a well-wooded district."

7. As is too often the result in these cases, no heed was taken of the warnings, and no steps were taken towards the forest conservancy of the Monghyr Hills. Had they been placed under forest management at that time, they would now have been a useful asset to the country.

8. Similar reduction of once useful forest to useless scrub in recent times has taken place in the Shahabad Hills (p. 6), Hazaribagh, and the Rajmahal Hills (see pp. 6, 8, 71), and the province now only contains between 2 and 3 per cent. of its area under forest properly reserved.

9. *Division of Area.*—The area is conveniently divided up into three main topographical divisions, a central highland, which forms a main water-parting, a northern mostly (Gangetic) plain area, and a southern area containing numerous mountains and several rivers which flow direct from the province into the Bay of Bengal. These are frequently referred to in the Flora as the Central, Northern and Southern tracts respectively.

10. It will be observed that some districts fall partly into the Northern tract and partly into the Central tract. Thus Shahabad, Monghyr and Bhagalpur have also all considerable hill tracts on the south which fall naturally into the Central tract. Gaya has also a few hills adjoining the Central tract.

11. The detailed topography of the districts would take up too much space to be dealt with in a Flora. Very complete accounts are given in the recent excellent *Gazetteers* published by the Government of the province.



## NORTHERN TRACT.

12. On the extreme west of the northern frontier is a small section, the Sameshwar Hills already alluded to, of the foothills of the Himalaya, but these forest-clad mountains, with their wealth of vegetation, are for the most part beyond the Nepal boundary, and the bulk of our Northern tract is occupied by the large alluvial plain of the Ganges, densely populated and closely cultivated. On the northern side of the Ganges the plain varies from 70—90 miles in width, north to south. On the southern side it is about 100 miles wide on the west, but becomes rapidly constricted eastwards by the central highlands, which finally meet the Ganges itself where that river sweeps round the base of the Kharagpur and Rajmahal Hills.

13. *Sameshwar Hills*.—The Sameshwar Hills in the north of Champaran are very distinct geologically and floristically from any other part of the province. They are composed of sandstones and gravels of the Siwalik system. The soil is mostly sandy, but some rather red argillaceous soils occur towards the Bhabsa river, probably derived from shales of the same system.

14. *The Gangetic depression* probably represents the bed of an ancient sea, and it is filled up with alluvial deposits of immense depth. This alluvial ocean is dotted here and there in the south with islets of archæan rocks, or with small hill ranges which may be considered rather as part of the Central tract. The soil varies from clay to sand, and patches of "usar"\* are frequent in Darbhanga and Muzaffarpur and to a less extent in other districts. Reh is connected with want of sub-soil drainage and excessive evaporation. Where the salt is not excessive, *Acacia arabica*, *Sissu* and *Butea frondosa*, besides several grasses such as *Chrysopogon aciculatus*, *Diplachne* and *Sporobolus*, will grow on such land. That there is no very characteristic halophytic flora in these usar lands of Bihar is probably due to the washing away of the "reh" or salt efflorescence in rainy weather, and a covering of vegetation tends to prevent its accumulation.

15. Geologists distinguish in the Gangetic plain between the older and the newer alluvium. The older is usually composed of argillaceous beds of a rather pale reddish-brown hue. In it kanker and pisolitic ferruginous concretions are disseminated. *Kanker*, an impure carbonate of lime, like *reh*, seems often associated with defective drainage and a hot sun, and it is by no means confined to alluvial formations (*cp.* p 18).

16. The great rivers of the Gandak and Kosi, and innumerable smaller ones, divide up the alluvial plain to the north of the Ganges into areas of varying fertility and slightly different levels. Where the later floods do not deposit silt the "diaras" or "churs" in the river beds are raised, sandy and barren or covered with coarse grasses. The rivers are sometimes connected by channels called "chars" of considerable

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\* Usar is land impregnated with saline matter, and the efflorescence of the salts is termed "reh." These salts vary in composition, but consist usually of carbonate of soda with sulphate of soda, and to a less extent of lime and magnesian salts and sodium chloride. See Ball, *Economic Geology*, iii, p. 696; Watt, *Dictionary of Economic Products and Articles in the Indian Forester*.

depth and width, in which the water will flow in one direction or the other. At other times stretches of old river-bed, now altogether cut off from the present rivers, form long marshes or even lakes, with a rich vegetation of aquatic plants. The marshy depressions in Champaran are sometimes called "chaurs."

17. That part of Shahabad in the Northern tract has no marshes or lakes which so often characterize other districts, except an old bed of the Ganges (near Bhojpur). Buchanan-Hamilton says that the whole of the inundated land near the Ganges is covered with reed and Tamarisk, but that he saw none of the wild rose so common towards the east.

18. The great uniformity of level of the Ganges plain is evident from the elevation at the junction of the Gandak being only 168 ft. above the level of the sea, a distance of some 450 miles! The vegetation, however, gradually changes from west to east in consequence of the increase in the rainfall, as will be seen by the table on p. 21, and Purneah has a more or less permanent greensward, whereas Saran is one of the driest districts in the province.

19. *Hills in the south of the Northern area.*—The districts bordering the Ganges on its southern bank are more diversified. Except Patna, they all pass into the central highlands on the south. Even Patna has part of a range of hills, the Rajgir Hills, on its southern boundary, but these enter it from Gaya, and only form a part of the south-east boundary of the Patna district. They reach 1472 ft. elevation at Handia Hill, and consist of schists and slates with massive beds of quartzite. In the Gaya district they end rather abruptly south of Gaya town. Their whole length of about 40 miles, including two breaks, is entirely isolated from the Central highlands by the alluvium, but they are geologically similar. They bear a scrub jungle with scattered Sal trees like the nearest southern hills. A few other unimportant isolated hills occur in the Gaya alluvium.

20. The southern parts of Bhagalpur present a considerable area of granitoid and porphyritic gneisses towards Monghyr and the Santal Parganas, sometimes showing as dome gneiss as at Mandar hill, and varying to foliated gneisses and schists\* as in the Central tract. Damuda rocks occur at Pathargatta Hill, and east of Pathargatta the Damuda sandstone is overlaid by dark green basaltic trap, as in the neighbouring Santal Parganas. In the southern division also a broad and well-raised belt of limestone extends along the bank of the Ganges about 60 miles from near Monghyr to Colgong. It is about 2 miles broad and the town of Bhagalpur is situated on it. Its botany does not appear to have been specially investigated, but it is said to be densely covered with mango, jack and palm trees.\*

### CENTRAL TRACT.

21. *Kaimur Hills.*—The north of the Shahabad district is a low-lying alluvial plain and one of the principal wheat-growing tracts

\* Account from *Gazetteer*. Mandar Hill is on the railway south of Pipra Station.

belonging to the Northern tract; the southern 800 square miles is an undulating mass of low hills, or rather a plateau, known as the Kaimur Hills. They are one of the ragged terminations of the great Vindhyan range, separated from the main mass in our province by the river Sone, on which they abut with cliff-like escarpments. These Kaimur Hills extend westwards into Rewa outside our area, and there become fused with the main range. They belong therefore to the Central tract, and consist of sandstones, shales and limestones, are unfossiliferous, and are assigned to the Vindhyan formation which is usually placed near the top of the Azoic formations (see p. 18).

22. The sandstones are the most important rocks as usually concealing the other rocks, and give the somewhat flat-topped character to the country with almost vertical escarpments, and are responsible, apparently, for the *Hardwickia binata*, once prevalent here, though now almost destroyed. The Kaimur Hills must at one time have borne magnificent forest, and Sir J. D. Hooker records specimens of *Hardwickia* 120 ft. high as existing even in his time. Unfortunately they were never placed under forest conservancy, and are now mostly covered with a scrub jungle, with scattered Sal in some places. They are not well known botanically, although visited by Hamilton. I have only examined their eastern extremity.

23. *Gaya Hills and Monghyr Hills.*—The hills on the southern border of the Gaya district are merely the northern scarps and outliers of the Palamau and Hazaribagh plateaux. In Monghyr, and again in the Santal Parganas, they form well-marked ranges.

24. The Gidaur Hills, which lie across the southern boundary of Gaya and Monghyr, are composed of Dharwars,\* including micaceous and ferruginous schists so highly metamorphosed by intrusive coarse pegmatitic granites that they yield workable mica. The rocks of the Kharagpur Hills are not nearly so much altered, the shales being converted to slates rather than into schists. The two ranges are more or less connected on the south by Archæan gneiss of lower elevation. A description of the flora of these hills was given by Buchanan-Hamilton. They are still more or less covered with scrub jungle, but at one time bore good Sal forest.

25. *Rajmahal Hills: Gondwana Rocks.*—The Rajmahal Hills are also conveniently treated separately from the main Central area. They form a long broad backbone in the Santal Parganas district, running south and north, and almost abutting on to the Ganges, which takes a sudden bend to the southwards after passing their northern foot.

26. The Rajmahal Hills proper are connected with the Central highlands by a lower tract, but still high ground, of more undulating country with isolated hills and ridges. They differ geologically from most of

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\* The Dharwars were formerly known as the sub-metamorphic or transition series. They underlie the Lower Vindhyan formation, and overlie the fundamental or Bengal or archæan gneiss, once called metamorphic, now believed to represent the primitive crystalline rocks resulting from the original cooling molten mass of the earth's crust. The Dharwars are metamorphosed sedimentary rocks, often so highly altered as to pass into the archæan in appearance. They include slates, quartzites, quartz, hæmatite and mica schists, phyllites, etc.

the Central tract in belonging to the Gondwana system,\* and in being interbedded with trap.

27. Vredenburg says that "in the Rajmahal Hills the Upper Gondwanas exhibit the exceptional facies of a volcanic series, consisting of some 2000 ft. of basaltic flows, with occasional intercalations of clays, carbonaceous shales and siliceous porcellanoid shales, which have long attracted attention on account of the abundance of beautifully preserved fossil plants which they contain, remarkable for the abundance of ferns, principally *Tæniopteris* and *Dicksonites*, and *Cycads*, principally *Phyllophyllum*." It is now known, however, that many if not most of these fern-like plants were seed-plants, and belonged to the interesting group of Pteridosperms.†

28. The Pteridosperms, fern-like plants which, however, bore seeds, were one of the constituents of the great "*Glossopteris* Flora," which was characteristic of the hypothetical continent "Gondwanaland." Possibly that great continent now hides beneath the sea the origin of the Pteridosperms and of the Angiosperms. In Permo-carboniferous times the plant remains indicate two great botanical provinces, a northern and southern, and it is the similarity of many of these remains of the Southern flora in South America, South Africa, Southern India (including especially the Lower Gondwana rocks) and Australia, to which the name "*Glossopteris* Flora" has been given, that forms the strongest evidence for a previous land connection between these regions.

29. "*Glossopteris*" itself is probably only a form genus. The name was first given to sub lanceolate or oval leaves with a strong midrib, and very close sub-parallel anastomosing secondary nervation. The leaves are of two kinds. The larger appear tufted on the rhizome or stem, and the close secondary nerves are scarcely distinct from the tertiaries, which with them form a close oblique reticulation with ellipsoid areoles (in *Gl. indica*; the areoles are broad in some species). The second kind of leaf are scale leaves. They have no midrib and were also apparently attached to the rhizome, otherwise they might be comparable to the small simple pinnules springing from the rachis between the pinnæ in some species of *Neuropteris* which were also reniform or orbicular in shape and without a midrib. The rhizomes or stems of *Glossopteris* were originally known as "*Vertebraria*" from their apparent articulation, and are about 1" diam. Unfortunately all the specimens are mere casts and are not therefore in a state for anatomical investigation, and the only sporangia found might be the micro-sporangia of *Cycads*. The *Glossopteris* type is commonest in the Lower Gondwana. From the Talchir-Kaharhari beds (see p. 16, footnote) in or near our area‡ have been recorded *Glossopteris* (*Vertebraria*) *indica* and other species, *Neuropteris*, *Gangamopteris*, etc.; from the Damudas many species of *Glossopteris*, and there is a specimen of *Glossopteris indica* (in the British Museum) collected from Buckley Island near the South Pole by members of the British Antarctic Expedition (1910—1913) by Dr. Wilson and Lieut. Bowers only a few weeks before their deaths. In the Damudas also occur *Sphenopteris* and *Alethopteris* (probably all Pteridosperms)

\* The Indian Gondwanas is the main coal-bearing formation of India. The Lower Gondwana correspond roughly with the Permian, the Middle and Upper with the Trias and Jurassic respectively. See also Tabular Statement of the Gondwanas on p. 16.

† See Scott, *Studies in Fossil Botany*, third edition, pp. 1—242, etc.

‡ It should be observed that specimens said to be from Rajmahal may be from the Raniganj coalfield, situated alongside our area, but in Burdwan. This confusion appears to have originated by Brongniart in 1828, "who obtained the first Indian specimens of *Glossopteris* from "Ranagunge, near Rajmahal." There are a few unimportant coalfields along the western border of the Rajmahal Hills, but none are, I believe, now worked, while the Burdwan coalfield at Raniganj is one of the most important. There are also coalfields in Manbhum (Jharia) and Hazaribagh (Giridih), all in the Gondwanas.

and *Tæniopteris*. A fern of the modern genus *Actiniopteris* (*A. benghalensis*) was at one time supposed to have been identified, but probably quite wrongly, and it is perhaps even not a fern. *Sphenopteris* is a form genus with 2—3-pinnate fronds superficially resembling some *Davallia* or *Asplenium*, but some species at least have the fronds forked. From the Panchet rocks are recorded *Glossopteris*, *Tæniopteris*, *Pecopteris concinna* (*Pecopteris* is a form genus probably comprising some ferns and some Pteridosperms), and *Cyclopteris*, possibly a fern. In the Upper Gondwana the *Glossopteris* type is rare, and at this epoch there appears to have been an admixture of the northern and southern floras, but the Rajmahal flora contains a very large number of *Cycadophyta*, including *Tæniopteris* (probably one of the *Williamsoniæ*) and a *Sphenopteris* (*S. arguta*), said by Duncan to be common to the Rajmahal and the Lower Oolite of Yorkshire!\*

30. Although most of the Rajmahal Hills are included in the large Government estate of the Damin-i-koh the forests are not reserved, and these hills show a terrible example of rapid denudation. When one reads that within comparatively recent times wild elephants and rhinoceros were found in the district and that the East Indian Railway obtained sleepers for its line from the Rajmahal Hills, the rapidity of the forest destruction is almost incredible. This destruction cannot but have had, and is no doubt still having, a pernicious effect alike on the climate, the cultivation of surrounding tracts, and the water supply. Floods and droughts alternate, as is usual in denuded districts.

31. The hills have mostly flat tops, as is common in trap districts, and most of these tops are under indifferent or shifting cultivation† by the Mal and Sauria Paharias. Some of the slopes are, however, cultivated with sabai grass. Common trees on the trap are *Mohwa*, *Nyctanthes*, *Eriolœna*, *Asan*, *Wendlandia exserta* and *Heteropanax* (on shady sides), but none are peculiar to it.

32. The nature of the surface, which in many cases is covered with rounded trap boulders, fortunately makes such parts of the forest more or less self-protecting against the pernicious effects of heavy grazing. The volcanics rest unconformably upon the Dubrajpur sandstone (of the middle Gondwanas), and where these are exposed the cattle find a good footing and the surface quickly becomes barren. Some of the outer hill blocks in the north are mostly sandstone or grit. Thus Belpahar shows the white rock exposed on the slopes from the excessive tread, and the surface is not only treeless, but now becoming bare of grass. On the top is shale which wears better, and here *Nyctanthes* and Sal saplings still struggle for life. Some spurs in the northern Godda Hills appear to be of trachyte, and this rock is well covered, though only with thorny scrubs, and there is much *Breynia rhamnoides*. The Mahanadi block is also covered with boulders of granite with *Diospyros tomentosa* and *Hollarhena* as the surviving trees.

33. The highest hill of the Rajmahals is perhaps Mori, which is about 2000 ft. high; it is capped by laterite. Dumka, the headquarters station, lies off the main ridge, and is only 500 ft., and this

\* For a full and very interesting account of the *Glossopteris* Flora see the *Catalogue* by E. A. Newell Arber published by the British Museum (1905).

† Here called "Karao."

part of the Santal Parganas, as on the west, has an undulating surface, and is chiefly under cultivation.

34. Cotton soil, a product of trap, occurs in some areas, while some of the rivers which rise in the hills, such as the Bansloi, cut their channels deep enough to expose the underlying gneiss.

### Main Central Tract.

35. The Central tract *proper* is a region of plateaux and mountainous spurs which are the eastward termination of the huge Satpura-Vindhyan massiv which radiates from Amarkantak (see map), in the Central provinces, elev. 3493 ft. above sea-level. Near this point rise the Nerbada running to the west, the Sone running north to the Ganges and the Mahanadi to the south and east, the last two rivers being for a considerable distance within our province. This elevated central tract has a trend somewhat north of east, and is mostly over 1000 ft. in elevation. It ends in the Rajmahal Hills (see above).

36. Formerly a densely forest-clad country, it is now more or less denuded of forest except on the broken flanks of the plateaux and more rugged hilly outliers, and is becoming worse every year. This denudation is no doubt correlated with the disastrous floods that take place periodically, both in the Gaya district to the north, in parts of the Santal Parganas, and along the course of the Damodar in Bengal.

37. The two main plateaux, those of Ranchi and Hazaribagh, are each about 2000 ft. high, separated by the deep valley of the Damuda, and carry, especially on the west, still higher plateaux (usually 1000 ft. higher), which are known as "*pats*." On one of these pats, on the borders of Ranchi and Palamau, is situated Neterhat, developed (by Sir E. Gait) as a readily accessible sanatorium.

38. Towards the edges of the plateaux are very frequently ranges of hills or mountains, which in some cases reach the elevation of the *pats*, and the scarps usually fall away in rugged spurs and hills which I have termed the "*ghats*," cup up by ravines and rivers, but rarely with the precipitous sides characteristic of the sandstones of the Kaimur Hills, and never with the noble scarps characteristic of the sandstones of the Pachmari Hills in the Central Provinces.\* At the same time the rugged ghats form a very beautiful feature of the province, and are some of the best botanical ground in the area. With the exception of the few reserved forest areas, the tops of the plateaux are for the most part under cultivation, occasionally varied by stony hills with scrub jungle, whereas the ghats and outlying ranges, like the Tundi Hills, are forest- or jungle-clad.

39. *Tundi Hills and Parasnath*.—Some of the outlying spurs form regular hill ranges such as those already dealt with as projecting into the Gangetic Plain, which really belong to the Central tract. One of these outlying ranges, the Tundi Hills, extending across the boundary of Manbhum and Hazaribagh, and to the east of Hazaribagh itself, contains the highest mountain in the province, Parasnath. The Tundi

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\* These sandstones belong to the Kamthi group of the Gondwanas.

Hills form a water-parting between the Damuda and Barakar rivers. Parasnath is well known from its being described by Hooker in the Himalayan journals. It has also been botanized by Anderson, Thomson, Clarke and others. Its elevation is 4430 ft.

40. To the east of the central highlands and between it and the Bengal boundary is an irregular, not very wide, area of lower-lying ground, chiefly in Manbhum. This merges gradually into the lower Gangetic plain of Bengal, and is cultivated country.

41. The Central tract may be considered to be roughly bounded on the south by the Bengal-Nagpur Railway, which passes up the valley of the Sanjai to the water-parting of that river and the Brahmini river, and then passes into the valley of the Mahanadi. The ridge of high ground between the Sanjai and the Brahmini is pierced by a tunnel, and the line here practically separates the Porahat forest division from the Singbhum forest division.

42. GEOLOGY OF MAIN CENTRAL TRACT.—*Gneiss*.—The basis of the Central tract geologically is the Archæan or Bengal gneiss, gneiss being considered now to be one of the primordial rocks of the globe, and the formation, as it were, of all other formations. The greater part of the Manbhum, southern Santal Parganas, Ranchi, Palamau and Hazaribagh districts show either exposures of the rock itself, or the immediate products of its decomposition, and, as already said, it dips under the alluvium of the Northern tract. It usually gives rise to a reddish stiff loamy soil, excellently suited to the growth of forest while kept covered, but bakes to a brick-like hardness in the hot season when denuded. This soil is sometimes of immense depth on the plateaux. The Bengal gneiss rarely stands out as prominent hill ranges. Parasnath, which is apparently of gneiss, is believed to belong to what is known as Nilgiri gneiss, a form distinguished petrologically by the constant presence of enstatite (ferrous magnesium silicate).\*

43. *The Dharwars*.†—Most of the higher hills resting on the foundations of Bengal gneiss, and the rocks forming the ghats, belong to the sub-metamorphic crystalline series or "Dharwars," sometimes so highly metamorphosed as not to be distinguishable lithologically from the Archæan rocks. A direct connection can, however, often be traced between outcrops of highly metamorphosed Dharwars with others undoubtedly of sedimentary origin, leaving no doubt of their relationship. Vredenburg especially instances the belt of which the northern edge (a fault) extends along the south of part of Ranchi and Manbhum districts. The southern part of this belt consists of slates, sandstones and limestones, while along the northern margin these rocks become crystalline.

44. Most of the forest-covered Palamau hills are of *Dharwars*, and much of the Porahat forests. They (the Dharwars) have already been mentioned as forming part of the Gaya and Monghyr Hills. In the Gidaur range they contain ferruginous schists and much slate of good quality which is quarried. The Rajgir Hills are mainly quartzite and

\* Vredenburg, *Summary of the Geology of India*, p. 13.

† See also p. 14 under the Southern tract.



slate, and very barren, not because forest will not grow on quartzite, but from the lack of forest conservancy and unrestricted grazing.

45. *Granites and Dome-gneiss*.—Thrust up through both the Archæan and Dharwar rocks are frequently true granites, which in many cases have resisted disintegration more slowly than the surrounding rocks, and assume the shape of conical or rounded hills, whence the term "dome gneiss" (more properly *dome granite*) has been given to the rock. The shelling off of the outer concentric layers of this rock renders it singularly bare of vegetation. On it species of *Ficus* are the commonest plants. The detritus at the base of these conical hills may, however, be well covered. Excellent examples of the "dome gneiss" may be seen on the Purulia-Ranchi road near Jhalda.\*

\* 46. *Mica*.—When these granites are in the form of a dyke they frequently become pegmatitic and where such dykes traverse mica-schists contain workable mica, as in the well-known mica-belt along the Hazaribagh-Gaya ghats which extends into the Gidaur Hills. On the south of the Ranchi plateau, north of Bandgaon and about Muru, pegmatite and large mica-plates have also been observed, and may perhaps become workable. The large hill known as Koderma Hill in the Dharwar mica-belt appears to be granitic, perhaps domegneiss. It contains no workable mica. Mica (composed of silica, alumina, magnesia, iron oxides, potash) is singularly proof against decomposition, so that old waste mica-dumps of over 30 years' standing remain barren of all vegetation.

47. *Vindhyan series*.—The Naga Untari Hills, situated in Zemindaris in the extreme west of Palamau, and covered with poor forest from which all large timber has been removed, are noteworthy from their abundant crystalline limestone, especially near Bonahatpur. It is frequently hollowed out into caves which form a refuge for bears. In these hills is also Biotite gneiss and a brownish slaty-looking rock with a black dull fracture (lydianstone?). These formations are possibly Vindhyan, like those on the opposite side of the Sone. Vredenberg speaks of the Vindhyan rocks spreading beneath the Sone, but generally overlaid by alluvium, and of volcanic rocks of the porcellanic group of the same formation occurring in a belt in the west of Gaya and Palamau about Nabinagar and Japla.

48. *Slate of Kadapahs*.—Near the Mirzapur boundary in Palamau is found the easternmost outcrops of a large mass of slate which belongs to the Kadapah System (or Algonkian, post-Dharwar and pre-Vindhyan), the only known rocks of this system, I believe, in the Central tract.

49. *Gondwana rocks*.—After the Cambrian (Vindhyan) period the Central and Southern areas remained a land area and no longer received any marine deposits, but fluvial and lacustrine (besides volcanic deposits) are of considerable importance. The Gondwana system of the Rajmahal Hills has already been referred to (para. 26 *et seq.*).

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\* For an excellent illustration see vol. xviii of the *Memoirs of the Geological Survey of India*.



50. Lower Gondwana sandstones occur in depressions in the main Central tract, especially along the Damuda Valley, between the Ranchi and Hazaribagh plateaux. Clays and carboniferous shales of this Damuda series may be seen where the Ranchi-Hazaribagh road crosses the valley (near 21st mile). The Gondwana system is well developed again in the parallel Barakar valley, the Giridih coal-field of Hazaribagh, and tilted beds of sandstone north of Bagoda as well as micaceous shales composing the small hills north of the Barakar possibly belong to it. The grits and sandstones to the south of Giridih are thrown into scarps and ridges formerly covered with Sal forest.

51. In Manbhum the now dreary waste of country known as the Jharia coalfield is mainly Damuda sandstone, but outcrops of conglomerate and black shales and also the underlying Talchir boulder beds occur.\* This area is remarkable in the rainy season for the vast quantities of the American weed *Hyptis suaveolens*.

52. Igneous dykes are of common occurrence in the Jharia coalfield, and are said to belong to the same epoch as the much vaster outpouring of volcanic rock which characterizes the Rajmahal Hills.

53. A considerable area of the central Palamau plateau, extending from eastwards of Loharsee† into Hazaribagh and westwards to Garhwa, is occupied by Gondwana rocks, chiefly sandstones which are frequently calcareous. In this area are situated the small Auranga, Hutar and Karanpara coalfields. Still further west in the neighbourhood of the Kanhar river the flat-topped hills are capped by massive sandstone and laterite, the former being also perhaps of Gondwana age.

54.‡ *Laterite, Kankar and Regur*.—Subsequent to the Gondwanas, and with the possible exception of some of the traps and intrusive granites, there appear to be no newer rocks in the Central area with the exception of such subaerial deposits as laterite and kankar.

55. Laterite occurs principally as a cap to the higher plateaux or *pats*, but is also found of fair thickness in some valleys. In most cases it appears (except in the Rajmahal Hills) to rest directly on gneiss or, as on the Neterhat plateau, a felspathic granite. It also occurs in considerable sheets overlying the Bengal gneiss in Eastern Manbhum. In such cases it may be the results of the complete decomposition of an original trap layer.

56. The soil in the valleys of the Rajmahal Hills especially, but also in parts of Hazaribagh (e.g. between Chatra and Itkuri), Palamau (e.g. from Leslieganj to Banki), Singbhum (e.g. near Chaibassa), and in many places in other districts is a *Black-cotton* soil or "regur," the origin of which is also sometimes ascribed to trap rocks. The species of the Cotton soil in this tract are largely *Butea*, *Carissa*, *Zizyphus* and *Acacia arabica*.

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\* For a detailed account of the Manbhum coalfields, see Vredenberg, Appendix to the *Gazetteer of Manbhum*.

† I see that I have not placed Loharsee on the map. It is situated almost in a line between Daltonganj and Simaria, not far west of the Palamau boundary. It is on the map attached to the *Forest Flora of Chota Nagpur*.

‡ See also paras. 74.—76.

## SOUTHERN TRACT.

57. The Southern tract is not sharply separated from the Central, but is on the whole characterized by the much more diversified topography, and its river system has a direct outlet on the Bay of Bengal. It contains a confused and broken mountain system, only a small part of which is in direct connection with the central tableland. From the sea this appears as a continuous range of hills, broken by the Mahanadi valley, and forming the northern end of the Eastern Ghats. The large rivers of the Burubulang, Baitarni, Brahmini and Mahanadi flow largely through country which is beautifully diversified with hills and mountains still more or less covered with forest. The Southern tract, into which the mountains of the Kolhan in Singbhum more naturally fall than into the Northern tract, is principally occupied by the Orissa Tributary States. Only a small fraction, therefore, of its beautiful forests are Government property for the permanent preservation of which there is any guarantee.\*

58. The generally more rugged sculpturing of the southern tract† has assisted Nature in resisting to a greater degree than in the Northern and Central tracts the destructive influence of man. On the east, it is true, there is a belt of flat open country more or less parallel to the coast and running back for a considerable distance up the broad valley of the Mahanadi, but even this belt is not homogeneous. On the coast itself there are stretches of sand and sand-hills alternating with deltaic and tidal mud with mangrove swamps. Both these tracts have a flora distinct from the interior. Behind this coastal belt is an area of cultivated alluvial and lateritic formations up to 50 miles in width near Cuttack and Balasore, but narrowed on the north by the outlying hills of Nilgiri and Mayurbhanj and again on the south by isolated rocky hills and tracts of scrub on a laterite formation. On the extreme south the boundary hills between our province and Madras meet the Chilka Lake, a large area of shallow water, separated only by sand-hills from the sea, and more or less fresh or brackish according to season.‡

59. *Archæan Rocks.*—As indicated above, it is difficult, except for an expert geologist, and with much study in the field, to discriminate between the highly metamorphosed rocks and schistose forms of the Archæan gneiss. Generally speaking, this last is far less in evidence in the Southern tract than in the Central. From a forest and botanical point of view the matter is not of much importance, as the soils yielded and the floristic formations are identical.

60. As Dharwar rocks are said to be absent from the hilly region of Orissa between the Godavari and Mahanadi, the quartzites and gneisses of the hills in the Mals of Puri presumably belong to the Bengal or Nilghiri gneiss. On the Khandobolo mountain (3000 ft.) quartz-mica

\* The Political Agent, Mr. Cobden Ramsay, has, however, done a great deal in the direction of persuading the Chiefs of the States to protect their forest property.

† For an excellent account of the rugged and picturesque scenery of the Tributary states of Orissa, see Cobden Ramsay in the *Gazetteer of the States*.

‡ For an account of the fauna of an island in the Chilka Lake and a list of its plants, see *Memoirs of the Asiatic Society of Bengal*, vol. vii, No. 4.

schist and micaceous quartzites are common, and most of these rocks closely resemble those of the Dharwars. Other hills, such as those of the Manibandh forest, contain massive quartz rocks with some laterite, and this forest contains a curious mixture of Sal with fleshy *Euphorbias* and *Randia malabarica*, the last a shrub more especially characteristic of the sandstones. In the Arang block the road was cut along the steep hillside through a dark, excessively hard quartzite,\* very unlike an archæan gneiss. The other large hill ranges of the feudatory states south of the Mahanadi have not been examined by me, but the low-lying country in Khandpara and Daspalla is either gneiss or granite with laterite. The high plateaux of Kalahandi and the Gandamardan range, on the borders of Borosambar and Patna (state), are said also to consist of gneiss with laterite caps. North of the Mahanadi there is much gneiss and granite which in going from Cuttack to Angul appears to begin in Dhenkenal, about 6 miles west from Bongarsingh, and except where interrupted by the formation subsequently referred to, is found right up to Sambalpur. All the hills of the Hathibari range consist of gneisses, including quartz schists and quartz rock, which appear to me to be of the Dharwar formation. On the granites the soil is sometimes cotton soil or kunker. Exposures of archæan gneiss are frequent towards the boundary of the Southern area in Singbhum, Saraikhela and Gangpur. The surface soil is frequently cotton soil.

61. *Dharwars of Southern tract.*—The Dharwars form magnificent hill ranges in Singbhum, Bonai, Keonjhar and Mayurbhanj, and to a less extent in Gangpur. Some of the quartz- and mica-schists of Chichamura forest, quartz-schists in the Jhargati-Gharpati forest, and almost certainly the shale and phyllite-looking rocks in the Jhargati forest (all in the Sambalpur forest range) and similar rocks in parts of the Hathibari range and in the Angul forests appear to me to belong to the Dharwars. They probably form most of the mountains of Angul. Typically they consist of shales and phyllites with quartz veins, siliceous clay slates, quartzites or hard sandstones, and especially mica- and hæmatite-schists. Hæmatite and other iron schists are very widespread. Whole hill ranges, e. g. the Lokudburu range in Porahat and the Ghatkori hills in Saraikha (Singbhum), are more or less composed of them and yield a very valuable ore, now largely worked.

62. The clay-schists are usually interbedded with quartz laminæ. On weathering the latter break up into innumerable quartz stones which sometimes conceal the fact that the subsoil is argillaceous. The clays derived from these schists are usually very impermeable after the heavy rains of the monsoon, and are baked a stony hardness in the hot season. They support a hill-type Sal often characterized by the presence of *Gardenia*, and when once disforested are very barren and difficult to restore.

63. *Sal on the Iron Schists.*—The forest growth on the iron schists is better, the roots being better able to penetrate the numerous clefts and fissures which are characteristic of these rocks, and some of the finest Sal is found in the valleys on the detritus of hæmatite-schist hills,

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\* Probably Khondalite.

while on no other formation does the large Sal ascend so high on the hill-sides.

64. In Kundrugutu and some other places magnesian schists (patradiri, K.) are found which are worked by the Kols into ornaments.

65. *Trap dykes in the Dharwars.*—Trap dykes are very common, and at least one hill, the Kita-buru in the Saitba forest, is composed of serpentine. In this forest chromite is being worked. The Kita-buru is strongly magnetic and clothed mainly with grass and *Phoenix acaulis*. The highest hill of the Dalma range (in Porahat, close to boundary of Central and Southern areas) contains numerous trap intrusions, and is also capped with trap. Crystalline limestones of good quality are found in several places with the Dharwars, the best known deposit being at Bisra in Gangpur. In Gangpur also are considerable deposits of manganese, an ore very characteristic of this system in the Central Provinces.

66. *The Kadapahs of Southern tract.*—The Kadapahs is a formation closely resembling the Gondwanas and Vindhians in many respects, but is older. It chiefly is composed of sandstones, but also very commonly limestones and shales. Extensive outcrops of limestone such as are met with in the neighbouring districts of Bilaspur and Raipur where the formation is better represented are not, I believe, met with in our area though the *Gazetteer* speaks of limestone of this formation at Padampur.\* The sandstones, as in so many other cases, are chiefly found forming cliffs and scarps. They may be observed in the town of Sambalpur (the circuit-house is built of them), where they are covered with *Oldenlandia Heynii* in the rains, and they extend west of that town to the boundary. They are also found south of the Mahanadi all over the Boropahar forest range, which extends south nearly to Paharsigida. This range consists of grits, sandstones and shales, but with granitic intrusions. The sandstones overlie the shales, as can be well seen in the exposures along the Bargat nala. They are very hard, almost quartzites, and the greater part of the hills consists of them.

67. Between Ambakhama and Santra the path first crosses these hard sandstones, which are almost bare of growth, and then passes over a ridge of massive shales which continue down the opposite slope to Mundkate and Santra villages. Between Lakhampur and Lonarabehra there is a very striking escarpment of the same sandstones, poorly stocked as usual above, but with a narrow belt of good sal at its foot. At Lohara-behra blocks of hæmatite occur scattered on the surface (cp. below, sandstones at Tikapara in Angul). Here both shales and sandstones are exposed, but the most remarkable exposure of the shales is north of Ramadaga, not far from the Mahanadi. With grazing the more flat-bedded shales become singularly bare of all vegetation, and the surface shows curious dendritic markings.†

\* Padampur is a town in Borosambar, but the Padampur referred to may be the zemindari of that name situated on our border, but just within the Central Provinces. I have not visited either place.

† I regret that I had no opportunity of getting specimens. They reminded me of fossil corallines.

68. All these Kadapah rocks grow somewhat poor forest, which is very poor indeed or the rock is quite bare where the lamination is parallel to the surface. The worst are the shales. Characteristic of the grits and hard sandstone are *Acacia Donaldi*.\* *Bridelia Hamiltoniana*, and to a less extent, and usually near ravines, *Atalanta monophylla* and *Walsura piscidia*. Bamboo, *Cleistanthus collinus*. Satinwood, *Albizzia odoratissima* and *Bija* also occur. The most noticeable grass is the pest *Aristida setacea*. On the shales are found *Strychnos potatorum* and poor mixed forest. Sal only occurs on the alluvium near the rivers, and neither formation produces good Sal except when detrital.

69. *Gondwanas in the Southern tract.*†—South of Angul a range of hills in the north of Narsingpur show large outcrops of hard shale and sandstone. These appear to be continuous with sandstones about Tikapara on the Mahanadi (in Angul), and blocks of hæmatite were found at the base of the large Tikapara Hill, which has red (apparently sandstone) rocks on the cliffs near its summit (much hung with bees' nests). A pink sandstone was also found in the Tainsi forest in Angul. I would assign the above rocks of Narsingpur and Angul to the same formation as those in Sambalpur but that there appears no record of Kadapahs in this region, and they are possibly Gondwanas. In the sandstone between Purnakot and Tikapara there are trap dykes.

70. Gondwana rocks occur of considerable extent in the Southern tract, and there is here a new group known as the Athgarh sandstones, said to be near the top (*i.e.*, in the Upper Gondwanas). These rocks, again, are principally sandstones (the Bhubaneswar, Konarak and Puri temples are built of them, and the Khandagiri caves cut out from them), but conglomerates and some shale-beds also occur. They occur all over the north of Puri district, and extend into Cuttack and Athgarh. The Rampur forest shows outcrops covered with thin laterite, the Chandka forest mostly grows on them with a little laterite on some of the scarps. The Hendesal forest has sandstone hills with a large laterite plain to the east, while the Barapita and Tirkai blocks are sandstone and conglomerate. There is much *Xylia* in some of these blocks, and

\* It was found on identical formations in the Central Provinces, *vide List of Trees, Shrubs, etc., of the Southern Circle, C.P.*, p. xv.

† The following table (from Duncan and Vredenberg) will make the succession of the Gondwana strata in our area clearer:

Upper	}	Rajmahal Hills.
		Son-Narbada outcrops.
		Athgarh sandstones, at head of Mahanadi delta.
Middle or Mahadeva	}	Kamthi, outliers only in Damuda Valley. Dubrajpur sandstones.
		Panchet beds at Raniganj (in Burdwan, just outside our area on Damuda).
Lower	}	Damuda { Raniganj.
		Ironstone shales.
		Barakar.
		Kaharbari (Giridih coalfield).
		Talchir.

The Lower Gondwana are supposed to be on about the horizon of the Permian, the Mahadeva of the Trias and the Upper of the Jurassic.

introduced Teak is growing better on the sandstone (in Chandka) than on the laterite (in Khurda, further south).

71. Other Gondwana rocks, again chiefly sandstones which are often ferruginous, form hills in Rairakhol. These are said to be of the Mahadeva (Middle Gondwana group). The Kuhuri hill (Boita Mundiar) in Puri belongs to this group, and a section is well seen close to the town of Rampur (Rairakhol), where the river cuts through the strata, but here it is perhaps the Talchir boulder bed which is exposed, as it contains large boulders characteristic of that group. The Talchirs, as the name implies, is well represented in the small Talchir state, and the area known as the Talchir coalfield is said to extend about 70 miles from Rairakhol to Khadakprasad on the Brahmini River. The Talchirs, according to geologists, underlie the actual coal-bearing (Damuda) strata which do not appear so well represented. Besides sandstones they contain also fine-grained greenish-grey arenaceous shales. The flagstones of the P.W.D. bungalow at Nakchi in Athmailik appear to have come from these beds.

72. In the south of Gangpur are coal-bearing sandstones of the Damudas which are continued into the north of Sambalpur (e.g. at Rajpur). Both Talchirs and Damudas (Barakar beds) have been found at Rampur on the Ib not very far from some of the northern forests of the Sambalpur division, and the Talchirs are said to be prolonged south-east to the Brahmini River in Rairakhol.\* If this were so, there would thus be a continuous series of Gondwana rocks from Gangpur to Puri and Angul (see below). But I am doubtful of such a connection unless it curves round through Bamra, as such a line would pass through several forest blocks of the Sambalpur and Hathibari ranges (Chichamura, Jhargati, Gharpati, Sangramul, etc.), in none of which have such rocks been noted (cp. p. 14).

73. Forming perhaps part of the above Rairakhol-Talchir area there are outcrops of pink sandstone in the north of Angul which are probably continued into the south of Bamra. They occupy the east of the Durgapur forest block, and are associated with a little laterite. The western part of the same block is granite or gneiss, and the surface is often covered with rounded quartz stones. In this forest the sandstones show Sal growth, whereas the western parts are mixed forest.

74. *Laterite*.—Laterite is said to occur at many horizons, being a superficial alteration of rocks under certain meteorological conditions. It thus sometimes assists in locating stratigraphical breaks in the absence of an unconformity. But most of the laterite is probably recent and still in course of formation. On the Neterhat plateau (Central tract) it is very free from silica, and contains a large excess of alumina and becomes *Bauxite*. It occurs largely in the Southern tract, chiefly capping hills and plateaux, but in Singbhum there is a thick deposit along some of the Saranda valleys of the amygdaloid type. Laterite occupies large areas about Khurda, and on it is situated the Jaimangal and other small forests. It extends interruptedly to Cuttack and into Athgarh

\* *Gazetteer of Sambalpur*, p. 7. The authority for the statement appears to be derived from Ball, *Records Geol. Surv., India*, vol. x.

and Dhenkenal, and north of Cuttack between Kapilas and Bysee, and at intervals to Bhadrak and Balasore. Many of the railway stations along the East Coast Railway in Orissa are built of it. The Balasore laterite is more gravelly than that further south, and is apparently detrital. South of Khurda it extends to Tangi, though the hills are of gneiss. It is less common in other districts of the Southern tract. In the Lamal Junan block (Sambalpur range) it forms scarps and ridges well stocked with *Cleistanthus*, Bija and Sal, and it frequently caps the plateaux in Kalahandi, Patna and Borosambar.

75. It may be noted that laterite, when capping or mixed with other soils, usually has a distinctly good influence on forest growth, but where laterite and other formations run side by side (as in the case of the Athgarh sandstone) it is not possible to find any particular species occurring on one and not on the other.

76. Kunker is apparently a recent formation, often found in the older alluvium, but especially in the Southern area on igneous and gneissic rocks, of which it appears to be a product of the decomposition of the felspars under the influence of extremes of climate and defective drainage or at least, as near nalas, where there is an excess of water. Kunker soils in the forests are for some reason or other very poorly stocked. This effect may be purely mechanical; the kunker is partly dissolved in the rains and forms a cement between the particles of soil in the dry weather. *Soyimida* and *Ischæmum* (*Pollinidium angustifolium*) are frequent species on kunker soils. Cotton soil (regur) is widespread in the Southern tract, characteristic species are given on p 62.

77.

## PRINCIPAL FORMATIONS.\*

Approximate Geological Age.	Formations represented.
Recent	— Newer Alluvium. Laterite (but see para. 74). Regur, Kunker, etc.
Pleistocene	— Older Alluvium.
Tertiary	Pliocene Siwalik.
Secondary or Mezozoic	Cretaceous Jurassic Triassic
Primary or Palæozoic	Upper Gondwana: Rajmahal Traps. etc. Middle Gondwana (see also note on p. 16). Lower Gondwana: Damuda, Talchir.
	Permian
	Carboniferous Devonian Cambrian
Azoic	Vindhyan (but azoic in our area). Algonkian Kadapah. Huronian Dharwar. Archæan Fundamental Gneiss.

\* From Geikie, *Textbook of Geology*, p. 679, Third Ed., and Vredenberg, *Summary of the Geology of India*.



## CHAPTER III.

## CLIMATE.

General: 78—80; Seasons, 81; Rainfall, 82; Rainfall of Central tract, 83; Rainfall of Southern tract, 84; Average number of rainy days, 85, 86; Relative humidity, 87; Vapour tension, 88; Cloud, 89; Mean maximum temperature, 90; Mean minimum temperature, 91; Range of temperature, 92; Frost, 93—95.

78. Meteorological stations in India\* have to be placed where there already exists an agency capable of taking the instrumental readings—that is, mainly, in the towns. They are not, therefore, well adapted, except in a very general way, for botanical purposes. None exists on the jungle-covered hills or at the tops of the mountains, nor are there paired stations inside and outside the forests. More may one day be done in this way with the aid of the Forest Department, but so far the establishment has been insufficient for the purpose. Even the existing data from towns are not always available in the best form for our purposes. Published results are nearly always means; but it is extremes that often have the largest bearing on vegetation, and such extremes, although not supported by figures, have to be referred to in the section on the character of the flora. Among such extremes may be mentioned years of extreme drought. Such droughts will kill large trees of some species, and the effects are not confined to the year of the drought, but, on account possibly of the death of the roots, will continue to show for two to three years. Means of temperature again do not show that several districts, especially those in the north of our area, and more rarely most districts of the Central tract, are subject to cold-weather frosts. Allied to climate in its effects are the hot-weather jungle fires, which have a very important bearing on the survival of species, so much so that their absence or frequency may entirely alter the character of a forest.

79. *Rainfall.*†—The attached rainfall map shows in blue approxi-

\*The following (taken from *Met. Memoirs*, 1904) are the dates of establishment of some of the meteorological stations and their elevation (elev. of barometer cistern) above mean sea-level. Where two elevations are given, this is due to change in position.

Station.	Date.	Elevation (feet).	Station.	Date.	Elevation (feet).
Patna	1867	170, 183	Ranchi	1883	2128
Gaya	1869	375	Hazaribagh.	1867	1996, 2007, etc.
Purneah	1874	125.	Balasore	1883	56, 48, etc.
Darbhanga	1875	166	False Point	1865	15, 21, etc.
Sambalpur	1875	474, 486	Cuttack	1867	80
Chaibassa	1883	760			

Other stations (without barometers?) not recorded, or stations established since 1903.

†The rainfall figures in the tables have been taken from the *Monthly Rainfall of India*, 1922, published by the Provincial Governments, and issued by the Meteorological Department, 1922 (kindly lent by the High Commissioner for India). The normals are calculated up to 1918 inclusive only. District averages are based on more stations than are reproduced by me, and do not therefore always correspond with the average of my figures for stations. Figures are not exactly comparable, records at the different stations being for different number of years.



mately those regions where the rainfall is over 60". The area so coloured to the north-west, along the Sameshwar Hills, in close vicinity to the Himalayas, will be seen in the chapter on the composition of the flora to have a special, chiefly sub-Himalayan facies, akin to that of the adjacent Nepal Mountains. This also applies to the north-east area, but that the latter lacks the special sandstone plants and more resembles the northern Bengal flora. A small portion of the north-eastern Santal Parganas, including the east of the Rajmahal Hills, properly belongs in climate to the north-east tract of the Northern area, although for convenience the whole Santal Parganas district is included in the Central area. The greater rainfall and relative humidity of parts of the Rajmahal Hills accounts for the presence of *Siphonodon* and a few other Himalayan species found nowhere else in the Central tract.

80. The Southern tract will be seen to have the greatest area with a rainfall of 60" and over. In addition to the area coloured blue, parts of the Angul forests, Daspalla and Baud, have probably a rainfall of 60" and a greater relative humidity than that shown for Angul station, and nearly the whole of the remainder of the Southern area with the exception of the Keonjhar plateau and perhaps the Sonpur-Patna belt has a rainfall of 52—58". But not only is the rainfall and relative humidity high, but the mean minimum temperature is over 70°, and there is (with the few exceptions mentioned in para. 94) a complete absence of frost. The flora has, therefore, an abundance of species characteristic of warm humid climates, many of them common to Chittagong and Burmah. The high winter temperature probably accounts for the natural Teak in Kalahandi, and it may once have spread into the south of Puri, where planted Teak is doing well. The Sonpur-Patna belt, including part of Sambalpur and perhaps Kalahandi, has a more continental climate than the rest of the Southern tract, and many of the distinctive Southern tract plants disappear. The relative humidity is lower and the range of temperature in Sambalpur, although frost is absent, is greater than that of any other district excepting perhaps Gaya and Palamau.

81. The climate is of the monsoon type, and is characterized throughout the province by a dry and comparatively cool season from the middle of October to the middle of February, a dry and hot season from the middle of February to usually some time in May or June, and a warm wet season from June or July to September. The rainfall\* is derived mainly from the Bay current of the monsoon, which in the north becomes deflected by the Himalayas and sweeps up the Gangetic plain, or further south is precipitated by the mountains of the Central tract, or those of Orissa, and thus the actual rainfall varies to a considerable degree according to the position of any place relative to the mountain masses and its proximity to the Bay. On this account there is a relatively wet belt along our eastern boundary, and on account of proximity to the Himalayas there is a second belt close to

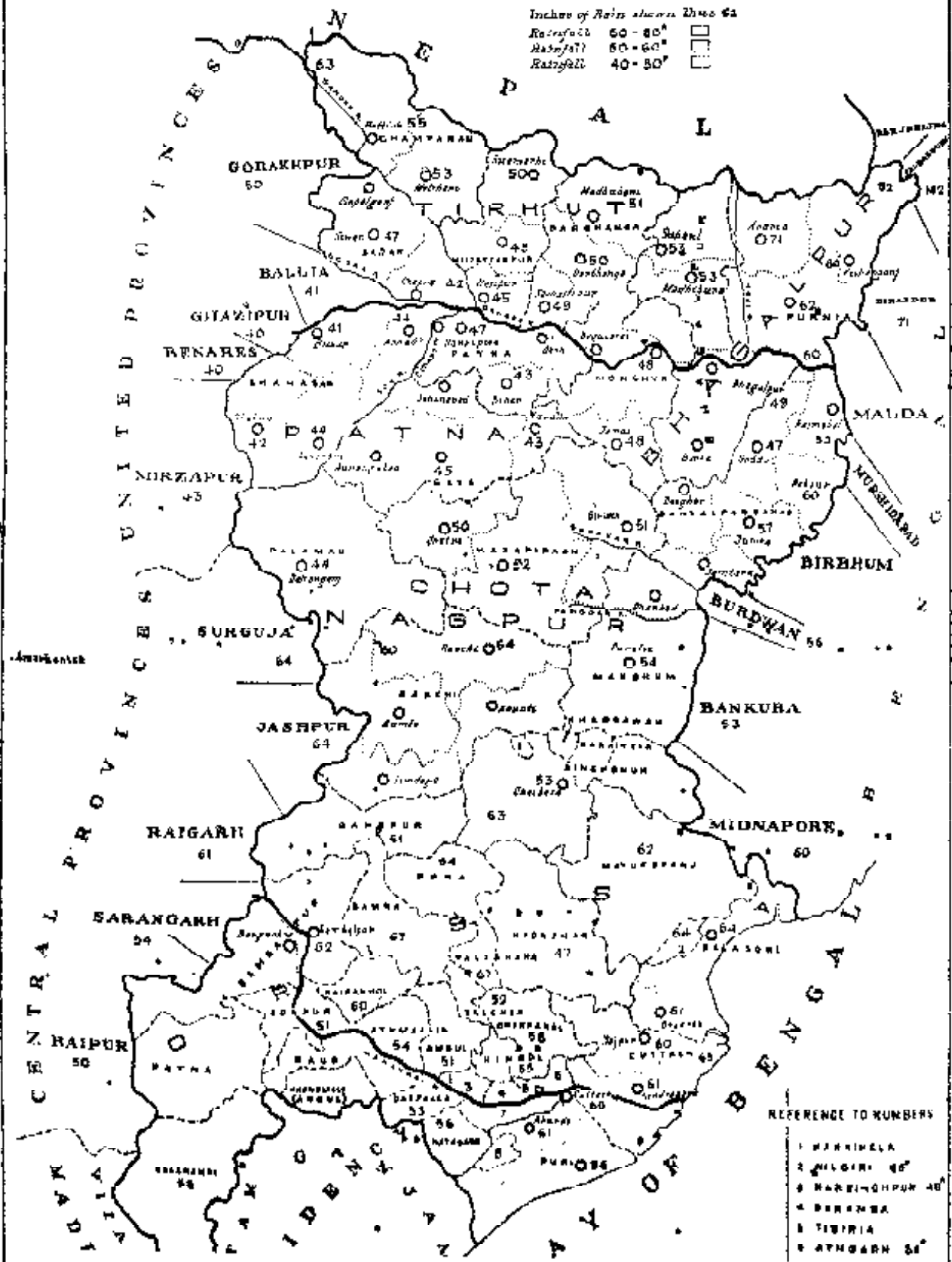
\* The small scale map (1"=64 miles) attached shows inches of rainfall (in bold figures) without fractions, the recording station, where named, being shown by a small circle.

# RAINFALL OF BIHAR AND ORISSA

Scale 1"=64 Miles

Inches of Rain shown above 62

Rainfall	60-80"	□
Rainfall	50-60"	□
Rainfall	40-50"	□



REFERENCE TO NUMBERS

- 1 MURSHIDABAD
- 2 MURSHIDABAD
- 3 MURSHIDABAD
- 4 BANGALORE
- 5 TIRUPUR
- 6 TIRUPUR

the northern boundary which as it recedes from the Bay becomes less and less marked, whereas where the two belts intersect, i.e. in Purneah, there is the heaviest rainfall of the province, attaining an average of 82" at Kaliaganj, which comes very much under the influence of the Himalaya. In this northern belt the fall rapidly slackens towards Darbhanga and Muzaffarpur, but again increases with proximity to the mountains in the north of Champaran. Owing to moist winds direct from the Bay becoming intercepted by the mountains of the south there is a large area of heavy rain also in the Southern tract, and probably the next highest rainfall to Purneah, or perhaps even higher, is that of the Simlipahar Mountains in Mayurbhanj, which attain 3550 ft. at Meghasani. There is, however, no meteorological station either here or on Parasnath, the highest mountain in the province, or indeed on the tops of any of the hill ranges. We know, however, that the fall in Mayurbhanj at Baripada, some 27 miles to east by north of Meghasani, reaches 62·8" which is as much as Purneah town (61·7") 40 miles south of the foothills of Nepal.

82. The rainfall in the northern area shows a fairly regularly graded distribution, as may be seen from the following table, in which the districts are enumerated from west to east, and the recording stations in each district from north to south.

## (1) RAINFALL OF NORTHERN TRACT.

## (a) North of Ganges.

Champan and Saran.	Muzaffarpur.	Darbhanga	Bhagalpur	Purneah.
Bagaha 62·5	Sitamardi 50·1	Madhubani 50·9	Supaul 52·9	Kaliaganj 82·3
Bettiah 54·6	Muzaffarpur 48·0	Darbhanga 49·7	Madhe- pura 52·5	Araria 70·2
Motihari 52·7	Hajipur 45·2	Samastipur 48·6		Kisanganj 79·6
Barharwa 48·2				Purneah 61·7
Siwan 46·6				
Chapra 41·6				
District { 53·2 } average { 44·4 }	46·4	51·2	52·3	67·9

## (b) South of Ganges.

Shahabad	Patna and Gaya.	Monghyr.	Bhagalpur.	Santal Parganas.
Buxar 40·7	Patna 46·7	Monghyr 48·4	Bhagalpur 47·0	Rajmahal 53·4
Arrah 43·7	Barh 43·0	Jamui 45·4	Bhanka 47·9	
Bhabua 42·4	Bihar 43·5	Sheikhpura 42·2		
Sasaram 44·3	Gaya 45·7	Gidhaur 46·1		
	Nawada 42·5			
District } 41·9 average }	{ 43·0 } { 42·6 }	47·8	47·6	

It will be seen that the rainfall increases from west to east except in Champaran, where the recording stations are affected by the nearer approach of the hills.

83. In the Central tract also there is a general average decrease of the rainfall from east to west, but here, as might be expected from the topography, the rule is subject to more exceptions. Not only do places in the lee of hill ranges show a considerable decrease of rain, e.g. Godda on the west of the Rajmahal range is only 49 compared

with Pakaur at the eastern foot 60", but the extreme western regions come under the influence of the vast elevated tract of the Vindhyan-Mahadeva mountains, which about Amarkantak\* form an axis of minimum pressure towards which the two branches of the monsoon converge from the opposite coasts.† Here, therefore, in the extreme western hills of Palamau, Ranchi and Gangpur there is again a large increase of precipitation, very imperfectly shown by the figures available.

## (2) RAINFALL OF CENTRAL TRACT.

## (a) Northern Districts.

Palamau.		Hazaribagh.		Santal Parganas.	
Hussainabad	43.6	Chatra	49.5	Godda	47.3
Garwa	46.2	Giridih	49.6	Pakaur	60.1
Daltonganj	43.7	Hazaribagh	52.1	Dumka	56.6
				Madhupur	49.9
District average }	44.9		50.4		54.1

## (b) Southern Districts.

Western States.		Ranchi.		Singbhum.		Manbhum.	
Sirjuga	64.4	Lohardaga	50.7	Chakradapur	52.5	Gobindpur	53.4
Jashpur	63.8	Ranchi	53.9	Ghatsila	57.9	Jhaida	54.4
Gangpur	60.5	Silli	50.6	Chaibassa	53.2	Purulia	54.1
		Chainpur	53.0				
		Tamar	50.4				
		Palkot	60.0				
District average }			55.3		55.9		49.8

The elevation of Bistrampur, the capital of Sirjuga, is 1953 ft.; of Jashpurnagar 2576 ft. Both these states are now transferred to the Central Provinces. The rainfall of Neterhat will probably approach that of these two places or exceed them. Palkot is on the Ranchi plateau on the west and close to windward of the Jashpurnagar pats. Gangpur and the Kolhan portion of Singbhum fall better into the Southern tract.

84. The Southern tract, by reason perhaps of its greater hilliness, more forest, and especially by being more directly influenced by the Bay winds, is on the whole more rainy than the other two tracts. By reason of the great irregularity of the arrangement into states or districts, it is not possible to arrange the districts into east and west series, and here again, while recording stations occur on the low ground along the coast, there are none on the inner hills except that of Pal Lahara.

## (3) RAINFALL OF SOUTHERN TRACT.

(a) Western Districts.—Sambalpur 61.9; Bamra—Deogarh 67; Rairakhol—Rampur 60.2; Sonapur, 51.0; Patna—Bolangir 52.0; Baud 52.6; Kalahandi—Bhawani-patna 58.1.

\* The position of Amarkantak has been shown on the maps attached.

† Cp. Blandford, *Met. Memoirs*, vol. III, part 3.

A rainy day is a day in which '1" rain or more is recorded. It will be seen that the number of rainy days is not proportional to the rainfall. This is partly, but by no means entirely, due to the figures being less recent. As the figures are to the nearest whole number, the average of the year does not always agree with total of the monthly normals.

The above figures of rainfall and its distribution sufficiently show that every part of the province is well adapted to the growth of forest, though not forest of the most luxuriant type.

86. The total normal number of rainy days and the normal rainfall brought up to the year 1910\* for a smaller number of stations is given below. The figures per month are not available.

	Normal Rainfall.	Rainy Days.		Normal Rainfall.	Rainy Days.
Motihari	55.57	59	Daltonganj	41.91	62
Chapra	42.30	52	Hazaribagh	52.59	75
Muzaffarpur	49.55	56	Dumka	56.21	78
Pusa	49.13	55	Ranchi	56.20	80
Darbhangha	51.09	59	Chaibassa	52.11	75
Purneah	61.72	70	Purulia	52.51	76
Buxar	41.09	53	Sambalpur	64.74	75
Arrah	44.95	55	Angul	47.04	72
Dehri	42.01	54	Balasore	62.09	77
Patna	47.98	56	Cuttack	59.30	74
Gaya	46.48	58	False Point	62.92	72
Monghyr	50.99	52	Puri	54.00	60
Bhagalpur	49.24	60			

87. *Relative humidity.*—The principal rain falls, as stated above, from June to September, but there are occasional showers towards end of December or beginning of January, and frequently heavy thunder showers in May, which tend considerably to raise the relative humidity of those months. In the months following on the cessation of the rainy season there are great differences between the temperatures and relative humidity of day and night, and very heavy dews occur which are of importance to the cold weather annuals.

In the following table the relative humidity is given in the same order as the rainfall for each month of the year. The recording stations are fewer.

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\* Calculated from (Government of India) *Indian Weather Review*, Annual Summary with figures of departures from normal, 1918. The normals are, however, only based on records available up to 1910 inclusive. The normal rainfall up to that date is therefore also given, and differs somewhat from figures in previous paragraph. The records of a few stations not available in 1904 have been added.

*Relative Humidity.*

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Gorakhpur*	82	72	57	53	63	78	87	88	84	77	76	81	75
Darbhanga	88	79	63	65	72	83	88	89	87	83	83	87	81
Purneah	91	84	68	68	77	87	90	91	90	88	89	91	85
Buxar	74	66	49	42	52	71	84	88	84	72	67	71	68
Patna	78	69	52	51	64	77	86	87	83	74	71	75	72
Gaya	75	69	55	51	58	73	83	86	82	73	71	72	71
Daltonganj	81	75	58	46	48	66	83	86	84	80	79	81	72
Dumka	75	65	50	52	67	80	87	88	85	78	74	73	73
Ranchi	65	60	45	42	51	72	88	89	84	70	63	64	66
Chaibassa	78	72	61	57	64	74	86	87	86	80	78	79	75
Purulia	73	65	55	54	66	79	88	90	88	78	70	69	73
Sambalpur	73	66	55	50	50	69	85	85	82	77	74	74	70
Angul	80	76	67	67	67	78	85	86	86	79	73	79	77
Balasore	81	77	77	75	75	81	86	87	87	83	80	78	81
Cuttack	81	80	78	74	73	78	82	83	83	80	78	77	79
False Point	88	86	85	82	82	83	87	87	85	84	82	84	85
Puri	82	81	84	85	85	85	86	86	85	81	78	77	83

88. The normals of vapour tension are given in the following table: †

*Vapour Tension.*

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Gorakhpur	35	36	41	55	73	91	97	96	91	72	50	37	64
Darbhanga	38	39	45	63	79	93	97	98	94	79	55	40	68
Purneah	36	39	48	65	81	93	98	98	96	80	55	38	69
Buxar	34	35	37	45	64	86	95	95	91	68	45	35	61
Patna	36	37	41	54	75	92	98	98	94	74	50	37	66
Gaya	35	38	45	59	77	91	94	94	89	69	47	34	64
Daltonganj	34	37	40	47	61	80	89	89	85	64	44	35	59
Dumka	35	39	41	58	77	90	93	93	91	74	51	36	65
Ranchi	31	32	34	43	58	74	79	79	75	60	40	31	53
Chaibassa	38	41	47	64	75	85	86	87	87	72	50	38	64
Purulia	36	37	44	56	75	88	91	91	89	70	45	34	63
Sambalpur	42	44	48	60	71	84	89	88	88	74	52	41	65
Angul	44	51	57	71	82	87	89	89	90	74	50	43	69
Balasore	44	51	68	83	92	95	95	95	95	81	56	42	75
Cuttack	48	57	71	84	91	92	90	91	90	80	58	45	75
False Point	55	66	82	92	100	99	96	96	95	87	65	51	82
Puri	56	66	83	91	101	100	97	97	96	85	64	51	82

\* Gorakhpur is not in our area, but is shown for comparison as the nearest recording station to the Gandak, on the west of which it is situated. The highest relative humidity is seen to be in the north-east corner (Purneah), and on the sea coast (False Point, Puri, etc.).

† The figures represent hundredths of an inch. The original figures (*Memoirs of the Indian Met. Dept.*, vol. xxii, part 3, 1914), being given to three places of decimals the averages do not in all cases quite agree with the year's average.

89. *Monthly and Annual Normals of Cloud.\**

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Gorakhpur	20	22	17	18	20	48	64	65	46	17	7	11	30
Darbhanga	18	17	12	14	23	56	72	71	51	18	6	8	31
Purneah	16	16	13	24	37	65	71	73	57	23	7	8	34
Buxar	24	25	19	16	18	49	73	73	52	22	11	14	33
Patna	21	25	17	15	20	54	82	85	60	22	11	11	35
Gaya	23	26	21	20	25	51	68	68	49	27	15	16	34
Daltonganj	20	20	15	17	15	41	58	56	40	19	11	12	27
Dumka	17	19	14	18	30	56	70	69	55	24	11	11	33
Ranchi	23	26	18	19	23	58	83	83	61	31	16	16	38
Chaibassa	17	22	18	17	23	55	73	71	56	29	17	15	34
Purulia	22	23	17	22	24	50	67	64	53	22	12	13	32
Sambalpur	21	23	19	22	29	64	82	80	59	29	18	18	39
Angul	21	32	30	23	20	57	62	56	45	29	12	16	34
Balasore	15	21	19	26	33	53	61	59	51	30	17	14	33
Cuttack	21	27	30	36	45	69	74	73	61	37	25	23	43
False Point	26	34	42	54	61	78	84	83	73	47	34	27	54
Puri	15	21	27	35	43	62	70	69	56	32	20	14	39

90. *Mean Maximum Temperature, °F.*

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Gorakhpur	73	77	90	100	101	97	91	90	90	89	82	74	88
Darbhanga	73	77	88	96	96	92	89	89	89	87	82	75	86
Purneah	74	78	90	97	95	92	90	89	89	88	82	76	87
Buxar	74	78	90	100	103	98	91	89	90	90	84	76	89
Patna	73	78	90	100	100	96	91	89	90	88	82	74	88
Gaya	75	80	93	103	105	100	92	90	91	90	83	76	90
Daltonganj	75	79	90	101	107	101	91	89	90	89	83	77	89
Dumka	75	80	91	100	99	94	89	88	89	88	82	76	88
Ranchi	74	77	87	96	99	92	84	83	84	83	78	73	84
Chaibassa	80	84	95	103	104	97	89	89	89	89	84	79	90
Purulia	77	81	93	102	102	97	90	89	89	89	84	78	89
Sambalpur	82	87	96	104	107	98	87	87	89	89	84	80	91
Angul	82	87	95	101	104	95	88	87	88	89	84	79	90
Balasore	81	85	92	97	97	93	89	88	89	88	84	80	89
Cuttack	84	89	97	102	101	96	90	89	90	90	85	82	91
False Point	79	82	87	89	91	90	87	87	88	88	83	78	86
Puri	80	83	86	88	90	89	88	88	89	89	85	80	86

\* Cloud is usually estimated according to a scale 0—10, 0 being a clear sky, 10 a sky entirely overcast. The meteorological records show it on the scale to one place of decimals, which I have converted into percentages of an entirely overcast sky.

91. *Mean Minimum Temperature, °F.*

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Gorakhpur	49	52	62	72	77	79	79	79	78	70	58	50	67
Darbhanga	51	53	62	71	76	79	80	79	79	73	61	53	68
Purneah	48	51	60	70	74	77	79	78	77	71	59	49	66
Buxar	50	54	63	74	79	81	79	78	78	71	60	51	68
Patna	51	54	64	73	78	80	80	79	79	72	61	52	69
Gaya	51	56	66	75	80	81	79	78	78	71	59	51	69
Daltonganj	47	51	59	70	79	81	78	77	75	66	53	46	65
Dumka	51	56	65	74	77	78	78	77	77	71	60	51	68
Ranchi	51	55	63	72	75	75	73	73	72	66	58	51	65
Chaibassa	54	59	67	75	79	79	77	77	76	70	60	53	69
Purulia	54	58	66	74	77	79	77	76	76	70	60	53	68
Sambalpur	55	60	67	75	81	81	77	77	77	72	61	54	70
Angul	56	61	67	74	78	78	77	77	76	71	60	55	69
Balasore	56	61	69	76	79	79	78	78	78	73	62	56	70
Cuttack	60	65	72	78	80	80	79	78	78	75	66	59	72
False Point	59	64	72	77	80	80	78	78	78	74	65	57	72
Puri	64	69	75	79	81	81	80	79	80	77	69	62	74

92. The *absolute maximum, absolute minimum and range of temperature* previous to 1903 is recorded for the following stations:

*Northern Area.*

	Maximum.	Minimum.	Greatest range.
Darbhanga	107·4 in May	38·3 in January	51·7 in March.
Purneah	109·9 „ April	34·7 „ February	59·4 „ „
Patna	114·4 „ June	36·4 „ January	61·3 „ „
Gaya	116·2 „ „	38·9 „ „	56·0 „ May.

*Central Area.*

Ranchi	110·3 in May	37·9 in January	54·9 in March.
Chaibassa	117·8 „ „	42·9 „ December.	57·6 „ „

and January

*Southern Area.*

Sambalpur	117·3 in May	40·1 in December	62·6 in March.
Balasore	116·0 „ „	45·4 „ January	49·0 „ „
Cuttack	118·0 „ „	48·6 „ „	31·3 „ February
False Point	108·5 „ „	45·9 „ „	45·7 „ „

93. *Frost.*—There are no figures available as to actual grass temperatures. The absolute minimum recorded in para. 80 must be temperatures in the screen, as I have recorded 2° frost on the roof of my tent as far south as Singbhum, while Hamilton\* states that "hoar frost is

\* Walter Hamilton (not Dr. Francis Buchanan, better known as Buchanan-Hamilton). Hamilton's "Bahar" (in *Description of Hindustan*) embraced our Northern and Central areas without Purneah and Singbhum.



found in some mornings in Purneah, which occasionally is so extreme as to injure some crops, especially the pulse." He also says, "During the cold season a blighting frost is sometimes experienced in the Bahar and Benares provinces." Frost is not believed to occur in the northern parts of Purneah or in the east of the Santal Parganas (coloured blue on map). The area of greatest frost corresponds approximately to the area coloured yellow on the rainfall map, which also contains those places where the tension of water vapour in January is least (see para. 88). In Palamau frost is frequent. In the Saidope forest and near the Koinari River, practically in the plains, the frost damage is sometimes great. On the elevated parts it is naturally still more severe. Where the original forest has been maintained but little damage is done, but especially in depressions in the open the effects of frost in January and the strong winds in the hot season make such places exceedingly difficult to reafforest. In the course of time, if protected from fires and grazing, the natural forest would probably reassert itself by very gradually spreading from the edges of existing woods.

94. The Southern area is practically free from frost, but in Singbhum frost has been noted at various times from December 17th to January 31st. They are slight at ordinary elevations, but it has been noted that Sal seedlings on the edges of grass tracts (the grass due primarily to cultivation) at an elevation of 2800 ft. in the Karampada forest have been repeatedly cut back by frost.

95. The comparatively frost-hardy species in our Northern and Central tracts appear to be *Mallotus philippinensis*, *Bauhinia retusa*, *B. purpurea*, *Eugenia obovata*, *Bombax malabaricum*, *Garuga pinnata*, *Embelia robusta*, *Aegle marmelos*, *Stereospermum suaveolens*, *Emblia officinalis*, *Lagerstroemia parviflora*, *Gardenia turgida*, *Carissa paucinervis*, *Salix tetrasperma* and the shrubs *Glochidion multiloculare* and *Woodfordia floribunda*. To a less extent *Terminalia tomentosa* and *Butea frondosa*. The Sal, *Dillenia* and most other species which are common in the Central tract and Southern tract are frost-tender.

## CHAPTER IV.

### GENERAL CHARACTER OF THE FLORA AND BOTANICAL FORMATIONS.

Botanical provinces, 96; Distinctive characters of Bihar and Orissa, 97; Mainly tropophilous, thorn woodland, induced scrub, 98; Principal seasons of leafing and flowering, bulbous plants, 99; Monsoon period, herbaceous climbers, 100; Dominant families, 101; Distribution, 102; Effects of fire on distribution, 103.

**Northern Tract:** Gangetic Plain area, 104; Long under cultivation, 105; Little natural growth, 106; Crops, 107; Higher cultivated lands, wild flora, 108; Semi-natural forest, 109; Swamps, 110; Aquatics, 111; Transition between swamp and aquatic flora, 112; Rice-field flora, 113; Natural woodland, 114; Khair-Sissu forest, 115; Sameshwar Hills, 116; Species characteristic of Sameshwar Hills and Lower Himalaya also found in Central and Southern tracts, 117; Species characteristic of Central tract found in the Sameshwar Hills, 118; Species normally common to sub-Himalaya, Central

and Southern tracts, 119; Purneah, 120; Grass lands of Northern tract, low-level savannahs, 121; High-level savannahs, 122; Other herbs of the grass lands, 123; First trees to appear in grass lands, 124; Effects of heavy grazing, 125.

**Central Tract:** General, 126; The Sal tree, 127; Trees on dry hills, white bark a xerophilous structure, 128; chasmophytes, 129; *Ficus*, 130; Other xerophytes, milky juice, 131; The Sal formation, 132; On trap and laterite, 133; On quartzite, limestone and cotton soil, 134; Dependence on lie of the strata or plane of bedding, 135; Valley type Sal, 136; Associates in valley type, 137; Associates in hill type, 138; Mixed forests, 139; *Terminalia*, 140; Dry type of mixed forests, 141; *Hardwickia*, 142; Khair type, 143; Evergreen type, 144, 145; Grass lands of Central tract, 146; Flora of the *páts*, 147; Endemic species, 148; The *páts* a connecting link between South India and the Himalaya, 149; Interesting species of the *páts*, 150; Flora of Parasnath, 151.

**Southern Tract:** General, 152; Sal, Teak and Bamboo, 153, 154; Thorny bamboo formation, 155; male bamboo, 156; Mixed forest, 157—162; Chittagong and Himalayan element, 157; Drier mixed forest, 158; Laterite and sandstone, 159, 160; Induced scrub, 161; Evergreen forest, 162; Coastal tracts, sand flora, 163; Mangrove swamps, 164, 165; Common characteristics, 166; Vivipary, 167; Drift seeds, 168.

**Plant Communities:** Species in a formation often independent of one another, 169; Easier to classify habitats than communities, latter very numerous, 170; Classification of habitats, 171; Allied species usually in different habitats, 172; Exceptions, 173; Temperate families, 174; List of trees and shrubs common to the Central tract and sub-Himalaya, 175; Table of habitats or plant associations, 176; Number of genera and species of each family, 177.

96. In the province of Bihar and Orissa as at present constituted are included parts of four botanical provinces of Hooker and Thomson, viz.: (1) the lower part of their province of the Upper Gangetic Plain; (2) a small part (the district of Purneah only) of Bengal; (3) the whole of their province of "Bahar" excepting a few native states recently transferred to the Central Provinces; (4) the northern part of the province of Orissa. Our Northern tract is in the first two, the Central tract practically corresponds to their botanical province of Bahar, and the Southern tract is in the last.

97. In Sir J. D. Hooker's sketch of the flora of British India (1904) he makes nine botanical provinces of the whole country, including Ceylon, Burmah and the Malay Peninsula. Our province falls into two of these. The Gangetic Plain area and the low country of Orissa north of the Mahanadi lies in his Gangetic Plain province, and the remainder falls into his large Deccan Province. Some authors make many more provinces, but these are chiefly founded on differences of the topography and climate. A true botanical province only arises when the whole is characterized by the more or less general presence or absence of particular families, genera or endemic species. Bihar and Orissa as a whole is characterized by the complete absence of *Cupuliferæ*, a general scarcity of laurels and myrtles, and by few, or very few, *Ranunculaceæ*, *Magnoliaceæ*, *Cruciferæ*, *Guttiferaceæ*, *Rosaceæ*, *Umbelliferæ*, and comparatively few *Orchidaceæ*. Further, except for the genus *Ficus* it possesses comparatively few of the *Urticales*. On the other hand it possesses marked positive features in the presence, practically throughout, of the Sal tree (but no other *Dipterocarp*) and in the almost general association with the Sal in

large numbers of individuals, if not of species, of *Terminalia*, *Anogeissus*, *Bassia* (the Mohwa), *Butea*, *Scleicheria*, *Rubiaceæ* (notably *Gardenia* and *Wendlandia*), *Acanthaceæ*, *Bauhinia*, *Diospyros*, *Zizyphus*, *Cleistanthus*, *Nyctanthes* and, except in the Gangetic plain, of the bamboo *Dendrocalamus strictus* and of the grasses *Ischæmum angustifolium* (Sabai grass) and *Heteropogon contortus* (Spear grass). The *Anonaceæ* are also well represented.

98. The general character of the vegetation is tropophilous, and there is no true rain forest in the province. The distribution of thorny species is adverse to Schimper's theory that thorn woodland is essentially a formation due to climate. As suggested in my *Forest Flora*, it appears here as rather the effect of selective cutting and browsing. In the pieces of semi-wild jungle of Purneah (one of the wettest districts, see para. 82) thorny species are abundant, and the very thorny *Flacourtia sepium* is one of the commonest in the type of heavily browsed scrub jungle which I have termed Induced Scrub. In this area also the prickly *Cæsalpinias* and Acacias are frequent, *A. concinna* sometimes forming a small tree. *Mimusops hexandra* is found with large blunt thorns, though it is thornless on the dry sandstones of the Central Provinces. It has been noted that the thorns of *Vangueria spinosa* are nowhere so formidable as when the tree is rapidly growing in the more humid jungles. In the Central tract the Khair (with stipular prickles) appears almost entirely due to the human factor (see para. 143), as do the *Zizyphus* tracts. The Induced Scrub, again, of the Southern tract bears no relation to the dryness of the locality, but rather to its accessibility to heavy hacking and grazing with the concomitant selection of the unarmed species to the benefit of the armed. And this Induced Scrub is gradually giving way to less thorny species with protection of the forests. On the other hand the dry hills of the Central tract have comparatively few thorny species, but are rather characterized by such xerophytic characters as succulence, thick branches, absence of leaves and white bark (see para. 128). The thorny species, such as *Gardenia turgida*, are most formidable when young and liable to be browsed.

99. Towards the beginning or middle of the hot season the forest is for the most part nearly leafless, but, contrary to what might be expected, the majority of the deciduous trees are in leaf again well before the monsoon. The hot season is the best one for the flowering of woody species, and the worst month is January. On the other hand a large number of herbs or suffruticose perennials flower in the cold season. The hot season, after the jungle fires and at the break of the monsoon, is the period for a quantity of bulbous and rhizomatous *Liliaceæ*, *Amaryllidaceæ*, *Soitamineæ*, etc., to send up their scapes and flowers, many of which are very beautiful. The leaves of these and other species form a characteristic monsoon undergrowth.

100. The monsoon period is further characterized by the rapid production of shoots and leaves of numerous suffruticose or herbaceous climbers such as *Dioscorea*, *Asparagus*, *Smilax* and *Ipomœa*, by the rapid growth or production of new leaves and shoots on both evergreen and deciduous trees and shrubs, and even undershrubs (such as

*Petalidium*), by the growth of innumerable annuals which either flower during the rains or after their cessation, and by the flowering of *Scitamineæ*, ground Orchids (epiphytic orchids mostly flower in the hot season), several *Liliaceæ* and *Tacca*, and also the rapid production of new shoots of the perennial grasses and bamboos, which mostly flower in the cold season. The result of monsoon activity is to make the forests, which in the hot season are easily traversable, difficult to walk through and still more difficult to see through, and the open country green with crops or tall grasses and other herbs, which before the rains is brown or bare.

101. The dominant families according to mere number of species are in the following order:\*

1. *Leguminosæ*. 2. *Gramineæ*. 3. *Cyperaceæ*. 4. *Compositæ*. 5. *Euphorbiaceæ*. 6. *Acanthaceæ*. 7. *Rubiaceæ*. 8. *Labiataæ*. 9. *Scrophulariaceæ*. 10. *Convolvulaceæ*. 11. *Urticaceæ* (in the larger sense). 12. *Verbenaceæ*.

The enumeration of the ten most prevalent families (according to number of species) is the method adopted by Hooker in the above-mentioned sketch. Until, however, we have complete accounts of the flora by districts, such as Prain's census of the flora of the Sundribans, it is almost useless to apply the system to subdivisions of a province. In our case, for instance, the grasses of the Central tract would appear to be far more numerous than those of the Northern or Southern tracts. This is merely due to the area having been more intensively worked.

102. In the body of this Flora, instead of recording the distribution of species by subdivisions or sub-areas, it has been considered preferable to name each district (administrative) from which there is a record of the occurrence of a species, or sometimes even the actual locality. There are several reasons for this, the chief being that our knowledge of the distribution of so many species is still very imperfect, and deductions from such imperfect data are apt to be misleading. It gives, for instance, a very imperfect idea of the distribution of *Didisandra lanuginosa* to quote Bihar or Chota Nagpur (or whatever sub-province or subdivision might be adopted) when it has only been collected or observed once or twice in a single district and near the same spot at 3000 ft. elevation. A few years ago it would have been assumed that many of the species here recorded from the province did not occur in Bihar and Orissa. For similar reasons, viz. the imperfection of available data, until the *Flora of Madras* has been completed, the flora of the Central Provinces and other adjacent and more remote areas have been more fully investigated and compiled, it is considered premature to show in detail or by numbers the spread of our species into other areas. It appears from the distribution notes in the following pages that the original barrier of the Gangetic Sea has been bridged partly *via* Chittagong and Orissa, as well as in north and south directions. Nowhere, however, have the *Cupuliferæ*,

\* A list of all the families with the approximate number of their genera and species is given in para. 177.

*Juglandaceæ* or *Betulaceæ* succeeded in crossing to the peninsula of India. In all problems of distribution bearing upon our area, the very serious disturbances due to the action of man (*cp.* para. 98) will have to be taken into account. The effects of fire are especially important (see para. 103).

With such an immensely old land surface as that of the Indian Peninsula, with the majority of the species probably immensely old, and with no serious obstacles to their distribution, their occurrence indeed in different localities of a province is almost entirely a question of similar climate and soil. And by climate must here be included the very local climatic conditions of environment due to the position of a plant in a valley in contrast to one on a hill, or in the shade of other trees, as compared to one in the open. As insolation is an essential factor of climate, the local climate in the shade of a mango *tóp* is radically different to the climate beyond its shade. And thus a plant species found in the open in the humid climate of Purneah may not be found in the Central tract, but may recur on the mountains of the Southern tract under perhaps partial shade, or it may be found in ravines in the Central tract, and so in numerous other instances. But although many species thus find approximately similar conditions and recur in separated districts, and the isohyetal lines which, running through the hills of Northern Champaran, Southern Nepal, and Purneah, leave our province and curve round through Bengal, return to it again in the mountains of the Southern tract, they follow a different course to the isothermal lines, and these again vary much in direction at different seasons. So that taking these two factors, alone it is impossible to reproduce exactly the same conditions in different parts of the province. Thus, although many species may be the same at widely separate points, with approximately equal humidity, the whole plant community is found to differ. Elastic species, like Sal and Saj, are found in many different plant communities.

103. *Effects of fire on distribution.*—Speaking generally the effect of hot-weather fires is gradually to transform forest to grass-land. This is done by repeatedly killing off young growth of all kinds, including the young branches of trees to a considerable height, and thus letting in the light favourable to strong-growing grasses which, in their turn, suppress tree reproduction and form every hot season dry fuel for the flames. The trees are themselves not killed by the fires if they have survived to the sappling stage. Where complete fire protection cannot be ensured the early intentional burning of the forest, when much of the heat is rendered latent by the large quantity of green material in the undergrowth as well as its intensity being initially less under the different climatic conditions (strong westerly hot-weather winds do not usually set in before March), will preserve the forest as such, but may alter its composition. Firing of any kind is inimical to evergreen forest. Very few evergreen species are at all fire-hardy. *Symplocos racemosa* is somewhat. But some deciduous species, the Sal especially, will thrive under a systematic *early* burning and gradually spread. Though the outermost seedlings of a clump get burnt to the ground they will send up a shoot in the ensuing hot

season, and those further inside the clump, or close to a parent tree, will get less and less burnt so that even an isolated tree will give rise in the course of years to a cone of young growth which gradually enlarges. Where fire protection is absolute on the other hand, evergreen forest will in the more humid situations encroach upon the Sal area. Evergreen forest was at one time, therefore, probably far more extensive than it is at present, not only on this account, but from the higher altitudes of the mountains, and it is the evergreen forests which support the larger number of species. (On the other hand it is probable that a large number of the bulbous and rhizomatous herbs, which flower after the fires have removed cover, owe their gradual evolution to annual burning. Some of the species, e.g. *Aneilema scapiflorum*, *Crinum latifolium*, species of *Pancratium*, *Hypoxis aurea*, etc., etc., are rarely found in evergreen forest. The dwarf shrubs *Grewia sclerophylla*, *Grewia sapida*, *Ochna pumila*, *Erythrina resupinata*, *Careya herbacea*, etc., may also have evolved in response to the same cause.

#### FLORA OF THE NORTHERN TRACT.

104. The Gangetic Plain area in view of its geological history might be expected to, and does in fact, separate very distinct floras. It constitutes the greater part of our Northern tract. It cannot itself be separated as a distinct province by the absence of the Sal tree, because absence of the latter is due to local factors, including extermination by man. As a matter of fact, Sal does occur in patches on rising ground in the heart of the Northern tract as in Bhagalpur, both north and south of the Ganges.

105. There are, to my knowledge, no records of the original flora of the greater part of the Gangetic Plain. Though we know from Hamilton that parts of it were covered with extensive Sal forests, etc. only a century ago, the bulk of the Gangetic Plain must have been highly cultivated for an immense period. Gotama Buddha preached in Magadha (Bihar) about 500 B.C., and Megasthenes was ambassador at the court of Chandra Gupta at Pataliputra (Patna) some 300 B.C., and it is suggestive that Asoka, king of Magadha 264—227 B.C., issued edicts for the planting of trees for *shade*!

106. The plain now possesses very little natural growth except in the marshes, which form a distinct, scattered formation.\* Omitting for the present the very distinct Northern Champaran (Sameshwar) Hills and Northern Purneah, there are roughly four classes of land (1) The open cultivated lands; (2) small remnants of the forest with their original constitution usually much altered by human agency; (3) the swamps; (4) the grass lands. To these a fifth class, the *reh*

\* A "formation" is a community of plants of more or less the same facies. This facies depends on climate and soil, and thus may be distinguished "climatic or district" formations and "edaphic or local formations." Schimper states that in each formation one species of plant, or a group of species, is characteristic; plants that merely occur sporadically are unessential to the formation, and commoner subsidiary constituents can only give a different facies to the formation. He would probably have included the whole Sal area in one formation. We have to regard it as consisting of several, or at least of several associations.



lands, might be added. Commonly cultivated trees, sometimes forming small plantations (tóps) or groves, are mango, sissu, jack (*Artocarpus integrifolius*), *A. lakoocha*, bael, custard apple and bullock's heart, guava, *Mimusops elengi*, and rarely *M. hexandra*, *Elæocarpus ganitrus* and (Purneah) *E. floribunda*, *Sapium sebiferum*, mulberry, and bamboos (see also para. 20 relative to the limestone belt).

107. The crops are usually classified by the season in which they are reaped, being either *rabi*, reaped in spring, *bhado* or *bhadoi*, reaped in August and September, and *aghani*, reaped in winter. The soils are variously classified in different districts.

The chief crops are rice (both *aghani* and *bhadoi*), indigo (cut July or August, with a second cutting in September), maize, marua (*Eleusine*), millets, sugar-cane, wheat, barley, oats (all three harvested in spring), arhar (*Cajanus*), urid and mung (spp. of *Phaseolus*), janera (*Sorghum*), tobacco (especially in Tirhut\*), oil seeds (*sesamum*), masuri dal (*Ervum lens*), and, less important, khesari dal (*Lathyrus sativus*), *kodo* (*Paspalum*), and others. Formerly the poppy was largely grown. Towards Purneah, where the rainfall is heavier, jute is grown.

108. The distinctive character of the wild flora of the higher cultivated lands is the presence of many European genera (see list on p. 66), and is due to the marked cold season or possibly also to direct seedling from the Himalaya. *Fragaria* and *Potentilla* occur in damp places under shade, but not in the cultivated area. Hooker refers to a *Veronica* and *Potentilla* on the banks of the Sone, no doubt *V. anagallist* and *P. supina*. Hamilton refers to *Cannabis sativa* as wild in Bettiah. The rice-land flora of the Northern tract does not, so far as I am aware, differ much from that of the rest of the province.

109. In addition to Sal which occurs in small outliers on rising ground, the patches of semi-natural forest contains *Flacourtia cataphracta*, *F. Ramontchi*, *Miliusa*, *Putranjiva*, *Terminalia bellerica*, *Albizia stipulata*, *Grewia Hainesiana*, *Aegle marmelos* (Bael), *Litsæa polyantha*, Sissu, *Anthocephalus cadamba*, occasional *Pterocarpus marsupium* (a tree of the Central tract), *Cæsalpinia sepiaria*, *Phyllanthus emblica* (*Emblica officinalis*), *Hymenodictyon* (also chiefly a tree of C.T.), Simal (*Bombax*), *Pongamia glabra*, *Streblus asper*, and in the moister districts *Trewia nudiflora*, *Celtis*, *Alstonia scholaris*, *Eugenia jambos* (Rose-apple), *Salix tetrasperma*, *Cordia myxa*, *Vitex leucoxydon*, *Sapium sebiferum*. The following smaller trees or shrubs are also common:—*Vangueria*, *Cæsalpinia crista*, *Antidesma ghaesembilla*, *Solanum indicum* (and in Purneah *S. torvum* and *S. ferox*), *Murraya Koenigii* (bakaina) *Adhatoda vasica*, *Ichnocarpus frutescens*, *Breynia rhamnoides*, *Cassia sophera*, *Randia dumetorum*, and many others. For a list of species peculiar or characteristic of the jungles of Purneah see p. 55.

*Streblus asper* is exceedingly abundant, as well in hedges in the fields as in the semi-jungles, from a small exceedingly dense rigid

\* Tirhut used to include the present districts of Muzafferpur and Darbhanga.

† *Veronica agrestis* is also frequent in the United Provinces at no great distance from the Sone. As regards the *potentilla* Anderson, who had probably seen Hooker's specimen, gives *P. supina* as found along the Sone.

almost thorny bush, closely browsed by goats, to a tree. As the intensity of the cultivation diminishes towards the Nepal frontier and Sikkim Tarai, and the rainfall also increases, the semi-natural forest and induced scrub passes into Sal or evergreen forest.

110. The swamps form a conspicuous feature of the Northern tract, but I have had little opportunity of studying them. In Monghyr, north of the Ganges, is a large shallow lake, the Kabar Tal, and the largest of the Muzafferpur lakes is the Tal Baraila. The marsh flora comprises woody as well as herbaceous plants, and even trees, e.g. *Barringtonia*, but these are sometimes survival species, and are found in more abundance in the evergreen forests of neighbouring areas.

*Rosa involucrata* (Koya), said to occur in large quantities in some places along the water channels of the Northern tract, occurs in the Central and Southern tracts only along rivers in the forest. Conspicuous along the chauris and dhars (p. 5) is *Tamarix*, Hijal or Hyal (*Barringtonia*), *Lippia geminata*, the Reed (Narkat, *Phragmites*), Kasi (*Saccharum spontaneum*), of which Hamilton speaks of two varieties probably due to locality. In addition to these two varieties of Kasi, Hamilton also refers to the Kangra and Ikri as two separate species: the former is a name used for both *S. spontaneum* and *S. arundinaceum* (or *S. procerum*, if this is considered distinct), and Ikri is similarly applied to both these species, but rather to the prepared culms for walls than to the plant. I have only seen the *S. arundinaceum* in Purneah and eastwards. In swampy localities at a further distance from the actual water are large masses of the *Vetiviera*, of which the fragrant root is called "kaskas," the plant in flower is called "siki," the leaves "katra" (used for thatch), and the reedy part of the stem which is also used for making the walls of houses is called "birna." In the jheels are also *Typha* and the kesari (*Scirpus grossus*), a sedge 4-6 ft. high, of which the black tubers are eaten and the stems used for mats, and large species of *Cyperus*. Wet grass lands and margins of jheels also bear the beautiful tropical gentian (*Exacum tetragonum*, and more rarely *E. teres*). *Melastoma malabathricum* with large handsome rose-coloured flowers with yellow stamens is common. *Osbeckia rostrata* and *O. nepalensis* I have only seen in the north of Champaran.

111. The fresh-water aquatic formation is apparently remarkably uniform throughout the province, and also possesses many genera and even species which spread into temperate climates and are nearly cosmopolitan. This is no doubt due to the more uniform conditions of aquatic life as compared with sub-aërial. In Bihar and Orissa frost never lasts long enough to form a coating of ice on water if only a few inches deep. Aquatics show a preference according to species for (a) still water, (b) running water. Still-water plants are either floating or submerged, those of running water usually submerged and generally with much cut or riband-like leaves. Those with the leaves entirely or mainly emergent I have included under marsh plants. Of *Nymphaeaceæ* (water-lilies) *Euryale ferox* appears confined to the Northern tract, and has so far only been found in Purneah, but the species of *Nymphaea* are general as in *Nelumbium*, the sacred lotus. They have usually tuberous rootstocks and flower in the r.s. and h.s.



*Nelumbium* has leaves floating and also exserted 1—2 ft. above the water. Species of *Limnanthemum* (*Gentianaceæ*) resemble the water-lilies in habit and shape of the leaves; they are common. *Trapa* (*Onagraceæ*), *Hydrocharis asiatica*, *Ottelia* and the grass *Hygrophorhiza* have also floating leaves and are common. All the above prefer still water. Two species of *Potamogeton* occur with floating leaves; other species are entirely submerged, with very numerous small or filiform leaves, e.g. *P. pusillus* and *P. pectinatus*, which are distributed throughout the northern temperate regions, and the latter also in Australia. Other submerged aquatics of the *Naidaceæ* and *Hydrocharitaceæ* are common, and the interesting *Cryptocoryne*, a submerged aroid in running water with grass-like leaves, which is equally at home on the sand or gravel after the water has subsided. Another aroid, *Pistia*, is a free floater with the habit of *Salvinia cucullata*, the latter a common water-fern in the rainy season. *Salvinia natans* so far is only recorded from the districts with a warmer winter temperature (Purneah). Both these water ferns as well as *Pistia* prefer water fairly warm and still backwaters, but they are often swept down the rivers in flood. *Lemna* is common on still waters or half stagnant water, and *Wolffia*, the smallest known flowering plant, is common in adjacent Bengal and no doubt in our province but it has not been collected. *Characeæ* (highly developed *Algæ*) are frequent but they are not dealt with in the Flora. Ainslie (*Materia Medica*) speaks of *Vallisneria alternifolia* and *Chara* being used for refining sugar in South Bihar; Hooker says *Chara* and *Zanichellia*. But there appears to be no particular virtue in these plants. *Hydrilla*, *Vallisneria spiralis*, etc., appear to be all used indiscriminately in a layer at the top of the refining vessels, through the tapering lower end of which the molasses slowly trickle while the sugar crystallizes at the top. The layer of water plants appears to function in keeping the top of the crude sugar moist, and water may be added to the top of the layer of weeds from time to time.

112. The true aquatic flora passes into that of the marshes by imperceptible steps. Some species like *Sagittaria* have long strap-shaped or riband-shaped leaves in deep running water, slender lanceolate blades in shallower water and erect sagittate leaves exserted from the water in marshes. The *Onagraceæ* in our area are chiefly marsh and water herbs. *Jussiaea repens* has long stems floating on the water, supported by white vesicular roots, but also creeps on the margin, *Trapa* is entirely aquatic, other species of *Jussiaea* and *Ludwigia* are erect in marshes and ditches. In the nearly allied family *Lythraceæ* the genus *Ammanina* (including *Rotala* and *Nesaea*) is very common in the marshes, not only in the Northern tract, but throughout the provinces, not only in natural marshes, but also in the rice-fields.

113. The rice-field wet flora differs somewhat from that of natural marshes in the great abundance of small and delicate plants which elsewhere appear to be only occasional in wet places. It differs also in the large number of apparently very closely allied species in close contiguity. These are mostly members of the *Scrophulariaceæ*,

*Cyperaceæ* (smaller species), *Utricularia* and *Eriocaulon*. Some of the *Utricularia* are slender climbers round the rice-halms and are leafless at the time of flowering. The floating *U. stellaris* with large vesicles is, however, a plant of the natural marshes, and I have not observed it in rice-fields. The species of *Eriocaulon* are more abundant after the water has subsided in the cold season, and with them appear several small *Compositæ* such as *Cotula*, *Sphæromorphæa*, *Centipeda* and *Grangea*, which are allied genera, and *Sphæranthus*, *Gnaphalium* and *Cæsulia*.

114. In dealing with the general flora of the open Gangetic Plain, which forms the bulk of the Northern tract, we have postponed consideration of the more natural Khair-sissu forests, the hills of Northern Champaran and the remnants of natural forest in Northern Purneah.

115. *Khair-Sissu*.—On the banks of the great rivers, like the Kosi and Gandak, many square miles of country are frequently inundated, old lands torn away and fresh deposits of gravel and silt formed. On these spring up a forest, the Khair-Sissu formation. The Sissu (*Dalbergia sissu*) and the Khair are not usually indiscriminately mixed, but each forms gregarious patches, no doubt due to the heavier seeds of the Khair being deposited where there is too much current for the lighter fruits of the Sissu (the seed germinates through the pericarp) to come to rest. Other very common accessory trees in these forests are the Simal (*Bombax*), *Odina wodier*, *Kydia calycina*, *Albizia stipulata*, *A. procera*, sometimes *A. lucida*, the Hog plum (*Spondias mangifera*), Karam (*Adina*), *Stephegyne* (*Mitragyna*), *Mallotus philippinensis*, *Terminalia bellerica*, *Eugenia* spp., Bael, *Trewia nudiflora*, *Streblus asper*, occasional Tun (*Cedrela toona*) in depressions, *Bridelia*, climbing acacias, and figs (especially *F. glomerata*).

116. *The Sameshwar Hills* (see p. 4) have a flora which is essentially lower Himalayan. A list of the more characteristic, arranged according to their habitat, is given on pp. 54, 55. Here it is only necessary to refer to such striking species as *Pinus longifolia*, *Cycas pectinata*, *Sterculia pallens*, *Grewia helicterifolia*, *Eriolæna Wallichii*, *Rhus semialata*, *Moringa oleifera*, *Butea minor*, *Osbeckia nepalensis*, *Piper peepuloides* and *Desmodium confertum*.

117. Other species now known to extend to the cooler parts of the Central and Southern tracts are also characteristic of the lower Himalaya, such as *Gnetum scandens*, *Uvaria Hamiltonii*, *Meliosma simplicifolia*, *Trevesia palmata*, and *Cyclostemon assamicus*.

118. On the other hand species more characteristic of the Central tract are here found in very small quantities, such as *Scleichera trijuga*, *Buchanania latifolia*, *Gardenia turgida*, *Bassia latifolia*.

119. The plants common to both the sub-Himalayas and to the Central and Southern tracts would form a very long list. It is only necessary to mention a few:—*Dillenia pentagyna* (more sub-Himalayan but found in valleys in other tracts), *Millusa velutina* (ditto), *Shorea robusta*, *Kydia calycina*, *Thespesia lampas*, *Bombax malabaricum*, *Sterculia villosa*, *S. colorata*, *Helicteres isora*, *Grewia tilizifolia*, *G. vestita* and *G. elastica*, *G. disperma*, *G. hirsuta*, *Aegle marmelos* (dry exposures), *Bursera serrata*, *Amoora rohituka* etc., etc. (a fuller list is given on p. 51).

120. The N.E. corner of Purneah used in Hamilton's time to be forest which formed part of "a large wooded tract that extends into the district of Tirahut." This corner, although not in the hills, is tropical Himalayan in character, and partakes of the nature of the Sikkim Tarai, though most of its natural jungle has now disappeared. The following trees are very distinctive:—*Alangium* (*Marlea*) *begoniæ-folia*, *Grewia multiflora*, *Premna latifolia* var. *Gamblei* (Gineri), *Tephrosia candida*, *Vangueria spinosa*, *Natsiatum herpeticum*, *Aporosa*, *Phlogacanthus*, *Vitis adnata*, *Calamus guruba*, *Deeringia celosioides*, and many ferns growing in the open, e.g. *Anisogonium esculentum*, *Nephrodium molle*, *N. aridum*, etc., which in other districts are found under shade.

121. The grass lands of the Northern tract occupy a considerable area. The low-level grass lands pass into the swamps, and their grasses are usually large or gigantic perennials with annual flowering stems and rootstocks which frequently form tussocks. The lowland savannahs are natural grass lands which are water-logged for a part of the year, but they pass into evergreen forest where the water is flowing. The high level savannahs often are the result of old cultivation, maintained in the state of grass by firing and grazing. The principal grasses on the lowlands are, according to a note by me in 1896, in the adjacent tarai *Saccharum procerum* (called *S. arundinaceum* in the Flora), *S. spontaneum*, *Ophiurus megaphyllus*, *Arundinella brasiliensis*, *Phragmites karka*, *Triraphis madagascariensis*.\* To these may be added the fragrant-rooted *Vetiveria*, which is sometimes very abundant, *Anthistira gigantea*, *Coix* and others, and the low land savannahs are further characterized by large *Scitamineæ*, species of *Alpinia*, *Hedychium*, *Costus*, etc., while in the adjacent Tarai the large orchid *Arundina* is conspicuous.

122. The grasses of the high-level savannahs are less large, but also usually perennial-rooted. The chief are *Saccharum narenga*, *S. fastigiatum*, *Cymbopogon nardus*, *Polytoca barbata*, and most of the grasses of the savannahs of the Central tract, but no list has been made on the ground.

*Saccharum munja* (*tanggha*) appears to be a grass of high-level savannahs in the northern more humid belt, though like many other plants it retreats to the neighbourhood of rivers in the Central tract. The woody stems are like those of some other large grasses used for the walls of huts. The sheaths are made into coarse ropes called *muj*. *S. munja*, *S. narenga*, *S. spontaneum* and large species of *Themeda* are sometimes all found in close association!

123. After burning the savannah tracts become pretty with numerous herbaceous perennials which spring up from their bulbous or rhizomatous stocks. Among these are *Careya herbacea* with red shoots and large white and pink flowers, *Olax nana*, *Grewia sapida*, *G. scabrophylla*, *Ochna pumila* with beautiful large yellow flowers, *Aneilema scapiflorum* with blue flowers, and species of *Pancratium* with pure

\* Mr. Hole, in a letter, informs me that he thinks there are two species included under this name in the *F.B.I.* the one named being a N.W. India form and ours being *T. Reynandiana*. I have not gone into the question.

white flowers. About this time also the *Imperata* flowers, with its white plumes, though most of the grasses flower in the cold season after completing their season's growth.

124. When the grass lands of the Northern tract are only subject to early annual fires and light grazing, the first trees to appear are *Eugenia obovata*, *Simal*, *Garuga pinnata* and the shrub *Glochidion multiloculare*. These are followed by *Stereospermum suaveolens*, *Embllica officinalis* and *Lagerstræmia parviflora*. Most of these trees appear to be comparatively frost-hardy as well as to a certain extent fire-resisting.

125. The effect of heavy grazing is gradually to eliminate the strong perennial grasses and finally to replace them by dwarf species, especially those, like *Panicum (Paspalidium) fluvidum*, *Urochloa reptans* and *Chrysopogon aciculatus*, with leaves appressed to the ground.

#### FLORA OF THE CENTRAL TRACT.

126. In contrast to the Northern tract, the Central tract still contains a considerable area of forest, or jungle-clad land, and (with the exception of the Sameshwar Hills and N. Purneah of the former), its flora is far more interesting. This is chiefly due to the rocky surface having presented difficulties to cultivation. Its beautiful hills have served as a refuge for less civilized non-Aryan tribes, which have found much of their sustenance in its jungle products.

127. The flora is essentially tropophilous, but with a tendency towards xerophilous structure in many of its species. The Sal itself, the most characteristic tree of the area, is somewhat xerophytic in structure. Its leaves are very nearly persistent, and they thus have to stand the hot dry winds of February and March, while the new ones appear in May, when the relative humidity of the air is very low. They are therefore markedly coriaceous,\* and possess a polished surface which reflects the sun's rays. On the drier aspects and dry tops of hills the trees become low and gnarled with relatively massive stems and smaller leaves (the so-called hill-type Sal), but provided the drainage is sufficient, the Sal is found on fairly heavy, as well as light soils. It is not deciduous sufficiently long nor sufficiently xerophilous to grow on the driest aspects.

On hot dry aspects it is supplanted by other trees of the dry mixed type, such as *Anogeissus latifolia*, the hill form of *Odina wodier*, *Nyctanthes*, *Cleistanthus collinus* (of which a form also occurs in the valleys), *Boswellia serrata*, *Sterculia urens* and *Cochlospermum Gossypium*.

128. A thin papery outer bark which appears quite white and easily allows the passage of light is, as I pointed out in my *Fl. Ch. Nag.*, very characteristic of many trees growing in dry exposed places. They

\* The upper surface has a thick cuticle and large epidermal cells deeper than broad. Beneath this are 2—3 rows of palisade cells, but this thin-walled tissue is interrupted at frequent intervals by large thick-walled tissue opposite to the vascular bundles which have numerous bast fibres. A similar thick-walled tissue interrupts the spongy parenchyma, so that the leaves are rendered very firm.

are almost true xerophytes and possess a layer of chlorophyll under the outer bark, and can remain therefore without their leaves for extraordinarily long periods. Thus *Sterculia urens* is leafless from November to May or sometimes June, *Odina wodier* from Nov.—May, and *Cochlospermum Gossypium* for the same period; the last, however, soon protects the lower part of the trunk with a very thick corky bark. The cuticle covering the chlorophyll layer of some of the white-barked trees is shed at short intervals. In some cases it is so thin that the bark appears green instead of white, as in species of *Commiphora* or *Balsamodendron*, a dry climate or desert genus, and to a less extent, the new bark after peeling, of *Sterculia urens* and others is green.

129. *Gardenia latifolia* is what is called a "chasmophyte." Its minute seeds germinate in the crevices of bare rocks. The crevices become filled with the growing rootstock, which also forms a broad cushion over the top. The tree has a *white stem with chlorophyll* and large coriaceous deciduous leaves covered with a resinous varnish when young. *Gardenia gummifera*, which grows on clay and quartz stones (p. 14) often on the tops of ridges in open forest, has polished smaller coriaceous leaves, also varnished while young. Its buds are protected by a large drop of resin. It and *Gardenia turgida*, one form of which is covered with strong opposite and decussate spines, have also a white bark. The young plants of all forms of *G. turgida* are exceedingly spinous.

130. *Ficus infectoria*, *F. glabella* and *F. tomentosa* are all species of rocky places (though *F. infectoria* is also an epiphyte, like many other figs), and more or less xerophytic in structure. The leaves of *F. tomentosa* are covered with a dense felt of hairs. It may sometimes be seen on old buildings (e.g. the Palamau Fort).

131. Among true xerophytes the candelabra-like *Euphorbia nivulia* often attains 20 ft. on bare rocky ground, though the seedlings often germinate under shade and somewhat resemble *E. fusiformis* of the Sameshwar Hills, which is mostly found under shade. Like the trees mentioned above the branches and young stems have chlorophyll, but in this case there is no, or very little, thin white bark but a green epidermis. The old stems develop thick cork. The asclepiad *Sarcostemma* is another xerophyte and chasmophyte, with green stems and branches. It also has a milky juice, and the presence of a milky latex (as in the more or less xerophytic figs, fleshy *Euphorbias* and the Euphorbiacean genera *Excæcaria* and *Sapium*, many more or less fleshy *Apocynaceæ* and *Asclepiadaceæ*) suggests that in some families it may originally have been favoured by xerophytic conditions, although still present in allies which are no longer xerophytic. The *Euphorbias* and *Sarcostemmas* develop leaves in the rainy season, though these are sometimes much reduced and soon deciduous.

132. The Sal formations occupy the greater part of the forest area. Sal ascends to the tops of the highest hills where the soil is sufficient, but occupies an intermediate position between the driest and wettest areas in respect of soil. But the type of Sal varies, and its associates change with the type. It is at its best in valleys with a deep loamy

soil derived from rocks of the Dharwars. This is the Valley type of forests.

133. It has been frequently stated that Sal is not found on trap or on laterite, and it is true that it is not found on the trap of western India, and it is absent from serpentine,\* but it is found on trap in the Santal Parganas and grows well on laterite in Singhbhum, and it once extended to the edge of the laterite into Midnapur, where the remnants of Sal coppice may still be seen. Although trap may be an unfavourable sub-soil for Sal, other reasons must also be looked for to account for its absence from Western India, as it is also absent on sandstones and other rocks in the western parts of the Central Provinces.

134. As in the Central Provinces it appears to avoid certain close-bedded quartzites,† though it will grow among quartzite boulders, and it is decidedly calciphobous. It also avoids the cotton soil.

135. As showing how dependent its occurrence is on the physical properties of the sub-soil and its permeability by the roots, it will grow well on one side of a ridge composed of hard ferruginous schists inclined at an angle, more or less parallel to one slope, but not or only badly on the other, and this is independent of the aspect. The slope on which it grows well has the edges of the schists exposed, the other slope is more or less parallel to the lamination, thus presenting a surface with few breaks. On such unfavourable slopes is poor dry mixed forest, with frequently an abundance of *Nyctanthes*.

136. In the valley type Sal will attain very large dimensions in the Central and Southern tracts. When I first knew Singhbhum in 1903, sound trees of 100 ft. in height and over 12 ft. girth were frequent in the then inaccessible parts of the forest.

137. The Sal associates in the valley type are different both from those of the Northern tracts and from the Hill type. Here *Careya arborea* and *Dillenia pentagyna* are not common, and they cease a little way up the slopes. On the other hand, *Terminalia tomentosa* and *T. delerica*, *Sclerchera trijuga* and *Pterocarpus marsupium* are frequent associates.

138. The associates in the hill type are *Gardenia* spp., especially on clay, *Dillenia aurea*, *Phœnix* (on very poor soils or in open forest), *Terminalia chebula* (most frequent on flat hill-tops), *Anogeissus latifolia* (for fuller lists see p. 62).

#### THE MIXED FORESTS OF THE CENTRAL TRACT.

139. Foresters usually distinguish between Sal forest and Mixed forest, but mixed forest means in this sense forest without, or at least with very little, Sal. The term is retained here in the same sense, but excluding the belts of evergreen forest which occur along many river valleys, and especially along ravines in the higher hills. We can distinguish in the mixed forests several subsidiary types:

\* It is absent at least from the only serpentine hill I know of, the Kita Buru in the Saitba forest, which is occupied chiefly by *Phœnix acaulis* and grass.

† See the Introduction to *List of Trees, etc., of the Southern Circle, Central Provinces* 1916.

140. *The Terminalia formation*.—Some valleys containing good soil, but apparently with too much sub-soil water for Sal, contain *Terminalia tomentosa* as the principal species. Here also occur *Terminalia belerica*, large *Bombax*, *Sterculia villosa*. The raising of the water level by railway embankments will sometimes kill out the Sal and convert a previous Sal forest into *Terminalia*.

141. *Mixed forest: Dry type*.—Very dry aspects do not as a rule grow Sal, but show a more xerophytic type, though not always of the same constitution. The components of these dry mixed forests agree in that many of the species have a white outer bark permitting of the passage of light (*vide* para. 128). Such trees are *Sterculia urens*, *Anogeissus latifolia*. Other species develop below a thick corky bark, such as *Erythrina suberosa*, *Cochlospermum Gossypium*.

The driest parts of the Central tract (see Chap. III) are parts of Shahabad, Palamau and Gaya.\* Gaya is said to be the hottest district in the province, and this is perhaps related to the destruction of the forest on the hill ranges. Parts of these forests still contain small Sal trees, but for the most part a dry mixed type or scrub, *Capparis sepiaria*, *Balanites*, *Zizyphus*, etc.

142. The sandstones of Shahabad once grew the *Hardwickia* formation, now mostly scrub. This was apparently a purely edaphic formation, although *Hardwickia* grows on other soils also in the Central Provinces.

143. *Khair type*.—Soil is apparently partly accountable for the distribution of the Khair (*Acacia Catechu*). It is a more crooked tree than the sub-Himalayan Khair and is apparently var. *Catechu* proper. Its presence is not always due solely to the soil. In parts of Palamau there is little doubt that human agency (including in this category fires, grazing, etc.) has favoured the Khair, and where the forests are protected the Khair disappears. It will not reproduce itself under shade either by seed or coppice. With the Khair, which must therefore have originated on open land, is associated *Woodfordia* (a shrub of open land), *Gardenia turgida*, *Carissa paucinervis*, *Stereospermum suaveolens*, *Boswellia serrata*, *Lagerstroemia parviflora*, *Embluca officinalis*. These are all frost-hardy species. There also occur Satin wood (*Chloroxylon*), *Adina cordifolia*, *Mitragyna*, *Bridelia retusa* and *Anogeissus latifolia*, *Garuga pinnata*, *Ehretia laevis*, *Odina wodier*, and *Grewia tiliaefolia*. *Pennisetum setosum* often occurs as an undergrowth.

144. *Evergreen forest*.—Along rivers and streams in deep valleys the outer curves usually have high banks with Sal or *Terminalia*, the inner side of the curve has low flat ground frequently growing forest of a more or less evergreen type. In the hills both sides of the more steeply graded streams are usually similar and evergreen. But neither the Central nor Southern tracts possess the more beautiful type of evergreen forest which occurs in the adjacent more humid Tarai and Duars, where the branches of the *Eugenia formosa*, *Dillenia indica*, species of *Elæocarpus* and numerous other hygrophytic trees are hung with epiphytes.

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\* Only extreme southern part of Gaya and southern Shahabad are in the Central tract.



145. At the lower elevations the evergreen belts are mainly composed of trees with their trunks clothed low down with branches, e.g., *Diospyros embryopteris*, which is very beautiful with its new flush of crimson leaves against the deep green of the older leaves, *Garcinia Cowa* with large edible yellow fruits, *Eugenia jambolana*, *Saraca indica* (also with tassels of crimson new leaves), and *Amoora rohituka*. Trees with tall clean stems also occur as a second storey, such as *Michelia champaca*, Mango, *Albizzia procera* and *odoratissima* (which are both deciduous), and *Litsaea nitida*. At higher elevations we find *Ficus Roxburghii*, *Symplocos spicata* and others (for more complete lists, see pp. 56 and 60).

146. The grass lands of the Central tract, apart from those of the *páts*, are not very extensive, and are usually quite fitted to grow forest, which is suppressed by cutting and burning. The predominant species and one of the worst pests when its barbed fruits are ripe is the Spear grass (*Heteropogon contortus*). The fruits ripen in the cold season but remain long attached to the spike by their twisted awns, the barbs becoming free and pointing in all directions. By May the ground is so closely covered with them that a sudden shower produces the effect of its being covered with writhing insects, due to the contortions of the hygroscopic awns, which gradually work the fruits into the soil. In rocky places the *Pennisetum pedicellatum*, with its handsome reddish spikes, is frequent in Palamau; and on very rocky hills, but chiefly in some shade, the *Chrysopogon lancearius* is characteristic. A valuable fodder grass, but not nearly so frequent as in the Central Provinces and occurring chiefly on cotton soil in the Southern tract is *Iseilema laxum*. It sometimes occurs mixed with Spear grass and species of *Themeda*.

*Imperata* is characteristic of clayey and lateritic soils in some places only. *Saccharum spontaneum* as usual occurs on open, often more or less water-bearing or water-logged lands. Other species of *Saccharum* are rare, but *S. munja* occurs along gravelly or sandy river beds, and *S. narenga* in the damper Sal forests, chiefly at high elevations. The grasses which occur in the forest under light shade are nearly all those which are found in the open, but the most important grass of the hills in the Central tract, and one naturally always found under partial shade (though it is cultivated in the open in the Rajmahal Hills, etc.), is the Sabai (*Panicum angustifolium*, better known as *Ischænum angustifolium*), so largely used for paper-making. It requires good drainage, but is often found on kunker or lime-impregnated soils. Species of *Pollinia* are very common in open Sal forests with clay soil. For other common grasses in the forest and a list of grasses on the *páts* see pp. 56, 57, 58, etc. Most of these latter are found, though less gregariously, in all parts of the Central and Southern tracts.

147. The *páts* (p. 9) and higher mountains of the Central tract possess many elements of a more temperate flora which occur elsewhere, either in the lower Himalaya or in the mountains of Madras, or both, and a few which are closely allied to plants in one or both of those regions, but appear endemic.



148. To this last category belong *Hypericum Gaitii* allied to *H. cernuum* (Himalayan) and to *H. mysorensis* (Madras), and *Thesium unicaule* allied to *T. himalense* (Himalayan) and to *T. Wightianum* (Madras). *Jasminum strictum* is apparently related to *J. Wightii* of Madras. *Pimpinella bracteata* is allied to *P. diversifolia* (Himalayan), and apparently to *P. Candolleana* (Madras). *Ligusticum alboalatum* appears to have no Madras representative, and *Carum villosum* also appears to be endemic or undescribed, but its fruit is at present unknown.

149. The high mountains and páts of Chota Nagpur would appear to have served as stepping-stones for the passage of species from the highlands of the peninsula to the newer Himalaya, or in some cases in a reverse direction, and at one time their elevation and that of many intermediate now low ranges was no doubt very much greater\* ; the high mountains of Meghasani and others in the Southern tract would similarly have served as stepping-stones.

150. A fuller list of the species of the páts is given on p. 58, from which the following are selected :

*Pittosporum floribundum*, distrib. Himalaya and Nilghiri. *Hypericum japonicum*, distrib. Garwhal, Himalaya to Burma, and hills of peninsula. *Geranium ocellatum*, distrib. Himalaya up to 6,000 ft. *Viola Patrini*, distrib. Himalaya and hills of peninsula (also in Cent. Prov.). *Rhamnus dahuricus*, distrib. Himalaya and western ghats. *Rubus molluccanus*, Himalaya and western ghats. *R. ellipticus* does not now occur in the Central tract, but it does on the higher mountains of the Southern tract. *Potentilla Kleiniana*, distrib. Himalaya and Nilghiri Mts. *P. Leschenaultiana*, distrib. Western Himalaya and Nilghiri Mts. *Rubia cordifolia*, distrib. Himalaya and most hilly districts of the peninsula up to 7,000 ft. *Artemisia parviflora*, distrib. Himalaya, ascending to 11,000 ft. in Sikkim, also western ghats and hills of Burmah. *Conyza ambigua*, distrib. Himalaya and Nilghiri and Pulney Hills over 6,000 ft. (Gamble). This is said to be an escape, but I doubt it. *Lobelia zeylanica*: ours is apparently a distinct variety, but the species is distributed in the Western Ghats and there is one record from Mysore. It is said to be common in Ceylon. *Geniosporum elongatum*, distrib. Jeypur Hills and Ceylon (this should be called *G. indicum*, Briq. according to Gamble). *Plectranthus ternifolius*, distrib. Himalaya to Assam. *Plectranthus menthoides*, distrib. Mahendragiri, Western Ghats, and if this be merely treated as a variety of *P. coetsa*, then also Himalayas. *Scutellaria discolor*, distrib. Himalaya to Assam and Burmah, also Bababudan Hills of Mysore (Gamble).

It will be observed that the Himalayan element is stronger and the Chittagong-Burmah element a good deal weaker than in the mountains of the Southern tract. This may be partly due to climate, the cooler drier cold season and the hotter drier hot season as compared with the climate of the mountains of Orissa with their tempering sea-breezes.

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\* Duncan and others also refer to evidences of an exceedingly cold if not glacial condition during part of the Gondwana period, but this would have been prior to the Angiospermous flora.

151. The flora of Parasnath has been more carefully investigated than that of any other portion of our province. It was dealt with by Hooker in the *Himalayan Journals* and Dr. Thomson spent several days on the mountain. He also paid a second visit there in company with Dr. Anderson, and it has been further botanized by Edgeworth, Clarke and others.

Anderson, while officiating as Superintendent of the Calcutta Gardens, collected the investigations of himself, Hooker, Edgeworth and Thomson into a paper, published in the *Journal of the Asiatic Society of Bengal*. The only species found on Parasnath but which have not been recorded also from other parts of the province now are: *Berberis asiatica*, *Pygeum Andersoni* and *Kalanchoe heterophylla*. Of these the *Pygeum* is an exceedingly rare plant. I believe that the only other locality where it has been found is Mahendragiri Mountain in Ganjam, elev. 4500 ft. The *Berberis* is Himalayan, but the Parasnath plant differs somewhat from the type. The *Kalanchoe* is frequent on mountains in the Dekkan. It is to be noted that, in addition to the above, Sir J. D. Hooker regarded the Parasnath palm *Phoenix robusta* as a distinct species, and Anderson in his paper mentions 2 species of *Araliaceæ* (undetermined), which I have not traced.

#### FLORA OF THE SOUTHERN TRACT.

152. It has been said that the topography of the Southern tract is much more varied than that of the Central or Northern tracts; the flora also shows much more variety. The climate, however, is more equable, frost never occurs, and the temperatures are higher with greater relative humidity, especially in the districts bordering on the coast. The area is also more tree-covered (i.e., has been interfered with less by man). The Saranda forests of Singbhum with their high mountains and deep valleys with perennial streams are floristically a part of the Southern tract. The higher parts of Parasnath, although more humid than the rest of the Central tract, do not bear any great resemblance to the Southern tract in their flora (see para. 151).

153. The Sal formations in the Southern tract, where they occur, do not differ much from those already dealt with, but they tend to become more mixed with the species belonging to other types of forest. The Sal sometimes occupies the flatter ridges, while the steeper drier slopes are occupied by a mixed forest, and a more humid type of mixed forests or thorny bamboo occupies the valleys. In Kalahandi natural Teak occurs in the valleys mixed with the Sal. In other cases and more especially in Sambalpur in a less humid climate the base of the hills is occupied by Sal, the slopes by poorer Sal and mixed forest, and the tops especially on quartz and mica schists are monopolized by the male bamboo (*Dendrocalamus strictus*). This last is apt to take possession entirely where coppice fellings are carried out without the bamboo itself being cut.

154. The better Sal forest which grows on loam in Angul above the level of competition with the thorny bamboo has as its chief associates *Terminalia tomentosa*, *Pterocarpus marsupium*, Mango, *Ougenia*

*dalbergioides*, *Anthocephalus cadamba*, *Bursera serrata*, *Miliusa velutina*, and also often large *Anogeissus latifolia*—a somewhat heterogeneous assemblage of trees of damper and drier conditions! On the quartz and mica schists which give a light-coloured soil, on which Sal is never seen well-grown, is *Gardenia gummifera* (especially characteristic of clays and quartz), *Chrysopogon monticola*, *Heteropogon contortus* and *Aristida*. In some parts of Sambhaipur the Sal is much attacked by *Loranthus longiflorus*.

155. *The bamboo formations.*—In many of the valleys and eastern plains the Sal and *Terminalia* is ousted by the growth of bamboo. Especially gregarious is the thorny bamboo (*Bambusa arundinacea*), but in a few cases *Cephalostachyum pergracile* or *Oxytenanthera nigrociliata* is found. Few formations are more impenetrable than the thorny bamboo forests, or grow fewer subsidiary species. The few trees that occupy them are remnants of those that obtained a footing during one of the recurrent flowering periods, and of undergrowth there is none. It was however in streams flowing through thorny bamboo that I first came across the *Lawia zeylanica*.

156. *Dendrocalamus strictus* often occupies the hills (see above under Sal), as in some areas of the Central tract. It is rarely very well grown, but is apt to take possession of the ground where the rock is near the surface. It does not flower gregariously like the *Bambusa*, but some different clumps flower every year.

#### MIXED FORESTS OF THE SOUTHERN TRACT.

157. *Humid mixed forests.*—The highest hills ascend to 4000 ft. and these possess a semi-evergreen type of forest (though Sal is common on the drier ridges) between 3000 and 4000 ft. The more interesting of the species are those which bring a strong Chittagong and Eastern Himalayan element into the flora. Among the former are *Machilus villosa*, *Vitex glabrata* (also Santal Parg.), *Alphonsea ventricosa*, *Turpinia pomifera*, *Eugenia fruticosa*, *Sapium insigne*. Among Himalayan species are *Euonymus glaber*, *Leea acuminata*, *Rubus ellipticus*, *Villebrunea frutescens*, *Pilea scripta*, *Baccaurea sapida*, while *Aralia armata*, *Hyptianthera stricta*, *Elæocarpus Wallichii*, *Clematis smilacifolia*, *Styrax serrulatum* extend to Burmah and *Phoebe lanceolata*, *Turpinia pomifera* are both of Chittagong and the Himalayas. The Chittagong element is especially interesting, in as much as it is found also at lower elevations and in the coastal districts (see pp. 48, 49).

Especially noteworthy is *Evodia meliæfolia*, from the mountain ravines of Bonai. This plant has only been previously found by me in the mountains of British Bhutan, and is only recorded in the *Flora of British India* from Assam.

158. *The drier mixed forests of the Southern tract* are usually those on steep slopes below the ridges. Sal is usually absent, though many of its associates remain. *Bursera serrata* (which attains 6 ft. girth in the Raigarh forest), *Dalbergia latifolia* (only reaching large girth in the valleys), *Cleistanthus patulus* (especially in rocky ravines), *Callicarpa arborea*, *Grewia tiliæfolia* and *G. elastica*, *Hymenodictyon*, *Sterculia*

*villosa* and *S. colorata*, *Anogeissus latifolia*, *Walsura piscidia*, *Ougenia dalbergioides*, *Bridelia retusa*, *Petalidium* are frequent. On rocks are *Hemionitis arifolia* and *Drynaria quercifolia*.

At lower elevations is much *Diospyros sylvatica*, *Melia composita*, *Gelonium*, *Capparis Roxburghii*, and *C. sepiaria*, but it is difficult to draw a line between this type and the evergreen forest on the one hand and the laterite or sandstone low mixed forest on the other.

159. *The Khurda laterite and Athgarh sandstone.*—A considerable area between the coast and the mountains is occupied by a low laterite plateau. It often overlies the Athgarh sandstones, and in some places laterite occurs on the sandstone, so that it is difficult without much study to separate the sandstone flora from the laterite. The list on p. 56 therefore merely records the species occurring in the mixed forests and scrub jungles of the lower elevations, whether on laterite or sandstone.

Among the most noteworthy trees are *Xylia* (dist. both peninsulas), *Zanthoxylum budrunga* (also Chittagong), *Vitex pubescens* (also Chittagong), *Erioglossum edule* (dist. Oudh to Chittagong and Burma), *Lepisanthes tetraphyllus* (dist. both sides of the western peninsula and also to Burma), *Diospyros sylvatica* and *D. cordifolia*, *Soymida febrifuga*, *Chloroxylon swietenia*, *Eugenia bracteata* (dist. both sides of peninsula and Assam and probably Chittagong), and *Hugonia mystax*.

160. More especially on the laterite appears to be the very important tree *Strychnos nux-vomica*. *Strychnos potatorum* also occurs, but in a more evergreen type of forest, and on alluvium. It is also a more westerly species. More characteristic of laterite is *Webera corymbosa* and *Flacourtia sepiaria*. Especially characteristic of the sandstone is *Randia malabarica*, *Maba buxifolia*.

161. Much of this tract is still in the state of "Induced Scrub" in the eastern districts. This occurs on heavily grazed lands, both on laterite and the sandstone. But the previously scrubby reserves are slowly forming a more arboreous type and, comparing them with Gamble's description of them forty years ago, the change may even be said to have been rapid. Excepting in the Mals of Orissa,† most of the forests are managed as coppice, and the undergrowth is so dense that the more arboreous species are handicapped in the struggle against the more shrubby and closely branched ones. The thorny species are chiefly *Flacourtia Ramontchi*, *sepiaria* and *cataphracta*, all of which also occur in Purneah; *Phyllochlamys spinosa* and *Plecosperrum spinosum*, the former of which spreads to Burma and the Andamans and the latter is sub-Himalayan and Cingalese, while *Limonia acidissima*, also common, is a small tree of drier regions and is frequent in the Central tract. *Atalantia*, species of *Carissa*, *Randia*, 2 spp., and other thorny or prickly trees or shrubs also occur. In these forests climbers are also excessively numerous, thus further handicapping the trees.

\* See Gamble, *Report on the Forests of Khoordah, Orissa*, April 27th, 1881.

† The Mals of Orissa is a hilly very feverish tract in the south bordering on the Madras Presidency. It contains much high forest.

162. *Evergreen forest type*.—The evergreen type is far more extensive in the Southern tract than in the Central, as would be anticipated from the greater humidity, especially near the coast. The evergreen of the mountain tops has already been referred to; that of the low-lying regions contains a large number of species (see pp. 55, 56), of which the most interesting, perhaps, are *Garcinia Xanthochymus*, a tree of the eastern Himalaya, Chittagong, Burmah and the Bombay ghats, all regions of heavy rainfall; *Garcinia cowa* (also Chittagong); *Aporosa Roxburghii*, also in eastern sub-Himalaya, Chittagong and Burmah; *Macaranga peltata*, a rapidly growing tree overtopping the Teak in plantations (dist. Western Ghats); *Polyalthia simiarum*, distributed Chittagong, Burmah, Duars, a tall straight tree with pale bark and large leaves; *Canthium glabrum* also occurs in the high-level evergreen forest, distrib. Burmah, Duars and Malay Peninsula; *Diplospora singularis*, distrib. Khasia, Burmah and Ind. Archipel.; *Alphonsea lutea*, distrib. Silhet and Burma; *Unona discolor*, distrib. Duars, Silhet, Chittagong and Burma; *Amoora spectabilis*, distrib. Duars to Burma.

#### COASTAL TRACTS.

163. The low laterite or rocky promontories rarely quite reach the shore line, and between them and the shore are frequently cultivated alluvial plains which run inland a long way at the principal rivers. These alluvial plains are chiefly rice-fields, of which the general character is much the same as in the other tracts. In some places they give way to sandy waste dotted over with the palms *Phœnix sylvestris* and *Borassus flabelliformis* or, nearer the sea, *Cocos nucifera*, and along the coast a semi-naturalized growth of *Casuarina*, *Calophyllum*, Cashew nut, *Pandanus tectorius* and *Opuntia*. On the littoral sands these species also grow, and there is in addition a natural herbaceous open formation which becomes denser in the rainy season. Some of the plants of this formation are sand-binders. Among these may be mentioned the *Ipomœa pes-capræ*, the interesting suffruticose dioecious grass *Spinifex squarrosus*, of which the large globose female heads, driven by the wind, bound along on its elastic spinous bracts, and *Cyperus arenarius*. But there are no sand-binders of the efficiency of (for instance) the Marram grass of temperate dunes. The *Opuntia* forms one of the best sand barriers and wind breaks, and it continually rises on a bank formed by itself as the wind-blown sand drives through it and is deposited on the lee side. The sand flora requires further study. (See also p. 59.)

164. *The Mangrove formation*.—The tidal forests extend along the coast from the Baitarani River at Chandballi to the Tallanga Canal south of the Mahanadi, but saline marshes with some of the characteristic trees of the deltaic swamps, e.g., *Excoecaria agallocha*, *Acanthus ilicifolius*, are also found in Balasore at the mouth of the Burubulung and at other places. The mouth of the Subarnareka I have not seen. The higher lands between the numerous creeks and channels are usually sandy open grassy areas as already mentioned, without forest, but grazing large herds of cattle and deer. They are fringed with trees

and shrubs common in the more inland forests, such as *Randia malabarica*, *Carissa spinarum*, *Azima*, *Maba*, *Erioglossum edule*, *Litsæa sebifera*, *Crotalaria striata*, *Zizyphus ænoplia*, *Streblus*, *Eugenia bracteata*, *Cæsalpinia crista*. More characteristic are *Cæsalpinia nuga*, *Pongamia glabra*, *Hibiscus tiliaceus* and the introduced trees *Anacardium* (Bajan, Or.) and *Calophyllum*.

165. In the swamp itself is an evergreen forest which relatively to a more terrestrial flora is exposed to the same conditions all the year round, the principal difference being perhaps the less salinity of the water in the monsoon. On the mud in the shallower water the "hital" *Phoenix paludosa* is often gregarious over considerable areas and a large handsome fern (*Acrostichum aureum*). Furthest out in the deepest water is *Rhizophora mucronata* with much branched stilt-roots and in less deep water *R. candelaria*. Other common species are *Ceriops Roxburghiana*, *Kandelia Rheedii*, *Bruguiera conjugata* with its variety *eripetala* and *B. caryophylloides*, *Sonneratia apetala*, *Lumnitzera*, the Sundri (*Heritiera minor*) and many other species (see p. 59), of which 18 species not before recorded from Bihar and Orissa occur in the Sunderbans and Chittagong\* and one, *Bruguiera caryophylloides*, has not been reported from these districts.

166. Most of the species are distinctly xerophilous in structure and possess thick or coriaceous leaves, sometimes with a shining at other times with a glaucous perhaps waxy cuticle, the thick leaves with aqueous tissue within. Several species, of diverse families, have pneumatophores furnished with numerous stomata or lenticels which admit oxygen to the roots. These are sometimes called blind root-suckers but they never appear to develop as suckers; they appear to be modified root structures, and all transitions occur from ordinary roots with ridge-like continuous projections furnished with numerous lenticels (*Carapa*), through rounded projections or knees in *Bruguiera* to erect peg-like projections 6—18" high above the surface, which are often a serious impediment to walking as in *Sonneratia apetala*, where the pneumatophores are conical with exfoliating bark (exfoliating bark also occurs in *Bruguiera caryophylloides* according to Schimper), and the more slender pneumatophores of *Avicennia officinalis* and *Ceriops Roxburghiana*. The function of pneumatophores (f. Schimper) is also carried on by the upper parts of the stilt roots in *Rhizophora*.

167. The germination of the seeds while still on the tree, or the phenomenon of vivipary, is well known in *Rhizophora*, where the hypocotyle often attains a foot in length before dropping, radicle downwards, into the mud. A similar vivipary is seen in several other species of the tidal swamps. In *Kandelia* the hypocotyle also attains a foot, in *Ceriops* and *Bruguiera* 4—6" in length. In the latter genus there may be 3—4 cotyledons. In *Avicennia* the comparatively short hypocotyle has upturned hairs which act as a barb, and a short hypocotyle is developed before the fruit falls in *Ægiceras*. This last also occurs on the muddy shores of the Chilka Lake.

\* I was only able to give three days to this tour, most of which was on board a steamer, and a more extended inspection would add a very large number of species to the list.

168. Along the sea front of the Orissa coast and washed up by the sea may be picked up various fruits and seeds. These may either be local or due to the North-East Monsoon drift, a current which sweeps up from the Malay Archipelago, curves round the Bay of Bengal and down the eastern coast of the Indian peninsula and which would thus convey drift from the Malay peninsula, Burmah, Chittagong and the Sunderbans and in favourable conditions of the wind deposit these on the Orissa coast. Among these fruits and seeds I have found *Nipa fruticans*, which may occur in the Mahanadi delta though I did not observe it growing there; *Heritiera minor*, which is known to grow in all the coastal regions but may have come from Orissa itself; the round smooth fruits (deprived of the exocarp) of *Calophyllum*, portions of the pseudocarp of *Pandanus*; hard grey, smooth seeds of *Cæsalpinia crista*,\* etc. Among them is also a pyramidal fruit (?) somewhat resembling that of a *Pandanus* in shape which has not been identified.

#### CONCLUDING REMARKS ON THE PLANT COMMUNITIES.

169. The types of forest usually recognized have been mentioned in the preceding pages, and it has been pointed out that extensive formations, like that of the Sal, really embrace a large number of minor plant associations. Such constitutionally robust species occur in different forms under comparatively diverse conditions, and in the majority of cases the presence of one species has no direct bearing on the other components of the association. As for example, *Strychnos* occurs with Sal not because Sal has any direct influence on the *Strychnos* but because the other factors of the locality suit it, or because it is not crowded out by other species more suited to the locality. Hence Sal may occur in many associations where *Strychnos* is not found, and *vice versa* *Strychnos* may occur in associations (such as on the southern laterite) where Sal is not always found.

170. In the Ramnagar (or Sameshwar) Hills *Bauhinia purpurea* is found on ridges with Sal, in the Central tract only along valleys or on cool sides of hills rarely with Sal. *Clausena pentaphylla* is found under Sal in Champaran; in Singbhum its place is taken by *Clausena excavata*, a species which occurs on ridges in the humid climate of British Bhutan. Whereas the presence of trees depends on the climate, elevation and soil, the presence of many of the smaller plants depends not only on these factors but on the presence of the trees, and the absence of many species from the Northern tract which occur in the adjacent Tarai and Duars and also sometimes in the more humid parts of the Southern tract is due to the destruction of the forests by human agency. The different combinations of species into associations are thus almost endless according to slight varying factors of the localities, and in the following tables it has been considered better to classify habitats rather than plant-associations arranged under the dominant species in the association. Even this must necessarily be incomplete

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\* *Cæsalpinia nuga* with large brown ellipsoid and compressed seeds is commoner in the tidal forests.



without involving excessive space, and only the more striking or characteristic species of each habitat can be mentioned.

171. The primary classification of habitats might be into Forests and Grass lands as is adopted by Schimper; but the grass lands in our area being for the most part artificial the prevalence of grass is a secondary consideration. Natural grass lands are probably only those in low-lying localities of very restricted area known to foresters as frost-holes.

172. It has been stated above that one species has usually no direct bearing on the presence of another. The proposition requires qualification in two directions. Apart from obvious cases where there is a direct relation (such as parasite and host), it appears from the tables as a fairly general rule that closely allied species are not usually found together or in similar habitats. Not only this but the plants, and this does not appear from the tables, even when they are so found in similar habitats are not always found in the same habitat. Thus *Mucuna imbricata* and *Mucuna monosperma* are both found in the more humid districts (with rainfall over 60") along streams in more or less evergreen forest. Yet I have never seen these two species together or in the same valley. Nor can I say in what their requirements differ except that *M. monosperma* is perhaps usually under denser shade than its congener, and is more restricted in distribution.

173. Marked exceptions occur to the rule that closely allied species are not usually found in the same habitat in association. These are perhaps where the species are somewhat recent or elementary. Cases occur especially in the flora of the rice-fields. Witness the many small species of *Utricularia* and the species of *Scrophulariaceæ* of the closely allied genera\* *Vandellia*, *Bonnaya* and *Lindernia*.

174. In some cases the presumed origin of some families under certain climatal conditions is well illustrated, e.g., the *Umbelliferæ*, presumably originated in a temperate or cold climate, are mostly confined to the elevated parts and tops of mountains.

175. The following trees and shrubs (in continuation of the short list on p. 37)† are common to the Central tract and to the Sub-Himalayan tract: *Naraveltia zeylanica*, *Dillenia aurea*, *Tinospora cordifolia*, *Capparis horrida*, *Flacourtia ramontchi*, *Cedrela toona*, *Olax scandens*, *Elæodendron glaucum*, *Celastrus paniculata*, *Zizyphus jujuba*, *Z. rugosa*, *Mangifera indica* (certainly wild in ravines of C.T. and S.T., also probably along water-courses in the N.T.), *Semecarpus anacardium*, *Odina woder*, *Spondias*, *Atylosia crassa*, *Butea parviflora*, *Millettia auriculata*, *Dalbergia volubilis*, *D. latifolia*, *Ougeinia*, *Indigofera pulchella*, *Cassia fistula*, *Bauhinia malabarica*, *B. purpurea*, *B. Vahlii*, *Mezocnuron*, *Mimosa rubicaulis*, *Acacia catechu*, *A. concinna* (rare in C.T. and S.T.), *Albizia stipulata*, *A. procera*, *A. lucida* (rare in C.T., not seen in S.T.), *Anogeissus latifolia* (only on dry ridges in N.T.), *Terminalia bellerica*, *T. chebula*, *T. tomentosa*, *Combretum decandrum*, *C. nanum*, *Eugenia jambolana*, *E. Heyneana*, *E. operculata*, *Careya arborea* (only in valleys in the south), *Woodfordia floribunda*, *Lagerstræmia parviflora*, *Cuscutaria graveolens*, *C. tomentosa*, *Heteropanax fragrans*, *Anthocephalus cadamba*, *Adina cordifolia*, *Mitragyna*, *Wendlandia tinctoria*, *Hymenodictyon excelsum*, *Gardenia turgida*, *Randia dumetorum*, *R. uliginosa*, *Pavetta indica*, *Coffea bengalensis* (only in cool valleys in the south), *Hamiltonia suaveolens*, *Ardisia solenacea*, *Sideroxylon tomentosum*, *Symplocos racemosa*, *Jasminum scandens*, *Nyctanthes*, *Alstonia*

\* The separation of these genera is artificial as I have shown in the Flora, p. 660.

† N.B.—The list is not a complete one.



*scholaris*, *Holarrhena*, *Wrightia tomentosa*, *Calotropis gigantea*, *C. procera*, *Cordia myxa*, *Ehretia laevis*, *Oroxylum indicum*, *Stereospermum tetragonum*, *S. suaveolens*, *Dædalacanthus nervosus*, *Gmelina arborea*, *Clerodendron infortunatum*, *Caryopteris Wallichiana* (rare in the south), *Holmskioldia sanguinea*, *Piper longum*, *Litsaea polyantha*, *Phœbe lanceolata*, *Loranthus longiflorus*, *L. scurrula*, *Bischofia javanica*, *Bridelia retusa*, *B. stipularis*, *B. tomentosa* (rare in south), *Flueggea*, *Kirganelia reticulata*, *Embllica officinalis*, *Croton oblongifolius*, *Putranjiva Roxburghii*, *Antidesma diandrum*, *Trewia nudiflora*, *Mallotus philippinensis*, *Celtis tetrandra* (very rare in south), *Trema orientalis*, *T. politoria*, *Streblus asper*, *Ficus bengalensis*, *F. retusa*, *F. comosa*, *F. religiosa*, *F. infectoria*, *F. hispida*, *F. cunia*, *F. glomerata*, *Salix tetrasperma*, *Smilax macrophylla*, *Phoenix acutis*.

## 176. ABSTRACT OF HABITATS OR PLANT COMMUNITIES.

### I. REGIONS OF GREATEST AËRIAL HUMIDITY, RAINFALL OVER 60".

#### § Betiah-Ramnagar Sandstones.

- a. Elevation 2000—3000 ft. (p. 54).
- b. Ravines in the higher hills (p. 54).
- c. Slopes and ridges up to 2000 ft.; Southern slopes (p. 54).
- d. Other slopes (p. 54).
- e. Lower valleys and river sides (p. 55).

#### §§ Other extra-littoral tracts. Soil physiologically moist.

##### A. Lands mostly tree-covered. Forests.

1. Northern Purneah, rainfall over 80" (p. 55).
2. Rainfall under 80". Evergreen forest, usually along streams in the plains, valleys in the mountains or on mountains at elevations over 2500 ft. (p. 55).
  - a. Species common to all three tracts (p. 55).
  - b. Species of Northern tract only (p. 55).
  - c. Species of Northern and Central tract (p. 55).
  - d. Species common to the Northern and Southern tracts only (p. 55).
  - e. Species of the mountains of the Central tract only (p. 56).
  - f. Species confined to the Southern tract (p. 56).
3. Mixed Forests of the lower elevations of the Southern tract (see also littoral scrub jungle (p. 56).
4. Riverian forests of the humid zone (p. 57).

##### B. Open lands with few or no trees.\*

1. Savannahs of the Northern Tract (p. 57).
  - a. Highland savannahs (p. 57).
  - b. Lowland savannahs (p. 57).
2. Along the courses of rivers and streams (non-aquatics) (p. 58).
3. The open areas of the Central tract over 2500 ft. (p. 58).
  - a. Grass lands proper (p. 58).
  - b. Along water courses (p. 58).
  - c. Sunny slopes (p. 58).
  - d. Rocky places (p. 58).
4. Marshes (p. 58).
5. Aquatics (see III, where all aquatics are dealt with together (p. 66).

\* Village lands are treated together under II.

§§§ Littoral tracts. Soil physiologically dry (mostly saline).

A. Tree covered.

1. Deltaic swamp forest (p. 59).
2. Littoral scrub jungle, rocky faces of Chilka Lake (see Bb).

B. Open coast.

- a. Sands (p. 59).
- b. Rocky places near the sea (p. 59).
- c. Saline marshes (p. 59).

II. REGIONS WITH A RAINFALL USUALLY UNDER 55" PER ANNUM.

A. Forests, or lands mostly tree-covered.

1. Soil mostly moist (p. 59).
  - a. Plains and valleys, general (p. 59).
  - b. *Dambusi arundinacea* formation (p. 60).
  - c. Evergreen forest belts, streams along valleys, etc. (p. 60).
    - i. General (p. 60).
    - ii. In muddy streams under dense shade (p. 61).
    - iii. Clinging to rocks in the forest streams (see also Aquatics) (p. 61).
    - iv. Rocky or gravelly beds of streams in the forest (p. 61).
    - v. In humus under shade (p. 61).
    - vi. Rocky ravines (p. 61).
    - vii. Well-drained sides of nalas (p. 61).
  - d. Cool sides of hills (p. 61).
2. Soil with the water table often above the surface at one season, very deep at another. Riverain Mixed Forest (p. 61).
3. Soil mostly dry except in the monsoon (p. 62).
  - a. Hill Mixed Forest of Central tract and Southern tract (p. 62).
    - i. General. Hill type Sal formation (p. 62).
    - ii. Hot slopes and rocky tops of hills, usually without Sal (p. 62).
    - iii. Among rocks in the hills, not necessarily at the top (p. 62).
    - iv. Sandstone hills (p. 62).
    - v. Trap hills (p. 62).
  - b. Cotton soil (p. 62).
  - c. Open forest (p. 63).
  - d. Scrub jungles (p. 63).
    - i. On mixed soils (p. 63).
    - ii. On laterite (p. 63).
  - e. Under the shade of trees near villages (p. 63).

B. Open lands.

1. Grass lands inside the forest (p. 64).
2. Waste ground and pastures (p. 64).
  - a. General (p. 64).
  - b. Weeds of the rainy season (p. 64).
  - c. Damp waste ground (p. 64).
  - d. Dry waste ground (p. 64).
  - e. Ruins and rubbish heaps (p. 65).
  - f. Feral and naturalized plants (p. 65).

3. Marshes, margins of tanks, etc. (p. 65).
4. Saline marshes (p. 65).
5. Along rivers (p. 65).
  - a. On the banks (p. 65).
  - b. In the dry beds (p. 65).
  - c. In the beds with the roots in the water (p. 65).
  - d. On or among the rocks of rocky beds (p. 65).
6. Village lands (p. 65).
  - a. Cultivated (p. 65).
    - i. Rice fields (p. 65).
    - ii. On the bunds between rice-fields (p. 65).
    - iii. High-level fields (p. 66).
      - † In Northern tract only (p. 66).
      - †† Central and Southern tracts (p. 66).
  - b. Uncultivated in hedges, on trellises, etc. (p. 66).

### III. Aquatics.

- a. General (p. 66).
- b. Running water (p. 66).
  - i. In the forest (p. 66).
  - ii. In the open (p. 66).
- c. Still water (p. 66).

### I. REGIONS OF GREATEST AÉRIAL HUMIDITY, RAINFALL OVER 60".

§ Bettial.-Ramnagar Sandstone hill tract:—

- a. Elevation 2000—3000 ft.:—

*Eriolæna Wallichii*, *Rhus semialata*, *Lespedeza macrostyla*, *Uraria pulchra*, *Rubus ellipticus* (also S.T.), *Boehmeria rugulosa*.

- b. Ravines in the higher hills:—

*Cleidion javanicum*, *Cyclostemon assamicus* (also S.T.), *Gymnosporia rufa*, *Sabia paniculata*, *Meliosma simplicifolia*, *Albizzia lucida*, *Trevesia palmata* (also S.T.), *Chonemorpha macrophylla*, *Phlogacanthus*, *Ficus glaberrima*, *Dendrocalamus Hamiltonii*.

- c. Slopes and ridges up to 2000 ft. General aspect south:—

- i. *Pinus longifolia*. This constitutes a distinct formation in one small relatively dry area (see "Forests of N. Champaran," *Ind. For.*, June, 1917). Associated with it are few Sal, *Grewia helicterifolia*, *Inula cappa*, *Pollinidium angustifolium*.

- ii. The Sal forms more than one formation according to type, chiefly on the lower slopes and on the bhabar at the foot. It calls for no special remark except that the lower Sal has *Dillenia pentagyna*, the upper *D. aurea* as an associate, and the damper Sal contains much *Croton oblongifolius*.

- iii. The following are subsidiary species on slopes and ridges in both formations, and also occur without the principal species:—

*Polygala crotalarioides* (shrubby form), *Sterculia colorata*, *Clausena pentaphylla*, *Iphigenia indica*.

- d. Other slopes. These are chiefly occupied by a mixed forest:—

- i. *Terminalia tomentosa* sometimes forms a nearly pure formation in saddles mixed with *Adina cordifolia* and with an undergrowth of

*Capillipedium assimilis*. This formation also occurs in valleys with much *Piper longum* on the damp ground.

ii. Interesting species of the mixed forests are in the higher parts:—

*Rubia angustissima*, *Polygala crotalarioides* (shrubby form), *Leucas helicterifolia*.

On a white sandy loam are found—

*Euphorbia fusiformis* and *Echinacanthus attenuatus*, *Tylophora rotundifolia*.

Rather damper parts contain—

*Sterculia colorata*, *Pterospermum acerifolium*, *Clausena pentaphylla*, *Hippocratea arborea*, *Jasminum caudatum*, *Smilax lanceæfolia*.

e. Lower valleys and river sides:—

*Sterculia pallens*, *Ilex umbellulata*, *Moringa oleifera* (river banks), *Tephrosia candida*, *Desmodium confertum*, *Butea minor*, *Osbeckia nutans* (along streams), *Osbeckia nepalensis* (open grassy jungles), *Bassia butyracea*, *Geniosporum strobiliferum* (open grassy jungles), *Lettsomia Thomsoni*, *Perilla ocimoides*, *Piper longum*, *Piper peepuloides*, *Cymbopogon microtheca*.

The last occurs in savannahs which are in most respects similar to those of the other moist tracts.

§§ Other humid extra-littoral tracts. Soil physiologically moist (cp. §§§):—

A. Forest lands or lands mostly tree-covered (cp. B, p. 57):—

1. Northern Purneah, rainfall over 80". Forest and sward mostly evergreen:—

*Stephania hernandifolia* (also Champaran), *Saccopetalum longiflorum*, *Vitis adnata*, *V. bracteolata*, *Elæocarpus serratus*, *Mallotus denticulata*, *Pueraria phaseoloides*, *Tephrosia candida*, *Jussiaea fissendocarpa*, *Alangium begoniifolium*, *Vangueria spinosa* (as distinct from *pubescens*), *Hedyotis scandens*, *Premna barbata* (as distinct from *calycina*), *Litsæa salicifolia*, *Polygonum chinense*, *Dracæna angustifolia*.

In this district, also, many plants, not enumerated, found in evergreen forest of other tracts, grow in the open.

2. Other evergreen forest, usually along streams in the plains, or valleys in the mountains, or on the mountains at elevations over 2500 ft. Rainfall under 80".

a. Species common to all three tracts:—

*Clematis nutans*, *Naravelia zeylanica*, *Dillenia pentagyna*, *Bridelia stipularis*, *Leea crispa*, *Vitis pedata*, *V. auriculata*, *Saraca indica*, *Melastoma malabathricum* (usually in open in N.T.), *Bidens pilosa*, *Amoora rohituka*, *Heteropanax fragrans*, *Celtis tetrandra*, *Artocarpus lakoocha*, *Sideroxylon tomentosum*, *Setaria plicata*, *Capillipedium pyviflora*.

b. Species of Northern tract only (also most of those enumerated under the Bettiah tract, lower valleys, §e):—

*Bassia butyracea*, *Stephania hernandifolia*.

c. Species of Northern and Central tracts only:—

*Vitis lanceolaria*, *Siphonodon celastrineus* (rare, only in S.P., in C.T.), *Vigna pilosa*, *Desmodium gyroides*, *Jasminum pubescens*, *Hedychium coronarium* (along watercourses in the hills of the Central tract).

d. Species common to Northern and Southern tracts only (the Saranda forests are included in the S.T.):—

*Mitchelia champaca*, *Tiliacora* (also northern S.P.), *Gelonium multiflorum* (also northern S.P.), *Bridelia tomentosa*, *Mallotus repandus*, *Aporosa dioica*, *Putranjiva*,

*Natsiatum herpeticum*, *Flacourtia cataphracta*, *Mesua ferrea*, *Pterospermum subersifolium*, *Alphonsea ventricosa* (northern S.P.), *Phœbe lanceolata*, *Calamus* spp., *Meliosma simplicifolia*, *Calonyction bona-nox*, *Premna scandens cum coriacea* (considered as one), *Randia fasciculata*, *Desmodium triquetrum*, *Vitex glabrata* (Rajmahal hills, moister parts, considered in this respect as part of Northern tract).

e. Species peculiar to the Central tract, rarely also S.T. These are mostly plants of high mountains.—

*Helinus lanceolatus* (almost in open), *Pygeum acuminatum*, *P. Andersoni* (Par.), *Berberis asiatica* (Par.), *Pittosporum floribundum* (down to 2000 ft.), *Viola Patrini*, *Drymaria cordata* (Par.), *Rhamnus dahuricus*, *Smithia ciliata* (Par.), *Tephrosia tinctoria* (on bauxite), *Desmodium parvifolium*, *Dumasia villosa*, *Rubus mollucanus*, *Geranium ocellatum*, *Kalanchoe heterophylla* (Par.), *Bupleurum* 2 spp., *Ophiorrhiza fasciculata*, *Anotis calycina* (Par.), *Knoxia brachycarpa*, *Rubia cordifolia*, *Laggera alata*, *Conyza ambigua* (sunny slopes), *Vernonia divergens*, *Rhynchoglossum*, *Didymocarpus*, *Didissandra*, *Vitex glabrata* (Rajmahal Hills), *Asparagus gracilis* (Neterhat only), *Chlorophytum tuberosum* (in thin forest or sometimes in the open, also in Sant. Parg.), *Habenaria Stocksii*, *H. goodyeroides* and *H. Lawii*, *Pogonia flabelliformis* (in humus in the shade of rocks).

f. Species only found in the Southern tract (including the Saranda forests). Many are also Himalayan:—

*Uvaria lurida*, *Unona discolor*, *U. longiflora*, *Polyalthia simiarum*, *P. cerasioides*, *P. suberosa*, *Alphonsea lutea*, *Anamirta cocculus*, *Gelonium lanceolatum*, *Prosurus indicus*, *Glochidion zeylanicum*, *Tragia Gegei*, *Bridelia verrucosa*, *Macaranga peltata*, *Acronychia laurifolia*, *Paramignya Griffithii*, *Evodia meliæfolia* (Bonai only), *Vitis assamica*, *Leea æquata*, *Harpullia imbricata*, *Erioglossum*, *Lepisanthes*, *Mucuna monosperma*, *M. imbricata*, *Desmodium viscidum*, *Atylosia cajaniifolia*, *Diplospora singularis*, *Hyptianthera stricta*, *Lasianthus truncatus*, *Psychotria adenophylla*, *Ophiorrhiza Harrisiana*, *Symplocos spicata*, *Jasminum scandens*, *Linociera malabarica*, *Ligustrum*, *Alstonia venenata*, *Anodendron*, *Ipomœa sepiaria*, *Ecbolium Linneanum*, *Litsæa nitida*, *Piper attenuatum*, *P. trioicum*, *Ficus asperrima*, *F. scandens*, *Laportea crenulata* (also in the Tarai and Duars), *Scindapsus* (rare also in C.T.), *Dracæna terniflora*, *Dioscorea oppositifolia*, *Curcuma aromatica*, *Oxytenanthera*.

The following are always close to the streams:—

*Uvaria Hamiltonii*, *Garcinia cowa* (Hamilton also reports it from Monghyr), *Garcinia xanthochymus*, *Elæocarpus robustus*, *Lagerflœmia flos reginæ*, *Citrus aurantium*, *Amoora spectabilis*, *Antidesma bunius*, *A. acuminatum*.

Along marshy streams:—

*Clinogyne dichotoma*, *Phrynium* spp., *Habenaria triflora*.

The following mostly over 3000 ft.:—

*Clematis smilacifolia*, *Elæocarpus Wallichii* (distrib. Burma), *Baccaurea sapida* (Tarai and Duars), *Citrus medica*, *Rhamnus nepalensis*, *Euonymus glaber*, *Tarpinia pomifera*, *Aralia arnata* (distrib. Sikkim and Burma), *Psychotria denticulata*, *Chasalia curvisflora*, *Styrax serrulatum* (distrib. Himalaya), *Peperomia reflexa* (also on Par. in C.T.), *Machilus villosa*, *Pilea scripta* (dist. Duars and Chittagong), *Villebrunea frutescens* (distrib. Himalaya), *Rhaphidophora*, *Saptium insigne*, *Leea acuminata* (also E. Himalayas), *Eugenia lanceæfolia* (dist. Duars), *E. fruticosa* (dist. Chittagong), *Rubus ellipticus*, *Ardisia depressa*, *Bridelia pubescens*.

The following mostly confined to rocky ravines:—

*Dimorphocalyx glabellus*, *Lasiococca Comberi*, *Sansevieria Roxburghiana*.

3. Mixed forests and scrub jungles of the lower elevations of the Southern tract. These are situated in the moister region and often not very far from the sea, but the soil is not saline. The scrub is an

impoverished state of the Mixed, and there is no sharp line of demarcation. Several also occur in II (regions of lower humidity):—

*Pterospermum Heyneanum* (extends to Sambalpur), *Xylia xylocarpa* (also Mayurbhanj, Narsingpur and Kalahandi, *Grewia rhamnifolia* (rocky forest), *G. aspera* (also C.T.), *G. multiflora* (also N.T.), *Cleistanthus collinus* (widespread), *C. patulus* (chiefly in rocky jungles), *Hugonia mystax*, *Ochna squarrosa*, *Zizyphus xylopyra*, *Allophyllus serratus*, *Cylista scariosa*, *Tinospora cordifolia*, *Capparis floribunda*, *Putranjiva*, *Aspidopterys indica*, *Zanthoxylum budrunga*, *Toddalia aculeata*, *Acronychia laurifolia*, *Glycosmis arborea*, *Melia composita*, *Ougeinia*, *Pterocarpus* (both also C.T.), *Ormocarpum sennoides*, *Capparis brevispina* (scrub), *C. Roxburghii* (rocky places), *C. septaria* (scrub), *Pavonia odorata*, *Hibiscus micranthus* (sandstones), *Grewia rotundifolia* (sandstones), *Webera corymbosa*, *Randia malabarica*, *Croton caudatus* (with Sal), *Mallotus repandus* (also N.T.), *Soyimida* (esp. on kunker), *Erioglossum*, *Lepisanthes tetraphylla*.

In the moister mixed forests of Angul, Mango, *Anthocephalus cadamba*, *Alstonia scholaris*, *Bursera serrata*, *Miliusa* and *Melia composita* are usually prominent.

4. Riverain forest of the more humid regions. This includes and is chiefly confined to the Khair-Sissu Mixed forests of the extreme Northern tract. Besides the form of Khair (*Albizzia catechu* var. *catechuoides*) characteristic of it and the Sissu, which is scarce in our area as a wild tree, the following subsidiary species are characteristic:—

*Erythrina indica*, *Adina cordifolia*, *Ehretia acuminata*, *Morus indica*, *Litsæa salicifolia* (in the moister parts only), *Putranjiva* (ditto), *Tiliacora acuminata*, *Grewia multiflora* (in S.T. found on ever. for.), *Vitis angustifolia*, *Pæderia foetida* (occasional also in C.T.), *Hedyotis scandens*, *Porana paniculata* (also in C.T. in hills and in Ramnagar Hills), *Premna latifolia* var. *Gamblei*, *Ipomæa vitifolia*, *Deeringia baccata* (with pretty scarlet berries), *Elæagnus latifolia*. Also very frequently *Albizzia stipulata*, *Cedrela toona*, *Trema orientalis*, *Streblus asper*, *Bridelia stipularis* with red drupes, *Ichnocarpus frutescens*, *Bryonia laciniosa*, *Hymenodictyon*. In more permanently moist depressions *Putranjiva*, *Calamus viminalis*, *Flacourtia cataphracta*, *Mallotus repandus*, *Litsæa salicifolia* and *polyantha*, *Alstonia scholaris*, *Randia uliginosa*, *Aporosa*, *Phlogacanthus thyrsiflorus* and *Entada scandens*

B. Open lands with few or no trees:—

1. Savannahs of the Northern tract:—

a. Highland (i.e. not waterlogged or with moving water) savannahs. These are maintained in a state of grass by artificial means. They are caused by fresh deposits of silt or destruction of the forest:—

*Grewia sclerophylla*, *G. sapida* (also C.T. and S.T.), *Glochidion multiloculare* (and C.T.), *Ochna pumila*, *Olax nana*, *Leea crispa*, *Abrus pulchellus*, *Desmodium triquetrum* (and S.T.), *Flemingia involucrata* (and S.T. in low grass-lands), *Flemingia angustifolia*, *Careya herbacea*, *Oldenlandia gracilis* (all tracts), *Calotropis acia*, *Rivea ornata*, *Premna herbacea* (all tracts), *Clerodendron serratum* and *C. siphonanthus* (ditto), *Plectranthus ternifolius*, *Cyperus niveus*, *Saccharum fastigiatum*, *S. narenga*, *Panicum articulata*, *Eulalia argentea*, *Andropogon apricus*, *Chrysopogon montanus*, *Amphilophis glabra*, *Cymbopogon nardus*, also many other Gramineæ. *Curcuma zedoaria*, *Pachystoma senifolium* (also C.T.), *Eulophia campestris* (also C.T.).

The first trees to obtain a footing in the savannahs are usually—

*Eugenia operculata*, *Caruga pinnata*, *Odina wodier*, *Phyllanthus emblica*, *Symplocos racemosa*.

b. Lowland Savannahs:—

*Saccharum procerum*, *S. spontaneum*, *Ophiurus megaphyllus*, *Arundinella brasiliensis*, *Phragmites karka*, *Tripsitis* sp., *Anthesisia gigantea*, *Colx*, *Polytoca bracteata*, *Alpinia* spp., *Calamus guruba*, *C. tenuis*, *Ficus heterophylla*, *Rivea ornata*, *Hedychium coronarium* and *H. stenopetalum*.

c. The same, but grass kept short by heaving grazing:—

*Zeuxine membranacea*, *Z. affinis*.

2. Rivers and streams in the moist region (exc. the pats).

Non-aquatics:

a. Chiefly on the banks:—

*Cochlearia flava*, *Pulicaria foliolosa*, *P. crispata*, *Rosa involucreta* (also in C.T. and S.T., but usually in the forest where shaded), *Barringtonia acutangula* (ditto), *Cratæva religiosa*, *Saccharum munja*, *Campanula canescens* (also in C.T., but at high elevations), *Streptocaulon* (steep sandy banks in Purneah), *Hygrophila polysperma*, *Colocasia antiquorum* (var.), *Gleichenia linearis*.

b. Chiefly in the beds:—

*Dentella repens* (also rice-fields), *Tamarix ericoides* (also C.T.), *Cotula*, *Phragmites*, *Saccharum spontaneum*.

3. The "pats" and other grass areas of the Central tract over 2500 ft. The pats are usually grass lands. The condition is mostly due to the firing and grazing, aided by frequently unfavourable subsoil (trap or laterite) and strong winds which make re-forestation difficult:—

a. Grass lands proper:—

*Euphorbia prolifera*, *Ochna pumila*, *Oxalis nana* (rare in II), *Hypericum japonicum*, *Geranium ocellatum*, *Viola Patrini*, *Leea crispa*, *Erythrina resupinata*, *Indigofera Hamiltoni*, *Pycnocycla glauca*, *Peucedanum dhana* (*P. nagpurensis* is a forest species at same and lower elevations), *Pimpinella monoica*, *P. bracteata*, *Combretum nanum* (also II), *Rhynchospora dahuricus* (rocky places), *Rubia cordifolia*, *Conyza stricta*, *C. ægyptiaca*, *C. ambigua* (sunny slopes), *Pulicaria angustifolia*, *Glossogyne pinnatifida*, *Artemisia parviflora*, *Senecio nudicaulis*, *Tricholepis*, *Crepis acaulis*, *Sonchus arvensis*, *Lobelia zeylanica* (var.), *Jasminum strictum*, *Ipomœa barlerioides*, *I. petaloidea* var. *pauciflora*, *Gnemosporum elongatum*, *Plectranthus ternifolius* (also N.T.), *Lavandula*, *Micromeria*, *Ajuga*, *Cyperus niveus*, *Curcuma angustifolia*, *Xyris coronata*, *X. pauciflora* (wet places), *Chlorophytum laxum* (dry places with rock near the surface).

The grasses themselves are not very characteristic:—

*Andropogon apricus*, *A. assimilis*, *Axonopus semialatus*, *Arundinella setosa*, *A. Wallichii*, *Apluda varia*, *Arthraxon ciliaris*, *Anthistiria gigantea*, *A. imberbis*, *A. ciliata*, *Chrysopogon monticola*, *Cymbopogon Martini*, *Imperata*, *Ischæmum laxum*, *Saccharum spontaneum*, *S. narenga*, *Sorghum fulvum*, *Andropogon intermedius*, *Pollinia argentea*, *P. articulata* (chiefly, like some of the others, in the neighbouring forest), and others.

b. Along the streams on the pats:—

*Osbeckia chinensis* and *rostrata* (wet places generally), *Osbeckia rostrata* var. *sexangularis*, *Hydrocotyle rotundifolia*, *Cenante stolonifera*, *Hypericum Gaitii*, *Desmodium parvifolium* (on banks), *Rubus mollucanus*, *Potentilla Kleiniana*, *P. Leschenaultii*, *Ligusticum albaalatum*, *Lobelia zeylanica* (var.), *Lysimachia obovata*, *Limnophila hypericifolia*, *Plectranthus menthoides*, *Dysophylla auricularia*, *Scutellaria discolor* (banks), *Polygonum pedunculare*, *Colocasia antiquorum* var. *stolonifera*, *C. fallax*, *Thesium* (in wet grass), *Eriocaulon collinum* (semi-aquatic).

c. On sunny slopes:—

*Elsholtzia incisa*.

d. Among rocks:—

*Dianella ensifolia* (in the shade of rocks).

4. Marshes:—

*Ranunculus sceleratus*, *Nasturtium palustre*, *Æschynomene aspera* (heels), *Stellaria Wallichiana* (under shade), *Fragaria indica* (damp shady places, hardly marshy),

*Potentilla supina*, *Pentapetes phœnicea*, *Lippia geminata*, *Juncus bufonius*, *J. prismatocarpus* (wet ground rather than marshes and also in Central tract).

§§§ Littoral tracts. Soil physiologically dry (saline, or sandy and rocky, or both saline and sandy or rocky):—

A. Forest:—

1. Deltaic swamp forest and saline marshes:—

*Hibiscus tiliaceus*, *Thespesia populnea*, *Heritiera minor*, *Brownlowia lanceolata*, *Excœcaria*, *Carapa obovata*, *Dalbergia spinosa*, *D. candenatensis*, *Derris uliginosa*, *Cæsalpinia nuga*, *Rhizophora* 2 spp., *Ceriops*, *Kandelia*, *Bruguiera* 2 spp., *Lumnitzera*, *Sonneratia*, *Salvadora persica*, *Sarcolobus carinatus*, *Gylophora asthmatica*, *Pandanus tectorius*, *Phœnix paludosa*, *Ægialitis*, *Ægiceras majus*, *Parsonsia*, *Acanthus ilicifolius*, *Premna integrifolia*, *Clerodendron inerme*, *Avicennia*, *Flagellaria indica*.

2. Littoral scrub jungle. This is doubtfully classified as a physiologically dry soil. Its condition may be due to the poor soil (often laterite or sand) combined with strong sea winds. It passes into the Mixed forest:—

*Gymnosporia emarginata*, *Scutia myrtina*, *Azima tetraantha*, *Pisonia aculeata*, *Weihea ceylanica*.

B. Open coast (the sands in the rains are physiologically wet):—

a. Sands:—

*Phyllanthus rotundifolius*, *Euphorbia rosea*, *Agynœia bacciformis*, *Vitis vitifera*, *Stylosanthes mucronata*, *Desmodium biarticulatum*, *Canavalia lineata*, *Osbeckia zeylanica* var. *non-rostrata*, *Oldenlandia arenaria*, *Hydrophyllax markima*, *Pedaliium murex*, *Cyperus arenarius*, *Bulbostylis subspinescens*, *Spinifex*, *Allmania nodiflora* var. *Roxburghii*, *Crinum asiaticum* (also partially under shade of trees), *Crinum defixum* (but partly in water derived from streams), *Launea pinnatifida*, *Ipomœa pes-capræ*, *Pandanus tectorius*, *Calotropis gigantea*. While further from the sea occur *Casuarina*, *Streblus*, Cashew nut, *Calophyllum* and Palms. Excepting the *Spinifex* grasses are rare. *Panicum paspaloides* grows in semi-salt water. *Panicum repens* occurs on the sands but is common inland, and *Zoysia pungens* is rare.

b. Rocky places near the sea:—

*Euphorbia caducifolia*, *Gymnosporia emarginata*, *Scutia myrtina*, *Vitis quadrangularis* (also inland), *Ægiceras*, *Maba buxifolia* (also inland), *Azima tetraantha*, *Pisonia aculeata* (also inland)?

c. Saline Marshes. This is mostly included under (A), as many of the species, like *Acanthus ilicifolius*, though preferring open marshes, are more or less shade-bearing and found in association with the trees in places with comparatively little water. *Salicornia brachiata*, *Suaeda* 2 spp.

II. REGIONS OF LESS AËRIAL HUMIDITY, RAINFALL UNDER 55" PER ANNUM:—

A. Forest lands or lands mostly tree-covered:—

1. Soil mostly moist:—

a. Plains and valleys, general:—

The principal species are *Sal*, *Terminalia tomentosa* (all positions, but attains its finest dimensions in low moist valleys, where it sometimes is nearly pure).

Other characteristic species are:—

*Polyalthia cerasioides* (moister valleys), *Miliusa velutina*, *Hibiscus cancellatus*, *H. solandra* (C.T. only), *Thespesia lampas*, *Kydia calycina*, *Helicteres*, *Grewia thiazifolia*, *G. Rothii*, *Bridella retusa*, *Antidesma diandrum*, *Croton oblongifolius*



(local), *Mallotus philippinensis*, *Phyllanthus debilis*, *Embllica officinalis*, *Garuga pinnata*, *Clausena excavata*, *Semecarpus anacardium*, *Vitis repanda*, *V. tomentosa*, *Leea aspera*, *Odina wodier* (moist type), *Ougeimia dalbergioides*, *Desmodium pulchellum*, *Millettia auriculata*, *Butea parviflora*, *Indigofera pulchella*, *Desmodium gyrans* (damp banks in r.s.), *Cassia fistula*, *Flemingia chapper*, *F. semialata* (moister places), *Terminalia belerica*, *Careya arborea*, *Lagerstræmia parviflora*, *Mitragyna parvifolia*, *Adina cordifolia*, *Randia dumetorum*, *Wendlandia tinctoria*, *Siegesbeckia orientalis*, *Symplocos racemosa*, *Lettsomia setosa*, *Ficus comosa*, *F. infectoria*, *F. Rumphii*, *F. religiosa*, *F. bengalensis*.

Of the few *Cyperaceæ* which grow in the shade and away from water may be mentioned the species of *Scleria* and *Carex cruciata*.

Shade-bearing *Gramineæ* in the valley forests are the bamboo *Cephalostachyum pergracile*, found rather in deep ravines than in normal valley forest, *Chloris incompleta*, *Setaria plicata* (chiefly in I), *Panicum montanum* (but usually in the hill forests), *Arthraxon ciliaris*, and especially *Oplismenus compositus* and *O. Burmanni* which often grow under dense shade (see also grasses of ravines and evergreen forest). Open grassy forests are not included here.

The following appear only in the r.s. or end of the h.s.:—

*Amorphophallus bulbifer*, *Arisæma tortuosum*, *Smilax macrophylla*, *Asparagus racemosus*, *Chlorophytum arundinaceum* (also in the most humid tracts), more in the forest than the other species, *Crinum latifolium* (usually on the dry banks of nalas under shade), *Tacca pinnatifida* (in rocky ground), *Dioscorea anguina*, *D. belophylla* (chiefly rocky forest), *D. Wallichii*, *D. bulbifera*, *D. pentaphylla*. Species of *Globba*, *Curcuma*, *Zingiber* and *Costus*.

Along streams under light shade:—

*Amomum dealbatum*, *Habenaria platyphylla* (on clay), *H. plantaginea*.

Under dense shade:—

*Habenaria furcifera*.

b. *Bambusa arundinacea*. This forms a pure formation in valleys in Angul or only fringing streams in the Central tract, where it takes the place of the more usual evergreen forest. When once well established it kills out all competitors until it flowers.

c. Evergreen forest. This includes also those species which, not evergreen themselves, are only found along streams in the less humid tracts. The type passes into that of the most regions (p. 53):—

i. General:—

*Michelia champaca* (perhaps always with rainfall over 60"). *Dillenia pentagyna*, *Clematis gouriana*, *Polygala glomerata*, *Hibiscus pungens*, *Sterculia villosa*, *Trumfetta pilosa*, *Grewia disperma*, *Glochidion lanceolarium*, *Antidesma acuminatum*, *Bridelia stipularis*, *Cleistanthus collinus* (valley form), *Bischofia javanica*, *Heynea trijuga*, *Cedrela toona*, *Amoora rohituka*, *Saraca indica*, *Zizyphus rugosa*, *Gouania leptostachya*, *Vitis latifolia*, *V. auriculata*, *V. repanda*, *Hiptage madaghlota*, *Micromelum pubescens*, *Xylosma longifolia*, *Mangifera indica*, *Cratæva religiosa*, *Leea robusta*, *L. sambucina*, *Pongamia glabra*, *Saraca indica*, *Albizzia stipulata*, *A. procera*, *A. odoratissima*, *Desmodium polycarpum* (spreading generally into the valley forests), *Flemingia stricta* (ditto), *Mezoneurum*, *Entada scandens*, *Mucuna imbricata* (perhaps always in I), *Barringtonia acutangula* (on edges of rivers and along nalas), *Anogeissus acuminata*, *Terminalia arjuna* (rarely in the evergreen forest), *Combretum decandrum*, *Vangueria pubescens*, *Hedyotis vestita*, *Ardisia solenacea*, *Sideroxylon tomentosum*, *Erycibe paniculata*, *Diospyros embryopteris*, *D. sylvatica* (chiefly in I), *Jasminum pubescens* (S.P. only perhaps in I), *Linociera intermedia*, *Alstonia scholaris*, *Wrightia tomentosa*, *Strophanthus Wallichii*, *Strobilanthes scaber*, *Dædalacanthus nervosus*, *Vitex glabrata* (only S.P.), *V. paucularis*, *Premna calcyina*, *Clerodendron infortunatum*, *Ipomæa turpethum*, *I. cymosa*, *I. vitifolia*, *Hewittia bicolor*, *Limnophila Roxburghii*, *Nelsonia campestris* (rarely in

the open), *Oroxylum indicum* (in the open in I), *Boehmeria platyphylla*, *Scindapsus officinalis*, *Actinodaphne angustifolia*, *Beilschmiedia Roxburghiana*, *Trema orientalis* (in opening only), *Ficus comosa*, *F. hispida*, *F. scandens*, *Cyanotis tuberosa*, *Dioscorea dæmona* (also outside evergreen belts).

ii. In muddy streams under shade:—

*Alocasia fornicata*, *Licuala peltata*, *Carex phacota*, *Curculigo recurvata*, *Musa ornata*, *Gastrochilus longiflora*.

iii. Clinging to rocks in the streams:—

*Lawia zeylanica* (Angul, rainfall probably over 60"), *Cyathocline lyrata*, *Ischæmum hirtum*, *Vitis trifolia*.

iv. Rocky or gravelly beds of streams under shade:—

*Ficus lanceolata*, *Lepidagathis fasciculata*, *Goodyera procera*.

v. In humus under shade:—

*Ægnetia*, *Balanophora* (on roots of trees).

vi. Rocky ravines:—

*Vitis trifolia*, *Musa sapientum*, *Melothria heterophylla*, *Hiptage madablota*, *Muraya exotica*, *Tinospora malabarica* (S.P. only), *Hibiscus tetraphyllus* (S.P. only), *Buettneria herbacea*, *Bridelia montana*, *Euphorbia nivulia*, *Ochna squarrosa* (also ordinary valleys in S.T.), *Pueraria tuberosa*, *Hymenodictyon*, *Hamiltonia*, *Millettia racemosa*, *Memecylon*, *Dimorphocalyx* (S.T. only), *Lasiococca Comberi* (S.T. only), *Combretum ovalifolium*, *Jasminum sambac* (S.T.), *Alstonia venenatus* (S.T. only), *Vallaris* (also N.T.), *Aganosma caryophyllata*, *Lepidagathis hyalina* and *fasciculata* (rock and grass near rocky streams), *Holmskioldia sanguinea*, *Colebrookia* (also N.T. in open), *Pogonatherum saccharoideum*, *Arthraxon microphyllum*, *Capillipedium assimilis*, *Paspalum scrobiculatum*, *Thysanolaena agrostis*, *Caryota urens* (in C.T., in ordinary valley forest in S.T.).

vii. Well-drained sides of nalas, usually outside the evergreen belt:—

*Combretum decandrum*, *Alangium Lamarckii*, and several of those species which spread from the rocky ravines or the evergreen forest.

d. Cool sides of hills (usually north aspects) where the ground is more damp and rocky. This locality passes into the last, but it is situated further from the bottom of the valley:—

*Hamiltonia suaveolens* (also Champaran. In S.P. it occurs on trap, in Singbhum on quartzite, common in Monghyr Hills, and is generally local), *Bursera serrata*, *Hypitiantera stricta* (also on cool ridges in moist zone), *Blumea virens*, *Sterculia colorata*, *Chloroxylon swietenia*, *Gardenia latifolia*, *Thalictrum*, *Homalium nepalense* (also on ridges in moist zone), *Kydia calycina*, *Ochna squarrosa*, *Pterocarpus marsupium*, *Heteropanax fragrans*, *Scleichera trijuga*, *Cleistanthus patulus* (S.T. only), *Siegesbeckia*, *Crepis japonica*, *Mæsa indica* (and valleys), *Nyctanthes*, *Hemidesmus* (and ev. for.), *Canscora decussata* (esp. on damp. clay), *Oroxylum indicum* (and in valleys), *Radermachera xylocarpum* (and valleys) (S.T. only), *Callicarpa arborea* (and cool tops of hills), *Vitex peduncularis*, *V. glabrata* (only in S.P. and Mayurbhanj, mostly in moist zone), *Canscora diffusa* (damp banks and wet rocks, also in valleys), *Ficus glabella*, *Ficus cunia*, *Remusatia vivipara* (among rocks in very damp places), *Colocasia antiquorum* var. *rupicola*.

2. Soil with very variable moisture content at different seasons and usually free water in the dry season deep down. Riverain Mixed Forest. This is not well marked as a type away from the sub-Himalayan tract (see I), but the following often compose a narrow belt near rivers.

*Terminalia arjuna*, *Albizia procera* (but chiefly in valleys), *Homonoia*, *Kirganelia*, *Trewia*, *Spondias*, *Crotalaria sericea*, *Phyllanthus Lawii* (see open river

beds), *Celastrus paniculatus*, *Pongamia*, *Ehretia laevis*, *Ipomœa vitifolia*, *Vitex leucoxydon*, *Holoptelea integrifolia*, *Saccharum spontaneum*.

3. Soil dry except in the rainy season:—

a. Hill mixed forest of Central tract and Southern tract:—

i. General:—

Sal, hill type, *Garuga pinnata*, *Flacourtia ramontchi* (also valleys, and N.T. in scrub), *Oxalis scandens*, *Crotalaria albida*, *Luchanania latifolia*, *Odina wodier* (hill type), *Indigofera pulchella*, *Butea scandens*, *Erythrina suberosa*, *Ougeinia dalbergioides* (hill form), *Cassia fistula* (general), *Clematis nutans*, *Dillenia aurea*, *Saccopetalum tomentosum*, *Cochlospermum*, *Sterculia urens*, *Cleistanthus collinus*, *Ægle marmelos*, *Eriolœna Hookeriana*, *Grewia Rothii*, *Zizyphus zylopyra*, *Boswellia serrata*, *Chloroxylon swietenia*, *Elæodendron*, *Semecarpus anacardium*, *Odina wodier*, *Buchanania latifolia* (rare N.T.), *Gardenia turgida*, *Schleichera trijuga*, *Grewia elastica*, *Bassia latifolia*, *Gardenia gummifera* (chiefly on clay with quartz stones), *Schrebera swirtenioides*, *Thunbergia fragrans*, *Ruellia suffruticosa* (mostly on clay), *Dædalacanthus purpurascens*, *Barleria cristata*, *Gmelina arborea*, *Wrightia tinctoria*, *Blepharis*, *Symphorema involucreta*, *Ficus Rumphii*, *F. infectoria* (also valleys), *F. bengalensis* (also valleys), *Pollinidium angustifolium* (Sabai grass, mostly on clay and lime soils), *Arundinella setosa*, *Pancreatium triflorum*, *Smilax prolifera* (especially near dry ravines), *Asparagus racemosus*, *Urginea indica* (esp. on fire lines), *Curculigo orchioides*.

ii. Hot slopes without Sal and tops (usually rocky) of hills:—

*Anogeissus latifolia*, *Sterculia urens*, *Boswellia serrata*, *Bridelia Hamiltonii* (rare chiefly on quartzite in S.T.), *Cochlospermum*, *Marsdenia tenacissima*, *Commiphora Roxburghii*.

iii. Rocky places in the hills:—

*Polycarpæa corymbosa*, *Bridelia montana* (rare, chiefly on quartzite, S.T., also Monghyr), *Waltheria indica*, *Boswellia*, *Marsdenia tenacissima*, *Hemigraphis latebrosa*, *Leucas montana*, *Glossocardia*, *Nyctanthes*, *Petalidium*, *Justicia betonica*, *Rhinacanthus communis*, *Dicliptera Roxburghiana* and *bupleuroides*, *Sarcostemma* (on the rocks themselves), *Boucerosia* (ditto, only in S.T.), *Pupalia lappacea*, *Ærua scandens*, *Allmania nodiflora*, *Ficus Arnottiana*, *F. tomentosa* (often on the rocks on the tops of the hills), *Arundinella setosa*, *Sorghum nitidum*, *Chrysopogon lancearius*, *C. montanus*, *Cymbopogon Martini*, *Pollinidium angustifolium*.

*Dendrocalamus strictus* usually forms a pure formation; the ground is not necessarily rocky, but the rock is usually close to the surface. In the *Dendrocalamus* formation is found *Lysimachia peduncularis*.

iv. Sandstone hills of C.T.:—

*Hardwickia binata*, *Grewia hirsuta* var. *helicterifolia*.

v. Trap hills:—

*Neuracanthus tetragonostachyus*.

b. Cotton soil or Regur:—

*Feronia elephantum*, *Soymida febrifuga* (also with kunker), *Zizyphus nummularia*, *Balanites Roxburghii*, *Dodonæa viscosa* (also on lime soils), *Butea frondosa*, *Dichrostachys cinerea*,\* *Acacia tomentosa*,\* *A. leucophylla*\* (only reproduces open forest), *Parkinsonia aculeata* (introduced), *Stephegyne parvifolia*, *Randia uliginosa* and the grasses *Ischænum laxum*, *Themeda ciliata*\* and *T. quadrivalvis*, *Iseilema laxum*,\* *Ophiurus corymbosus*, *Polytoca barbata*.

Very frequent, but less characteristic are—

*Terminalia tomentosa*, *Gardenia lucida*, *Wendlandia exserta*, *Nyctanthes* and *Chrysopogon monticola*.

\* These are the most characteristic.

c. Open usually grassy forest (the grassy tracts at high elevations mostly come under I):—

*Grewia hirsuta*, *Vitis latifolia* (also in close forest), *Butea frondosa*, *Eugenia operculata*, *Wendlandia exserta* (usually in second growth), *Gardenia turgida*, *Elephantopus scaber* (also pastures), *Blumea flava* (mostly on clay soils), *Cassia tora*, *Knoxia corymbosa* (also in open), *Triumfetta rhomboidea* (also waste ground), *Cocculus hirsutus*, *Celastrus paniculata*, *Acacia lenticularis*, *A. catechu*, *Paderia fætida*, *Spermacoe stricta*, *Vernonia Roxburghii* (on trap in S.P.), *Antidesma ghezsembilla*.

In open forest with clay soil and not much grass the following are more usually found:—

*Polygala leptalea*, *Ægle marmelos*, *Desmodium brachystachyum*, *Atylosia scarabœoides*, *Woodfordia floribunda* (it usually germinates on bare soil, and is hence found in second-growth forest, which may ultimately become grassy), *Hedyotis hispida* and *pinifolia* (on clay), *Vernonia teres* (on clay), *Vicoa indica* (Clay), *Blumea glomerata* (esp. on fire lines), *B. flava*, *Habenaria Susannæ* (in the monsoon), and some other species of *Habenaria*.

Open forest (continued). Not necessarily either grassy or on clay:—

*Symplocos racemosa*, *Holarrhena* (prefers well-drained damp localities), *Buddleia asiatica* (near open nalas), *Ehretia buxifolia* (rare), *Barleria prionitis* (usually on river banks), *Lepidagathis Hamiltoniana* (and waste ground), *Premna latifolia*, *Buchnera*, *Andrographis* spp., *Premna herbacea*, *Pupalia atropurpurea* (also waste ground), *Ærua monsoniana* (open Sal forest), *Achyranthes aspera* var. *porphyri-stachya*, *Aristolochia indica*, *Ficus parasitica*, *Plesmonium margaritifera*, *Phoenix acaulis*, *Dioscorea Hamiltonii* (local, often along nalas but sometimes tops of high hills).

Chiefly grass glades:—

*Rauwolfia serpentina*, *Swertia*, *Lettsomia bella*, *Ipomœa hispida*, *Hypoxis aurea*, *Tacca pinnatifida* (often among rocks), *Dioscorea glabra* (esp. near nalas).

The grasses are mostly—

*Eulalia argentea* (clay soils), *Puliculum articulata*, *Sehima nervosum*, *Amphilopsis glabra*, *Heteropogon contortus*, *Andropogon apricus*, *Apluda varia*.

d. Scrub jungles and Induced Scrub:—

\*i. General. This type extends into the more humid zone (see p. 56) and is not always separable\* :—

*Woodfordia*, *Cæsalpinia*, *Capparis sepiaria*, *C. horrida* (but rather muister localities), *Flacourtia sepiaria*, *F. Ramontchi*, *Balanites* (esp. on cotton soil and along Sone valley on sand), *Limonia acidissima*, *Ægle*, *Zizyphus jujuba*, var. *fruticosa*, *Carissa paucinervis*, *Ipomœa quinata*, *Ichnocarpus frutescens*, *Cryptolepis Buchananii*, *Cassytha*, *Schizachyrium*, *Gloriosa superba* (and in hedges). On kunker—*Dodonœa viscosa*, *Mimusops hexandra*.

ii. Laterite scrub of the Southern tract. Where protected this is passing into Mixed forest:—

*Capparis floribunda*, *C. brevispina*, *C. Roxburghii* (rocky jungles) and *C. sepiaria*, but rarely in association, *Atalantia monophylla*, *Limonia acidissima*, *Ægle marmelos*, *Toddalia aculeata*, *Glycosmis arborea* (but especially on sandstone), *Gymnosporia emarginata*, *Vitis repens*, *Webera corymbosa*, *Randia malabarica*, *Eugenia bracteata*, *Canthium Parviflorum*, *Maba buxifolia*, *Diospyros sylvatica* (scrub form), *Hugonia mystax*, *Carissa spinarum*, *Ipomœa quinata*.

e. Under shade of trees usually near villages:—

*Vernonia anthelmintica*, *Laggera pterodonta*.

\* The rainfall varies from 51 to 65" in the Southern tract on the east, where the scrub principally occurs. See para. 133.

## B. Open lands:—

1. Extensive grass lands in the forests (see also thin forest and glades and waste lands; many spp. are common to all three):—

*Sida* spp., *Urena* spp., *Sesbania aculeata* (wet ground), *Æschynomene indica* (ditto), *Osbeckia chinensis*, *Melastoma malabathricum* (in N.T.; in C.T. etc. it requires shade), *Leca aspera*, *L. crispa* (only in damper, cooler parts), *Grewia sapida*, *Indigofera* spp., *Glochidion multiloculare*, *Combretum nanum*, *Ochna pumila*, *Striga lutea* (wet places in grass), *Premna herbacea*, *Dysophylla* spp. (wet places in grass), *Clerodendron serratum* and *siphonanthus*, *Exacum tetragonum* (wet grass), *Cyperus niveus*.

The grasses themselves are very various, the most gregarious being:—

*Heteropogon contortus* and *Themeda* spp., *Polytoca barbata*, *Coix*.

In wet grass lands esp.:—

*Rottbællia exaltata*, *Mnesithea perforata*, *Hemarthria compressa*, *H. protensa*.

Showing especially after the grass fires:—

*Ancilema scapiflorum*, *Scilla indica*, *Chlorophytum* spp.

2. Waste ground and pastures:—

a. General:—

*Triumfetta rhomboidea*, *Sida* spp., *Urena lobata*, *Euphorbia hirta*, *E. hypericifolia*, *Chrozophora Rottleri*, *Phyllanthus niruri*, *Zizyphus jujuba*, *Vernonia cinerea*, *Elephantopus scaber*, *Knoxia corymbosa*, *Crotalaria striata*, *Blumea lacera*, *B. laciniata*, *Mollugo stricta*, *Ageratum conyzoides*, *Eclipta alba*, *Blainvillea*, *Trichodesma*, *Striga euphrasioides*, *Leucas* spp., *Calotropis gigantea*, *C. procera*, *Cynoglossum* spp., *Solanum indicum*, *S. torvum* (moister regions), *Vitex negundo*, *Anisomeles indica*, *Ærua lanata*, *Achyranthes aspera*, *Polygonum plebejum*, *Cyperus rotundus*, *Mariscus sieberianus*, *Eragrostis* spp., *Desmostachya*, *Urochloa repens*, etc.

The following especially in close-grazed grass:—

*Ionidium*, *Tribulus* (sandy ground), *Crotalaria acicularis*, *Desmodium triflorum*, *Zornia*, *Spermacoce* spp., *Chrysanthellum*, *Blumea oxyodonta*, *Heliotropium strigosum*, *Rungia parviflora*, *Eragrostis viscosa*, *Aristida setacea* (esp. on gravel), *Perotis latifolia*, *Chrysopogon acicularis* (esp. on damp ground).

b. Many are weeds only conspicuous in the rainy season, though some continue to flower and fruit into the cold season, e.g.:—

*Cleome*, *Gynandropsis*, *Portulaca*, *Trianthema*, *Melochia corchorifolia*, *Corchorus* spp., *Phyllanthus urinaria*, *P. simplex*, *Cassia occidentalis*, *C. tora*, *Berthaavia diffusa*, *Amarantus spinosus*, *Digera*, *Ipomæa pes-tigridis*.

c. The following especially occur on damp ground and several of the preceding may be found on damp ground in the h.s.:—

*Sida acuta*, *Triumfetta annua*, *Mollugo spargula* (sandy ground), *Blumea Hamiltoni*, *Xanthium strumarium* (esp., near river banks), *Centipeda*, *Launea nudicaulis*, *Centunculus tenellus* (damp banks), *Exacum petiolare*, *Ipomæa chryseides*, *Mazus*, *Adenosma*, *Lippia nodiflora*, *Clerodendron siphonanthus*, *Nepeta hindostana*, *Alternanthera sessilis*, *Commelina nudiflora*, *C. salicifolia*, *C. benghalensis*, *Ancilema vaginatum*, *Burmanna cælestis*, *Zeuxine sulcata*, *Eragrostis amabilis*, *E. gangetica*, *Isachne australis*, *Echinochloa colona*, *E. crus-galli*, *Paspalum flavidum*, *P. punctatum*, *Saccharum spontaneum*, *Imperata*, *Vetiviera*, *Eulalia Cumingii*, *Iseiloma Wightii*, *Manisuris*, *Ophiurus corymbosus*, *Cynodon dactylon* (on sand).

d. The following chiefly on dry ground:—

*Cocculus hirsutus*, *Triumfetta rotundifolia*, *Sida spinosa*, *Waltheria indica*, *Eleiotis sororia* (sandy ground), *Echinops*, *Coldenia*, *Cucumis*, *Coldenia*, *Heliotropium indicum*, *Evakulus alsinoides*, *Solanum xanthocarpum*, *Lepidagathis Hamiltoniana*, *Plumbago zeylanica* (among rocks), *Anisochilus carnosus* (ditto), *Dicliptera micranthes*, *Eragrostis tremula* (sandy ground).

## e. Ruins and rubbish heaps:—

*Fleurya interrupta*, *Lindenbergia*.

f. The following are naturalized in waste ground, often remote from villages:—

*Jatropha gossypifolia*, *Anona squamosa* (sandy soils), *Argemone mexicana*, *Parkinsonia aculeata* (cotton soil), *Mimosa pudica* (more humid districts only), *Tridax procumbens*, *Martynia diandra* (r.s.), *Hyptis suaveolens*, *Datura fastuosa*; *Scoparia dulcis* (r.s.), *Alocasia macrorrhiza* (wet ground near villages).

3. Marshes, margins of tanks, etc. (see also moist waste ground):—

*Ranunculus sceleratus* (N.T. only), *Polycarpon laciniatum*, *Ammania* spp., *Cyathocline lyrata* (but chiefly on rocks in shade along streams), *Grangea*, *Sphaeranthus*, *Gnaphalium*, *Cæulia*, *Jussiaea* spp. (*J. fissendocarpa* in Purneah only), *Smithia conferta*, *Pentapetes phænicea*, *Drosera Burmanni* (damp sandy ground), *D. indica*, *Osbeckia chinensis*, *Sphenoclea*, *Hydrolea*, *Dopatrium*, *Limnophila gratioloides*, *L. sessiliflora*, etc., *Asteracantha*, *Hygrophila angustifolia*, *H. quadrivalvis*, *Lippia geminata*, *Chenopodium ambrosioides*, *Polygonum* spp., *Ficus heterophylla*, *Sagittaria*, *Butomopsis*, *Typha*, *Phragmites* (near running water), *Elytrophorus*, *Leersia hexandra*, *Isachne australis*, *Sacciolepis*, *Hymenachne*, *Panicum repens*, *P. proliferum*, *Floscopa scandens*, *Xyris pauciflora*, *Monacharia hastata*, *M. vaginalis*.

4. Saline marshes. The only saline marshes are those coming into the area of greatest humidity (see p. 58).

5. Rivers (excluding true aquatics. See also marshes):—

a. River banks:—

*Ranunculus sceleratus* (N.T. only and banks of Sone), *Cochlearia flava*, *Pulicaria foliolosa* and *crispa*, *Celsia*, *Salvia plebeja*, *Cotula*, *Campanula canescens*, *Hygrophila polysperma*, *Vitex leucoxydon*, *Rumex maritimus* and *dentatus*, *Saccharum munja*, *Sorghum halapense*.

b. River beds (plants not in the water):—

*Dentella repens*, *Tamarix ericoides*, *Enhydra fluctans*, *Volutarella*, *Cryptocoryne* (also under water as an aquatic), *Eragrostis stenophylla*, *Nephrodium proliferum*.

c. River beds, plants with roots in the water:—

*Wedelia calendulacea*, *Spilanthes acmella*, *Veronica anagallis*,\* *Sutera glandulosa* (and marshes), *Polygonum hydropiper*, *P. glabrum*, *Cyperus tegetum*, *Phragmites*, *Crinum defixum*.

d. On or among the rocks of rocky river beds:—

*Homonnia*, *Rhabdia lycioides*.

6. Village lands:—

a. Cultivated:—

i. Rice-fields (mostly after the water has subsided. See also marsh lands):—

*Wahlenbergia*, *Hydrolea*, *Herpestis*, *Limnophila*, *Vandellia* and many other small *Scrophulariaceæ*, *Utricularia carulea* and other spp. (often climbing on the rice-stems), *Dysophylla verticillata*, *D. crassicaulis*, *Ammania* spp., *Blyxa oryzetorum*, *Elytrophorus*, *Panicum humile*, *Echinochloa colona*, *Ischaemum rugosum* (when dry), *Eriocaulon quinqueangulare*, *E. Sieboldianum*, *Cyanotis axillaris*, *Ancilema vaginatum*, *Ancilema spiratum* and others.

ii. On the bunds between the rice-fields:—

*Melochia corchorifolia*, *Canscora decurrens*, *Sopubia*.

\* Hooker speaks of a *Veronica* on the shaded banks of the Sone, probably *V. anagallis* var. *punctata*.

## iii. Higher level fields:—

† Chiefly in Northern tract:—

*Nigella*, *Fumaria*, *Capsella*, *Thlaspi*, *Saponaria*, *Stellaria media*, *Spergula arvensis* and *pentandra*, *Medicago lupulina*, *Cnicus arvensis*, *Convolvulus arvensis*, *Ageratum conyzoides*.

†† Also or chiefly in Central and Southern tracts:—

*Emilia sonchifolia*, *Cnicus arvensis*, *Anagallis arvensis*, *Vinca pusilla*, *Physalis minima*, *Solanum nigrum*, *Leucas cephalotes*, *L. aspera*, *L. linifolia*, *Orobanche* (root parasite, chiefly in tobacco fields), *Celosia argentea*, *Chenopodium album*, *Blumea oxydonta*, *B. lacera*, *Asphodelus tenuifolius*.

b. Uncultivated (hedges, spontaneous on trellises, etc.).

Pastures, rubbish-heaps and ruins are included under waste lands:—

*Cassia sophera*, *Capparis horrida*, *Kirganelia reticulata*, *Celastrus paniculata*, *Ichmocarpus*, *Pergularia extensa*, *Cryptolepis*, *Ipomæa obscura*, *I. hederacea*, *Peristrophe bicalyculata*, *Leonurus sibirica* (N.T. only), *Commelina suffruticosa*.

## III. AQUATICS:—

a. General:—

*Ceratophyllum*, *Naidaceæ*, *Hydrilla*, *Lagerosiphon*, *Vallisneria*, *Cryptocoryne* (also flowering after drying up of the water). Hooker mentions as occurring in the Kymore Hills *Damasonium* (*Ottelia*), *Villarsia* (*Limnanthemum*), *Aponogeton*, 3 species of *Potamogeton*, 2 of *Naias*, and *Zanichellia*.

b. Running water:—

i. In the forest under shade:—

*Eriocaulon riculare*.

ii. In the open:—

*Ottelia*, *Eriocaulon setaceum*, *Monocharia hastata* (slow running water).

c. Still waters:—

*Myriophyllum*, *Jussieua repens*, *Trapa*, *Limnanthemum*, *Ipomæa reptans*, *Achyranthes aquatica*, *Hydrocharis*, *Pistia stratiotes*, *Lemna*, *Hygrophiza aristata*, *Eichornia crassipes* (and back waters of rivers).

## 177. NUMBER OF GENERA AND SPECIES IN EACH FAMILY.

Family.	Number of genera.	Indigenous or feral species.	Species only cultivated.	Total described species.
<b>PTERIDOPHYTA:—</b>				
1. <i>Cyatheaceæ</i>	1	—	1	1
2. <i>Polypodiaceæ</i>	26	40	—	40
3. <i>Parkeriaceæ</i>	1	1	—	1
4. <i>Gleicheniaceæ</i>	1	1	—	1
5. <i>Schizeaceæ</i>	1	3	—	3
6. <i>Marattiaceæ</i>	1	1	—	1
7. <i>Ophioglossaceæ</i>	3	4	—	4
8. <i>Salviniaceæ</i>	2	3	—	3
9. <i>Marsiliaceæ</i>	1	1	—	1
0. <i>Equisetaceæ</i>	1	2	—	2
1. <i>Lycopodiaceæ</i>	1	4	—	4
2. <i>Selaginellaceæ</i>	1	11	—	11
<b>Total</b>	<b>40</b>	<b>71</b>	<b>1</b>	<b>72</b>

Family.	Number of genera.	Indigenous or feral species.	Species only cultivated.	Total described species.
<b>GYMNOSPERMEÆ:—</b>				
1. <i>Cycadaceæ</i>	1	2	2	4
2. <i>Coniferæ</i>	3	1	3	4
3. <i>Gnetaceæ</i>	1	1	—	1
Total	5	4	5	9

**ANGIOSPERMEÆ:—**

DICOTYLEDONS:—				
1. <i>Ranunculaceæ</i>	5	10	—	10
2. <i>Dilleniaceæ</i>	1	3	—	3
3. <i>Magnoliaceæ</i>	3	1	2	3
4. <i>Anonaceæ</i>	8	15	1	16
5. <i>Menispermaceæ</i>	6	7	—	7
6. <i>Berberidaceæ</i>	1	1	—	1
7. <i>Nymphæaceæ</i>	3	5	—	5
8. <i>Papaveraceæ</i>	2	1	1	2
9. <i>Fumariaceæ</i>	1	1	—	1
10. <i>Cruciferæ</i>	11	15	2	17
11. <i>Capparidaceæ</i>	4	11	—	11
12. <i>Violaceæ</i>	2	3	1	4
13. <i>Bixaceæ</i>	2	1	1	2
14. <i>Flacourtiaceæ</i>	4	9	—	9
15. <i>Pittosporaceæ</i>	1	1	—	1
16. <i>Polygalaceæ</i>	2	8	—	8
17. <i>Caryophyllaceæ</i>	6	8	—	8
18. <i>Portulacaceæ</i>	1	4	—	4
19. <i>Aizoæceæ</i>	2	6	—	6
20. <i>Elatinaceæ</i>	1	2	—	2
21. <i>Tamaricaceæ</i>	1	3	—	3
22. <i>Hypericaceæ</i>	1	3	—	3
23. <i>Guttiferaceæ</i>	4	4	1	5
24. <i>Ternstroemiaceæ</i>	1	—	1	1
25. <i>Dipterocarpaceæ</i>	1	1	—	1
26. <i>Malvaceæ</i>	13	36	9	45
27. <i>Sterculiaceæ</i>	12	22	3	25
28. <i>Tiliaceæ</i>	5	29	1	30
29. <i>Euphorbiaceæ</i>	42	86	17	103
30. <i>Callitrichaceæ</i>	1	1	—	1
31. <i>Linaceæ</i>	4	3	2	5
32. <i>Malpighiaceæ</i>	4	3	2	5
33. <i>Zygophyllaceæ</i>	4	3	1	4
34. <i>Geraniaceæ</i>	4	5	2	7
35. <i>Balsaminaceæ</i>	1	1	—	1
36. <i>Rutaceæ</i>	15	19	3	22
37. <i>Simarubaceæ</i>	1	1	—	1



Family.	Number of genera.	Indigenous or feral species.	Species only cultivated.	Total described species.
38. <i>Ochnaceæ</i>	1	2	—	2
39. <i>Burseraceæ</i>	4	5	1	6
40. <i>Meliaceæ</i>	13	17	?	18
41. <i> Icacinaceæ</i>	1	1	—	1
42. <i>Olacaceæ</i>	3	4	—	4
43. <i>Ilicaceæ</i>	1	1	—	1
44. <i>Celastraceæ</i>	5	7	—	7
45. <i>Hippocrataceæ</i>	2	3	—	3
46. <i>Rhamnaceæ</i>	6	13	—	13
47. <i>Ampelidaceæ</i>	2	25	—	25
48. <i>Staphyleaceæ</i>	1	1	—	1
49. <i>Sapindaceæ</i>	10	9	5	14
50. <i>Sabiaceæ</i>	2	2	—	2
51. <i>Anacardiaceæ</i>	8	8	—	8
52. <i>Moringaceæ</i>	1	1	—	1
53. <i>Papilionaceæ</i>	58	179	21	200
54. <i>Cæsalpiniaceæ</i>	15	28	17	45
55. <i>Mimosaceæ</i>	12	31	6	37
56. <i>Rosaceæ</i>	8	9	6	15
57. <i>Saxifragaceæ</i>	1	2	—	2
58. <i>Crassulaceæ</i>	2	3	—	3
59. <i>Droseraceæ</i>	2	4	—	4
60. <i>Halorrhagaceæ</i>	1	2	—	2
61. <i>Rhizophoraceæ</i>	6	9	—	9
62. <i>Combretaceæ</i>	6	11	2	13
63. <i>Myrtaceæ</i>	7	9	13	22
64. <i>Lecythidaceæ</i>	2	3	—	3
65. <i>Melastomaceæ</i>	4	9	—	9
66. <i>Lythraceæ</i>	6	16	2	18
67. <i>Onagraceæ</i>	3	6	—	6
68. <i>Turneraceæ</i>	1	1	—	1
69. <i>Passifloraceæ</i>	1	1	—	1
70. <i>Caricaceæ</i>	1	1	—	1
71. <i>Cucurbitaceæ</i>	14	20	6	26
72. <i>Begoniaceæ</i>	1	1	—	1
73. <i>Cactaceæ</i>	4	3	4	7
74. <i>Umbelliferæ</i>	12	19	4	23
75. <i>Araliaceæ</i>	5	4	2	6
76. <i>Cornaceæ</i>	1	2	—	2
77. <i>Rubiaceæ</i>	32	66	9	75
78. <i>Compositæ</i>	58	92	11	103
79. <i>Stylidaceæ</i>	1	2	—	2
80. <i>Campanulaceæ</i>	5	12	—	12
81. <i>Plumbaginaceæ</i>	2	2	2	4
82. <i>Primulaceæ</i>	4	5	—	5
83. <i>Myrsinaceæ</i>	4	6	—	6
84. <i>Sapotaceæ</i>	4	5	1	6

Family.	Number of genera.	Indigenous or feral species.	Species only cultivated.	Total described species.
85. <i>Ebenaceæ</i>	2	10	2	12
86. <i>Styracæ</i>	2	3	—	3
87. <i>Oleaceæ</i>	6	14	1	15
88. <i>Salvadoraceæ</i>	2	2	—	2
89. <i>Apocynaceæ</i>	22	20	13	33
90. <i>Asclepiadaceæ</i>	23	34	2	36
91. <i>Loganiaceæ</i>	4	5	—	5
92. <i>Gentianaceæ</i>	6	12	—	12
93. <i>Hydrophyllaceæ</i>	1	1	—	1
94. <i>Polemoniaceæ</i>	2	0	2	2
95. <i>Boraginaceæ</i>	8	21	—	21
96. <i>Convolvulaceæ</i>	17	52	9	61
97. <i>Solanaceæ</i>	9	14	12	26
98. <i>Scrophulariaceæ</i>	25	55	6	61
99. <i>Orobanchaceæ</i>	2	4	—	4
100. <i>Lentibulariaceæ</i>	1	9	—	9
101. <i>Gesneraceæ</i>	3	3	—	3
102. <i>Bignoniaceæ</i>	12	9	20	29
103. <i>Pedaliaceæ</i>	3	2	1	3
104. <i>Acanthaceæ</i>	34	73	17	90
105. <i>Verbenaceæ</i>	17	40	5	45
106. <i>Labiataæ</i>	27	61	8	69
107. <i>Nyctaginaceæ</i>	4	4	3	7
108. <i>Amurantaceæ</i>	10	21	1	22
109. <i>Chenopodiaceæ</i>	7	7	4	11
110. <i>Phytolaccaceæ</i>	1	1	—	1
111. <i>Polygonaceæ</i>	4	23	2	25
112. <i>Podostemonaceæ</i>	1	1	—	1
113. <i>Aristolochiaceæ</i>	1	3	—	3
114. <i>Piperaceæ</i>	2	6	2	8
115. <i>Lauraceæ</i>	8	11	3	14
116. <i>Hernandiaceæ</i>	1	1	—	1
117. <i>Proteaceæ</i>	1	1	—	1
118. <i>Eleagnaceæ</i>	1	1	—	1
119. <i>Loranthaceæ</i>	2	7	—	7
120. <i>Santalaceæ</i>	2	2	—	2
121. <i>Balanophoraceæ</i>	1	1	—	1
122. <i>Ulmaceæ</i>	3	5	—	5
123. <i>Cannabinaceæ</i>	2	1	1	2
124. <i>Urticaceæ</i>	8	14	—	14
125. <i>Moraceæ</i>	8	30	9	39
126. <i>Salicaceæ</i>	1	1	—	1
127. <i>Casuarinaceæ</i>	1	1	—	1
128. <i>Ceratophyllaceæ</i>	1	1	—	1
<b>Total</b>	<b>819</b>	<b>1585</b>	<b>271</b>	<b>1856</b>

Family.	Number of genera.	Indigenous or feral species.	speci only cultiva	d
MONOCOTYLEDONS :—				
129. <i>Alismaceæ</i>	4	7	—	7
130. <i>Naiadaceæ</i>	5	16	—	16
131. <i>Hydrocharitaceæ</i>	6	8	—	8
132. <i>Araceæ</i>	22	24	7	31
133. <i>Lemnaceæ</i>	2	6	—	6
134. <i>Typhaceæ</i>	1	2	—	2
135. <i>Pandanaceæ</i>	1	2	—	2
136. <i>Cyclanthaceæ</i>	1	1	—	1
137. <i>Palmaceæ</i>	11	15	5	20
138. <i>Cyperaceæ</i>	16	120	—	120
139. <i>Gramineæ</i>	90	207	11	218
140. <i>Eriocaulaceæ</i>	1	11	—	11
141. <i>Xyridaceæ</i>	1	3	—	3
142. <i>Flagellariaceæ</i>	1	1	—	1
143. <i>Commelinaceæ</i>	6	19	2	21
144. <i>Juncaceæ</i>	1	2	—	2
145. <i>Liliaceæ</i>	19	19	13	32
146. <i>Hæmadoraceæ</i>	1	1	—	1
147. <i>Stemonaceæ</i>	1	1	—	1
148. <i>Pontederiaceæ</i>	2	3	—	3
149. <i>Amaryllidaceæ</i>	17	13	14	27
150. <i>Taccaceæ</i>	1	1	—	1
151. <i>Bromeliaceæ</i>	2	0	2	2
152. <i>Dioscoreaceæ</i>	1	11	2	13
153. <i>Burmanniaceæ</i>	1	1	—	1
154. <i>Iridaceæ</i>	3	0	3	3
155. <i>Musaceæ</i>	3	2	3	5
156. <i>Zingiberaceæ</i>	9	31	5	36
157. <i>Cannaceæ</i>	1	1	—	1
158. <i>Marantaceæ</i>	4	3	2	5
159. <i>Orchidaceæ</i>	28	70	3	73
<hr/>				
Total Monocoty- ledons	262	601	72	673
<hr/>				
Total Angio- sperms	1241	2186	343	2529

## CHAPTER V.

## NOTES ON THE HAZARIBAGH AND MONGHYR FLORAS.

178. There is a very good account of the Botany of the Hazaribagh district in the *Gazetteer* (1917) by the Rev. S. L. Thompson, formerly Principal of St. Columba's College, Hazaribagh, which I have not reproduced as it is readily accessible. In this he states that there are no less than 11 *Utricularias*, two of which have not been reported from the province and are very minute, growing among moss. Unfortunately he does not enumerate the species, especially as the present Flora only records 9 species of *Utricularia* from the whole province. Mr. Thompson's full results would have been a welcome contribution to this book had they been available. The following passage of Mr. Thompson's account bears on the subject of the pitiful devastation of the forests: "Unfortunately no report on the Hazaribagh flora can omit the most striking fact about it, *i.e.* its rapid disappearance. The forest is being most wastefully destroyed, and with it a great number of plants of great botanical and economical interest are becoming extinct. Mutilated stumps are all that remains of many valuable trees like *Dillenia aurea*, *Sterculia villosa*, *Kusum*, *Paisar*, *Dalbergia latifolia*, *Soymida* and *Ailanthus excelsa*, where even ten years ago there was considerable jungle. Whether one considers the disastrous effect on the cultivated fields lying below the ruined jungle, or the loss to the villagers of their invaluable forest produce, or merely the botanical loss, this is by far the most important fact about the vegetation of Hazaribagh."

179. For the most part the other accounts of the Botany in the district gazetteers are meagre, and antiquated in nomenclature. The source of the information is rarely given, but there are seldom positive errors as, for instance, the allusion to the "graceful festoons of *Spiræa* and masses of Cactus in the Caya Hills," where, no doubt, the *Porana* and *Euphorbia* are alluded to.

180. A general description of the botany of Monghyr is given in the *Forest Flora of Monghyr* (*Statistical Reporter*, 1877), and also a more detailed account by Buch-Hamilton in his MS., which are here partly reproduced. In the first publication the author states that among survivals the Cotton tree, spectre tree (*Sterculia urens*) and screwpod (*Helicteres*) are common on all sides, while many other species of *Hibiscus* appear as annuals or undershrubs. The pea family, after the mallows, is the commonest of all, and here we have tamarind, Indian laburnum, flame tree (*Butea*), purple azalea pea (*Bauhinia variegata*), and many acacias and mimosas. Nor must the Karzanis (*Abrus precatorius*) be forgotten as its vermilion seeds are conspicuous in every part of the jungle during the cold season. The frankincense tree is found throughout the hills; as fuel it gives out such dense clouds of smoke that nobody cares to burn it. Next in numerical order come the Dog-banes, which are always conspicuous in the cold weather with their long pods enclosing seeds winged with a tuft of silken hairs. These when ripe burst open and are borne by the wind to any square

inch of ground that may be without a tenant. The Peruvian bark family is well represented. The Nepaul lilac (*Hamiltonia suaveolens*) is one of the few common plants with fragrant flowers which adorn the hills in the cold season, and when this and the red chamber candle (*Holmskioldia*) grow side by side, they stand out in beautiful relief against the background of dark green trees. Then belonging to this family is the Indian cinchona (*Hymenodictyon*), which may always be recognized during the cold season by its brown capsules containing winged seeds hanging in clusters on the wintry leafless branches. An account of the trees would be incomplete without mention of the *Terminalias*, which, given fair play, would grow into large trees. There is the fly-wheel *Terminalia*, whose winged fruit looks like the miniature screw of a steamer, and the dhao, which is very common, and commands as fuel by far the best price in the Monghyr market.\* Then there are the tan trees (*Terminalia bellerica* and *chebula*), which, however, are becoming scarce. There is also the Kawa (*T. Arjuna*).

181. The author then proceeds to give a list of 153 trees and shrubs, from which I have selected the following most interesting or characteristic (he included a large number of cultivated ones) with his remarks, and added the names where necessary†:—

*Tinospora cordifolia* (Guruj), *Capparis horrida* (Bagnai), *Flacourtia Ramontchi* (Baincha; Banj Baincha is the male), *Tamarix dioica* (Jhau) on diaras along the Ganges. Sal, Sakwa; all the forests are properly speaking Sal forests, but it would be difficult to find half a dozen full-grown trees left. *Kydia calycina* (Dhamin), *Sterculia urens* (Mogul, Karaunji), *Helicteres* (Ainthia dhamin), *Hiptage madablota* (madmalta), *Zanthoxylum alatum* (Gaira) [no doubt *Limonia acidissima*], *Grewia pilosa* (Ghorkund): [probably *Grewia hirsuta*], *Murraya exotica* (Ban mirchi). *Feronia elephantum*, not uncommon in the jungles. *Ægle marmelos*, common. *Boswellia serrata* (Sale). *Balsamodendron mukul* (gugal) in the gardens. *Ola scandens* (Arthil, chigas). *Zizyphus cænoplia* (markhoa). *Z. xylopyra* (Ghunt), common. *Schleichera trijuga*, most of the large trees cut down. *Sapindus laurifolius* (Rirha), cultivated. *Semecarpus anacardium*, common. *Buchanania latifolia* (Piar), most of the large trees cut for timber and fuel [sic]. *Butea frondosa* and *B. superba*. *Ougeinia dalbergioides*, not uncommon in the hills. *Cæsalpinia bonducella*, common in hedges (kat kareza). *Colvillea racemosa*, thrives well in Monghyr. *Acacia Farnesiana* (Guhya Babul). *A. Catechu*, very common on the hills. *Combretum decandrum* (Madlat). *Woodfordia floribunda* (Dhaura). *Randia dumetorum* (Man), common. *Embelia robusta* (Babari). *Diospyros melanoxylon* (Kend, Abnus), common. *D. montana* (Makr Kend), not uncommon. *Carissa diffusa* (Karaundas), general in the hills [probably *C. paucinervia* var. *opaca*]. *Wrightia tomentosa* (Dudh Koraiya), rare. *W. tinctoria* (Chhota dudh Koraiya). *Holarrhena antidysenterica* (Dudhi). *Ichnocarpus frutescens* (Dudh latta). *Calotropis gigantea* and *C. procera* (Madar), common. *Marsdenia tenacissima* (Sitti, har chikkar), occasional on the hills. *Porana*

\* Apparently the *Anogeissus latifolia* was considered to be a *Terminalia*.

† My own remarks are in square brackets.

*paniculata* (Burhi lat). *Stereospermum suaveolens* (Parar). *Clerodendron phlomidis* (Bhant), at Bhimband in Kharakpur Hills. *Cl. infortunatum* (Tit bhant) in every grove and hedge. *Streblus asper* (Sahora). *Ficus repens* (khoksa) in marshy country north of the Ganges [see under *F. heterophylla*]. *Sponia* (*Trema*) *orientalis* (Jhungjuni). [Hamilton refers to "Jhungjuni as the large-leaved *Grewia orientalis* mentioned by Willdenow. A small useless tree growing about villages in Bhagalpur." I don't know which *Grewia* he can mean by this.] *Croton oblongifolius* (Puter). One of the most abundant trees in the hills, chiefly as an undershrub owing to being cut. *Jatropha glandulifera* (Belati bagandi), said to have been introduced about 30 years ago, now found all over the district. *Briedelia retusa* (Khaj) common in the hills. *Phyllanthus emblica* (Aura), general. *Breynia rhamnoides* (Sikkat), hedges. [I suspect this is *Kirganalia*.] *Salix* (Bes), North-east of Ganges. [No doubt *S. tetrandra*.]

182. The following additional plants\* and information or additional vernacular names are added from Buchanan-Hamilton's MS. of the survey of Bhagalpur, which then included Monghyr and the Santal Parganas.

The most common wild bamboo is called "Tanai bangs" [no doubt *Dendrocalamus strictus*]. "Khajur" (*Phoenix sylvestris*). It does not sucker like the true date. Abundant. Is fit for being tapped when 10 years old, and lasts 20 years more. Season commences beginning of October and lasts 5 months or more. The juice is called Mitha Tari [sweet toddy]. "Tal" or "Tar" (*Borassus*) perhaps as common as last. Far less tapped and juice less sweet. Begins to yield about the middle of March and season lasts 2 months. Begins to flower between 25 and 40 years old, and continues to a great age. The spadix is cut 3 times a day from the point of the unopened spathe until it withers. New spadices shoot in succession. In Bhagalpur only the male spadices are cut, but I am told that after fruit ripens in Aug. or Sept. the female may be cut.

183. "Harila" (*Terminalia chebula*). [Hamilton considers the tree different from the "Haritaki" of Bengal and the Mysore tree.]

*Terminalia tomentosa*, "Asan." [The system of pollarding the trees described by him for feeding the Tasar is the same as is practised in Chota Nagpur; his account of the ritual observed is full and interesting. He discriminates between the "Kahu" and the "Arjan" (*T. arjuna*). He says the latter tree more resembles the "Kahu" than it does the "Asan," and was only seen in the south-east of the district. But I consider that these are two vernacular names for the same tree. I have, however, observed hybrids of *T. arjuna* and *T. tomentosa*, and his Kahu may have been one of these].

[Similarly he says that "Dha" must be distinguished from "Dhao," but may belong to the same genus. He says the latter is the name used by the Northern Mountaineers (by which term he refers to the

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\* The determinations are mine own. These were made easy by Hamilton's remarks and classification.

Mal Paharias of the northern Santal Parganas). "Dha" and "Dhao" also I consider to be the same tree, viz., *Anogeissus latifolia*.]

184. "Morawa" of the Mungger Hills [he describes as a fine species of *Vitex* seen nowhere else. This is doubtless the *Vitex glabrata*, probably now extinct in Monghyr, though still found in the Rajmahal Hills.]

"Dantranga," *Ehretia levis*. The bark used to stain the teeth red. *Schrebera* called, "ja" in the woods of Bangka and "Ghatera" in south of Mungger is very common in the former. It is allied to the *Bignonia* and has not the smallest affinity to *Schrebera albens* of Willdenough. [ja is doubtless *Schrebera swietenoides*, while "Neuri," which he mentions later on as *Schrebera albens*, Willd. is *Elæodendron glaucum*, common in the woods of Bangka. Banka or Bangka (as spelt by Hamilton) is shown on the map attached with a range of hills and some unreserved jungle on them in the south of Bhagalpur.]

185. *Strychnos nux-vomica*, "Kungchla," common in the southern hills. [This record is interesting as the tree is now only abundant in Puri.] "Mahal" or "Mahuya," *Bassia latifolia*, in great quantities.

*Mimusops elengi*, "Maleswari" at Bhagalpur, but in the woods of the south "Baul." This reference to *M. elengi* as wild in the southern part of Bhagalpur is interesting as the tree is usually not considered wild north of the Deccan.

"Khirni" or *Achras dissecta*, Willd. is evidently *Mimusops hexandra*. He says "woods of Mungger, very common and fruit sold on the market. Coarse furniture made from the wood."

"Makarkand, *Diospyros cordifolia*, fruit excessively bitter." [Possibly this is *D. montana*, which is not otherwise mentioned, although another Makarkand is referred to. This latter was one of the *Rubiaceæ* but the information given is insufficient to identify it.] "Gab," *Diospyros embryopteris*. "Kend," *D. melanoxylon*, produces a black heart called "abnu:" [ebony].

"Hyal," *Barringtonia acutangula*, on the banks of every river and in the marshy woods on the north side is the only tree that grows.

186. In the drier woods one of the most common trees is called "Dungruki" in Lakardewani and "Harhar" near Mungger. It is a species of *Gardenia* close to the "Dhaniya" of Purneah and perhaps the same. The fruit possesses saponaceous quality. Wood formerly used for sepoy drums and even now is employed for the hoops. It is very flexible and does not split. [This must be, I think, *Gardenia turgida*.] "Popro," a very common hill species [is certainly *G. latifolia*.] "Pindar" or "Pindalu," *Gardenia uliginosa* [*Randia uliginosa*]. "Gulte Karam," wood better than that of "Karam" (*Adina*) [is *Mitrogyna parvifolia*]. He then enumerates the following *Rubiaceæ*: 52. "Tilai." 53. "Khangta," a species of *Ixora*, *I. arborea* of Dr. Roxburgh's MS. 54. Another called "Chhota Khongtu." 55. A third called "Maruya." 56. Towards Virbhum, a tree called "Burha," greatly resembling the last, but without flowers or fruit. 57. "Makarkand" (see para. 185), no fl. or fr. 58. "Putal." 59. "Banakangro." [These I can only partly

identify as 52. *Wendlandia* sp. 53. *Ixora parviflora*. 54, probably the same as 53, 55 and 56. *Pavetta indica*. Nos. 57—59 I cannot identify, but one is likely to be *Canthium didymum*.]

*Garcinia* sp., each berry with 4 seeds [probably *G. Cowa*].

"Sakuya," *Shorea robusta*. Resin extracted from trees not thicker than a man's arm, by cutting a ring of bark 6" wide about 2 ft. from the ground. I everywhere saw trees cut. The dhuna (resin) is used as incense. [Cp. p. 59.]

"Tita kangta" or "Gira," *Limonia acidissima*.

"Sale, Salhar, or Sondar," *Boswellia serrata*. [Yields gum which Buchanan-Hamilton rightly insists is not the *Olibanum* of the bazars or the true *Olibanum*. The latter is probably imported from Arabia. According to Colebrooke (*Asiatic Researches*, vol. ii), whom he refutes, the olibanum, or frankincense of the ancients, was the product of this tree. Much olibanum is imported into Bombay from Somaliland.]

"Phulka," *Sterculia colorata*, hills of Monghyr.

187. "Hiran" or "Chhota Gandhai" and "Gandhai" or "Gandhana Hiran" are described as species of *Uvaria*. He describes the first as very useful to the turner. [These trees are no doubt *Miliusa velutina* and *Saccopetalum tomentosum* respectively.] Further on he says that the "Hiran" of Lakardewani\* seems very different from that of Mungger (the first mentioned), and seems from its leaf to be rather a *Tomex* than an *Uvaria*. The fruit is said to be esculent. [This is probably *Litsæa polyantha*, which sometimes is called by the same vernacular name as the *Saccopetalum*, and the leaves of which have somewhat the same smell.] Two other species of *Lauraceæ* are mentioned: the "Gidha" "with somewhat the appearance of a *Laurus*, and leaves sometimes alternate, sometimes opposite or collected" [might be a *Machilus*, but none is known from Monghyr, and it is more probably *Litsæa sebifera*], and "Jugya of Banka, with alt. cordate leaves with the appearance of *Uvaria*." [I don't know what laurel this could be.]

188. The "Phalsa" of Monghyr is called in the woods of Banka "Dhaman." It grows to be a tree. [Apparently *Grewia Hainesiana*.] "Singgiya Dhaman" is stronger and is the *Grewia arborea* of Roxburgh's MS. [Probably *G. tiliaefolia*.] "Arhariya Dhaman" is also a *Grewia*. [There is a specimen of this in the Wallichian Herbarium called by Hamilton *Grewia araria*, collected May 26th, 1811. It is one of the critical forms and apparently *Grewia elastica* forma *a* of the Flora, p. 94, with leaves narrower than usual, or a hybrid of this and *G. Rothii*. I have met with exactly similar forms in other districts of the Central area.] "Jhungjhuni," see p. 73.

"Galgal," *Cochlospermum Gossypium*.

189. "Thanki" is a very common tree throughout the southern woods, and the Tasar feeds on it. It is sometimes called Nilkar, and is also used in medicine. It is certainly the *Kasjavomaram* of Rheede. [This

\* Lakardewani was a large pargana to the south and east of Pargana Banka and partly in what is now the south of the Santal Parganas. It is dotted with detached rocky hills and was covered with wood in Hamilton's time.



latter is evidently a species of *Memecylon* and its occurrence in Monghyr is very interesting.]

"*Alangium tomentosum*" of the *Encyclopædia*, very common in the woods. Called "Dhela" and grows to a considerable size [= *Alangium Lamarckii*.]

"Sidda." Tasar often found on its leaves [*Lagerstrœmia parviflora*]. Nos. 107—110 are species of *Eugenia*.

Nos. 115—121 are species of *Acacia*. *Erythrina indica*, "Pharhar." Another species in the woods of Kharakpur, *E. alba* of Roxb. Near Birbhum it is called "Mandar" [*Erythrina suberosa*].

"Pangdan," leaves very like an *Erythrina*, but the flowers approach a *Glycine*. It is a fine tree, but has a kindred species which is an immense climber. [This is *Ougeinia dalbergioides*, and the climber, perhaps, *Butea parviflora*.]

"Paras," *Butea frondosa*, also has a kindred climber = *B. superba*.

"Murga" = "Paysar" of Kharakpur [*Pterocarpus Marsupium*].

"Chagalnadi" of the Mungger Hills is a *Dalbergia* of no use, but grows in all situations, on the parched rocks of Mungger and the half-drowned banks of Dhaka. [This can only be *D. lanceolaria*.]

"Jiyal" = "Doka" of Bangka and "Kasambar" in the woods of Tarapur, but the tree called "Kasambar" in Mungger and "Parmi" in Tarapur is different and = Katow Kalesiam of the *Hortus Malabaricus* (iv, pl. 33). [The first of these two trees is *Odina Wodier*, the second is *Garuga pinnata*.] "Amsaheri" of Mungger, "Saheri" of Bangka is a species of *Schinus*. Fruit eaten. Leaves and bark used in medicine. Timber takes a good polish. [It is probably *Bursera serrata*.]

190. "Kadrapala" in Bangka, *Clutia stipularis* [*Bridelia stipularis*]. "Namta," also a *Clutia*. Its berries are eaten; [is probably *Bridelia retusa*, though this species is often called Kadrapala]. "Haril" and another species of "Bradleya" [are species of *Glochidion*]. "Palasi" allied to "Aongla" (*Emblica*) [I cannot identify].

191. Hamilton enumerates 7 figs. which are referable to *F. bengalensis* ("Bar"), *F. Arnottiana* ("Khota pipar"), *F. religiosa*, *F. Rumphii* ("Pakar"), *F. infectoria* ("Pakar"), *F. glomerata* (Gular, Bara Dumar, Yog Dumar), also another fig allied to *F. glomerata* with "figs size of a small apple and also called Gular," and a fig called Gadha Bar, which is very common and also sends roots from the branches; [the latter is probably *F. tomentosa*].

"Chulmuli," of woods of Karakpur [*Holoptelea integrifolia*].

"Tilai" with very rough leaves [*Trema politoria*], "Chamari Tilai" [*T. orientalis*]. "Amtiya" in Bangka, "mamroja" at Mungger "kshir" in Purneah and "mangjari sag" by the physicians [*Antidesma dian-drum*]. "Matisura" of Bangka, "tarsi" of Mungger [*Antidesma Ghæsem-billa*]. "Pitangjira" [Putranjiva].

## CHAPTER VI.

## TAXONOMY AND CLASSIFICATION.

**Principles :** Arrangement should be phylogenetic, 192; Difficulties, 193; Parallel development, 194; The archegoniatae, 195; Relative age of Gymnosperms and Pteridophyta, 196—200; Gondwana-land, 197; Primofilices, 198; *Rhyniaceae*, 200; Hofmeister's theory, 201; Arrangement of the subdivisions of the Pteridophyta, 202; General arrangement of the Pteridophyta and Spermophyta according to Scott, 203; Arrangement of the subdivisions of the Pteridophyta based on Bower and Scott, 204—207. **The Angiosperms**, 208—221; Arrangement of the subdivisions of the Angiosperms, relative age indeterminate from geological record, 208; Similarity of Dicotyledons to *Gymnosperms* compared with Monocotyledons, 209; Points of resemblance of some orders to the *Gnetales*, 210—213; Points of resemblance of some orders to the *Cycadeoids*, 214, 215; View of Arber and Parkin, 216; View adopted in this Introductory Synopsis, 217; Arrangement adopted in the body of the Flora different, reasons, 218; Endlicher's system, 219; Hutchinson's outline, 220; Position of the Monocotyledons, 221. **The System adopted :—**  
**Synopsis of Classes, Orders and Families :** Main divisions of the Vegetable Kingdom, 222; Pteridophyta, 223; *Lycopodineae*, 224; *Equisetineae*, 225; *Filicineae*, 226; *Spermophyta* or *Phanerogamia*, 227; Division of the Phanerogams, 228; *Gymnospermæ*, 229; *Angiospermæ*, 230 (p. 91); **Class Dicotyledones**, 231, pp. 92—147; Arrangement according to Bentham & Hooker, 232; Arrangement, based on preceding discussion, of the families occurring in Bihar and Orissa, 233; Conspectus of the Choripetalous groups, 234; (p.93.) Descriptions of Orders and Families of the Choripetalæ, 235 (pp. 98—133); Gamopetalæ, 236; Origin of the Gamopetalæ, 237; Conspectus of the Gamopetalous groups, 238; Descriptions of the Orders and Families of the Gamopetalæ, 239 (pp. 135—147); **Class Monocotyledones**, 240; Descriptions of Orders and Families of the Monocotyledons, 241 (pp. 147—157).

192. A philosophic natural classification should, if the theory of evolution be maintained, be based on that theory, and although no linear arrangement of families can adequately express the relation of different phyla, the arrangement should, so far as possible, be phylogenetic. The groups derived from the supposedly more primitive ancestors should logically come first. But as each phylum and its branches evolve, the later subdivisions will have receded much further from the original stocks than have some or all of the families of other phyla which, in a linear arrangement, have to be placed subsequently. Such returns to less evolved phyla, or breaks in a phylum, where it is necessary to take up a new group, can be partly indicated by a new heading, name of the new phylum, a break or line, and the supposed allied group or groups to which references back or forward should be made are sometimes also pointed to with an arrow.

193. The real difficulty of a phylogenetic arrangement is our ignorance of the true relationship of so many families and of the real origin of any of them.

194. Even the relative position of the main groups such as Bryophyta, Pteridophyta, Pteridosperms, Gymnosperms and Angiosperms, which once appeared satisfactorily settled, are again under discussion. It has even been suggested that the different groups of vascular plants have originated independently, and at different times in the history of

the world, from the marine algæ.\* It is asserted that such persistent, and on the whole uniform, morphological structures as the archegonium are not necessarily homogenetic, but that their similarity in structure through the most varied groups are merely cases of homoplasy or parallel development under the influence of constantly recurring conditions. In other words that, under given conditions, "there are a limited number of ways in which protoplasm can react."† Allied to this theory is that of *Phyletic Drift*. Bower (*Nature*, March 8th, 1924) states that by this term it is meant to convey that along a plurality of nearly related evolutionary paths, parallel but independent, a similarity of structure has been reached. He quotes as an instance the slide of the sorus from the margin of the leaf to the under surface, and says "there is no doubt that the primitive position was marginal; but along many phyletic lines . . . the sorus has passed . . . to a superficial position." That parallel development is of very frequent occurrence seems well established, but to find it on such a scale as is necessitated by this theory of the archegoniatae appears to imply a want of plasticity in Nature at variance with our experience of her marvelous versatility. Witness the extraordinarily various forms of sexual apparatus in the marine algæ themselves under more constant conditions than could ever have applied to a terrestrial flora, or the even more varied reproductive organs of the fungi. In no group do the archegonia closely resemble the oogonia of marine Algæ.‡

195. The forms of archegonia appear to have undergone a retrogressive evolution such, as might have been anticipated if the several phyla in which they occur were descended from some primitive archegonium-bearing stock. In the Bryophyta they are usually stalked and free and with a long multicellular neck. In the Pteridophyta the archegonia become sunk in the tissue of the thallus, the wall of the venter, which contains the oosphere, being formed from the tissue of the prothallium itself, bearing in fact such a relation to that of the Muscineae as (though the cases are totally different) an inferior ovary does to a superior ovary. Further, in the Pteridophyta there is a progressive shortening of the neck which consists, as in most Muscineae, of 4 rows of cells and a central canal (derived from a row of disorganized canal cells). This neck, shorter than in the Mosses, but consisting of several cells in length in the *Filices*, is only 2 cells in length in *Selaginella*. In the *Coniferae* again the archegonia are formed from single superficial cells of the contained prothallium exactly as in the more typical archegoniatae. Here also the neck consists of rosettes of 4 cells, but is reduced to one cell in length in some *Abietineae*. The conditions of life in coniferous and angiospermous trees would appear to be very similar as compared with fern prothallia and tall conifers, yet it is precisely between the Angiosperms and Gymnosperms that the biggest step has been taken in the evolution of the archegonia, which are now reduced to naked cells. Indeed the homology of these

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\* Church, Tansley. † Tansley, Jan. 19th, 1924. ‡ The freshwater algæ groups Chrotophoraceae and Coleochaetaceae are sometimes considered nearer to the line of descent of the Archegoniatae.

cells with archegonia is only deduced by their relation to other apparently homologous structures.

196. Granted that the Angiosperms are the youngest group and should be treated last in a phylogenetic arrangement, are the Gymnosperms or the *Pteridophyta* the older group? *i.e.* assuming that each of these really form homogenetic groups and do not consist of several phyla of independent origin as has been suggested.

197. Scott and other palæontologists have shown that many of the orders of Gymnosperms are of immense age. Many families of Gymnosperms and Ferns abound in the Mesozoic period; but in the Permian-carboniferous epoch the true Cycads and Conifers appear not to have arisen. There is, however, an important family, the *Cordaites*, with somewhat generalized characters and undoubtedly Gymnospermous. There is also a very important and remarkable class of plants, once supposed to be ferns, known as the Pteridosperms or Seed-ferns. These seed-ferns had large fern-like leaves, but the anatomical structure rather of Gymnosperms and, as it has since been abundantly proved, bore *true seeds* resembling those of Gymnosperms. Dr. Scott states that the *Cycadophyta* were probably derived from the great plexus of Pteridosperms. The Pteridosperms are well represented in our area in the intertrappean rocks of the Rajmahal Hills and in the Panchet and Damuda rocks (*vide* Geology, p. 7). They were apparently a strong constituent of the great *Glossopteris* flora which was characteristic of various regions separated now by the ocean, but which once perhaps formed parts of the hypothetical continent known as Gondwana-land. Possibly that continent itself now hides beneath the ocean the long-sought-for evidences of the primitive Pteridosperms and the origin of the Angiosperms.

198. The Pteridosperms are quite as strongly represented in the Lower Carboniferous as in the upper beds (though the evidence is mainly from anatomy) whereas Gymnosperms are very rare. They occur also in the Upper Devonian, and as far back as the early Devonian a single fossil (*Palæopitys Milleri*) was either a Gymnosperm or Pteridosperm. No connecting link has as yet been found between the Pteridosperms and the ferns except their remarkable similarity in leaf.

In the early Devonian there is no satisfactory evidence for the presence of the Filices, and even the Primo-filices (a group apparently of true ferns; their sporangia are furnished with an annulus composed of *two* rows of cells, but without any lamina to the leaves) have only been found as far back as the Upper Devonian, although allies of the Lycopods were already flourishing. Precursors of the Sphenophylls (allied to the early Horsetails) were also present in the Middle Devonian.

199. On the geological record alone, therefore, it would appear that the Gymnosperms are of quite as old a stock as, if not older than the Ferns, and on this record there appears to be some reason for supposing an independent origin not only for the Gymnosperms and *Pteridophyta*, but also for the Lycopods and Horsetails.

200. There is, however, a group of plants known as the Rhyniaceæ, the simplest and among the most ancient of land plants known, of which Dr. Scott writes, "it is possible to interpret the family as a synthetic

group, related to both the Vascular Cryptogams and the Bryophyta while still retaining some of the characters of the algal stock." Allied to or belonging to these Rhyniaceæ is a genus *Psilophyton*. The tips of the young branches were curled in a circinate manner like the young fronds of a fern. It had only small spines in the place of leaves—and we have already seen that the Primo-filices were without leaf lamina—and it bore long oval sporangia, often in pairs, on the ends of the fine branches. There is some evidence that this genus goes back to the Silurian, and if so, this would take the fern-stock lower down than is known for any Gymnosperm. But the general conclusion that one, who has himself no first-hand knowledge of fossil botany, comes to, is that the geological record is at present far too incomplete to settle the question: that if there is too little evidence to decide the monophyletic origin of the separate groups of Pteridophytes and Gymnophytes, still less is there direct evidence of connections between these and the several phyla of the marine algæ.\*

201. Where geological history fails us it is necessary to fall back upon general morphological structure and the ontology of existing plants, and to form some workable hypothesis of descent which will tally with known facts. "A working hypothesis is very useful in stringing facts together; if the thread breaks, a better one can often be found; it is the pearls that are of value, not the thread" (*Lodge*). For the general arrangement of descent of many of the groups Hofmeister's researches still appear to show a connected logical arrangement.

202. As to the arrangement of the Pteridophyta among themselves, the system most in accordance with Hofmeister's views is to commence with the homosporous *Filicineæ* and to end with the heterosporous *Lycopodineæ*. This is the arrangement in the body of this Flora, which, however, differs from that usually adopted by my treating all the really fern-like families, whether lepto-sporangiate (archesporium a single hypodermal cell of an axile row) or eu-sporangiate (archesporium a group of cells), before the *Hydropterideæ* or water-ferns, which totally differ in foliage and in the formation of sporocarps.

203. Hofmeister's system adopted by most pteridologists is not, however, in unison with what is now known of the geological history of the Pteridophytes. The true ferns appear to have originated later than the Marattiales, the Horsetails or the Lycopods.

The following is the arrangement of the larger groups of Pteridophyta and Spermophyta based on fossil evidence, according to Scott†:

Psilophytales	{	Rhyniaceæ.	
		Asteroxylaceæ.	
Lycoposida	{	Psilotales (?).	
		Lycopodiales.	
Sphenopsida	{	Equisetales	{
		Sphenophyllales	

\* Indeed there are not wanting biologists who maintain the thesis that organisms evolved first in fresh-water areas. See *The Causes and Course of Organic Evolution*, by J. M. Macfarlane, Chapter XI.

† *Studies in Fossil Botany*, third edition, ii, p. 395.

Pteropsida	{ Filicales. Pteridospermeæ Gymnospermeæ Angiospermeæ }	Spermophyta.
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Or, confining ourselves to existing Orders (and omitting Psilotales, which do not occur in our area), the Lycopodiales, Equisetales and Filicales are treated as three distinct phyla, but possibly all descended from a stock akin to the extinct Psilophytales, while there appears to be some connection, though with a large unfilled gap, between the modern Spermophytes and the Filicales, through the extinct Pteridospermeæ.

204. The above is somewhat at variance with the views of Hofmeister, who, it will be remembered, traced the descent of the seed-plants through allies of the heterosporous Lycopods. Heterospory has arisen, apparently as a parallel development, in all three phyla. Although not now existent in the Equisetales, it was prevalent in the extinct Calamostachys and other Calamariæ.

205. In the following pages the relative position of the families within the Filicineæ (based on Bower and Scott's views) is therefore different to that usually adopted in systematic works (and in the Flora). The Eusporangiate ferns, in spite of their more complicated or more modified sporangia or sporangia-bearing leaves, are concluded to be relatively ancient to the Leptosporangiate and usually more delicate ferns.

206. Scott states that various facts connect the Marattiales with the primo-filices; the latter (*Botryopteridaceæ*) occur commonly in the Lower Carboniferous, the Marattiaceæ are known in the lower Coal-Measures of the Upper Carboniferous, while ferns of the Polypodiaceæ have not been traced back further than the Jurassic rocks.

207. The order given by Bower for the Filicales\* is (excluding families which do not occur in our area): 1. *Ophioglossaceæ*; 2. *Marattiaceæ*; 3. *Osmundaceæ*; 4. *Schizeaceæ*; 5. *Gleicheniaceæ*; 6. *Cyatheaceæ*; 7. *Polypodiaceæ*.

208. Turning to the relative position of the orders within the Angiosperms, geological evidence throws no light on the relative antiquity of the several groups. Dr. Scott remarks that the fossil history of the Angiosperms shows no signs of a beginning. The appearance of the most widely separated groups is said to be sudden and simultaneous, and what are universally believed to be younger groups occur in the same beds with what are believed to be primitive. Even *Gamopetalæ*, and actually the *Caprifoliaceæ* (*Viburnum*), are, if leaf diagnosis can be relied upon (which, however, is very doubtful), found as far back as the Cretaceous period! Highly evolved *Apetalæ*, like *Artocarpus* (in this case with both leaf and fruit), highly evolved Monocotyledons, like the reeds, as well as palms, arborescent *Liliaceæ*, etc., have all been found as far back as the upper Cretaceous. By the upper Cretaceous

\* Bower, *The Ferns (Filicales)*. Only Vol. I is published, but the author gives a tentative arrangement on p. 58, and this is practically the same as in his previous paper in *Phil. Trans.*, vol. 192, B (1899), and *The Origin of a Land Flora*, p. 653.

epoch the Angiosperms were already dominant! Before the lower Cretaceous they do not exist so far as the geological record at present has yielded up its history! No light is thrown even on the relative ages of Monocotyledons and Dicotyledons. The Monocotyledons are placed first in many arrangements, but it would appear to be the Dicotyledons which are nearer to the common stock of Angiosperms and Gymnosperms.

209. The wood of the Dicotyledons exhibits in its general structure and arrangement of the secondary wood a very strong resemblance to that of the Gymnosperms. The main difference is in the general absence of true vessels in the Gymnosperms, but these do occur in the *Gnetaceæ*, and it is of special significance that the wood of a few *Magnoliaceæ* consists entirely of tracheids with bordered pits as in most Gymnosperms. The leaves of *Gnetum* are very dicotyledonous in appearance, though in the continuous plate-like medullary rays of their vascular bundles are also gymnospermous in character.

210. The inflorescence and flowers of the *Gnetales* are very different to that of most Gymnosperms, and appear to partake of the character of some groups of Dicotyledons classed by Engler as primitive.

211. In *Gnetum scandens* (p. 1286) the integument (or inner integument of the nucellus, if there are two, see below) is prolonged into a very slender 3-toothed tube which makes it appear as the style and 3-lobed stigma of a closely investing ovary of a single ovule. This is surrounded by two tubular sacs of doubtful morphology, the inner being regarded sometimes as a second (outer) integument, and the outer sac as a rudimentary perianth which is not unlike the perianth of the female flower of some *Urticaceæ*. The male flower consists of a column terminating in two anthers and is surrounded by a single angular tubular sac or perianth. Both male and female flowers are whorled in the axils of annular bracts on paniced spikes.

The flowers are mixed with numerous cellular hyaline hairs, and the spikes with their numerous simple flowers remind one strongly of the catkins or spikes of some *Amentiferaæ*, *Piperaceæ* or *Chloranthaceæ*, but the resemblance is perhaps merely superficial. We might consider the second integument as an ovary open at the apex, but then the style-like organ should be borne on this ovary, whereas it is merely a pollen-chamber, such as is found in other Gymnosperms formed from the integument, but much produced. It is, however, just conceivable that the neck of the outer integument or of one of the outer sacs, by growing up similarly to that of the inner integument and gradually absorbing its function, may have been a mode of origin of some ovaries. One or both these outer sacs may be a single sporophyll or connate sporophylls, as there is evidently a tendency in the genus for cataphyllary leaves to become connate, as is seen in the annular bracts.

The *Gnetales* no doubt had an origin very far down the Gymnospermous line.

212. There are other Angiospermous characters in *Gnetum*, viz. the reduction of the archegonia to free cells and the 2-cotyledonous



embryo, and according to Seward, "it is in the *Gnetales* more than in any other Gymnosperms that we find features which help us to obtain a dim prospect of the lines along which Angiosperms may have been evolved."

213. If this be true, then the commencement of the Dicotyledons with such families as *Piperaceæ*, *Casuarinaceæ* and *Amentiferæ*, as is done by Engler, receives strong justification. *Casuarina* has several embryo sacs, and the ovule is orthotropous, *Juglandaceæ* has a single orthotropous ovule with only one integument, *Piperaceæ* has a single orthotropous ovule and its vascular bundles are in one or more rows. *Gnetum scandens* has alternating zones of wood and bast, reminding one of the structure in *Dalbergia paniculata*. Before leaving *Gnetum* it should be noted that the very long micropyle is surpassed in some palæozoic Pteridosperms, e.g., *Trigonocarpus* (probably the seed of an *Alethopteris*, which, in its turn, was the foliage of a *Medullosa* stem).

214. There are, however, striking analogies, if they are not more, between another group of the Angiosperms and more primitive Gymnosperms. Among the most interesting of the mesozoic fossils are the large group of *Cycadophyta* known as the *Cycadeoids*, first met with (in descending order) in the Cretaceous, and overlapping the appearance of the Angiosperms. Scott says that they may be called a dominant race as far back as the Trias, but below that their remains are scanty. They are divided into two tribes, the *Bennettitæ* and the *Williamsoniæ*. In outward appearance the *Bennettitæ* were like stumpy cycads (the crows' nests of the Isle of Purbeck belonged to them). At the risk of repetition\* Scott's very fascinating account of the flowers of the *Bennettitæ* may again be well reproduced:—

"The center is occupied by the gynæceum, seated on the convex receptacle, and consisting of numerous long-stalked ovules, imbedded among the interseminal scales. Surrounding this central body is the hypogynous whorl of stamens, fused below to form a tube, and expanding above into the pinnate sporophylls, bearing very numerous compound pollen sacs or synangia, filled with pollen. The whole is surrounded by an envelope of spirally arranged bracts, springing from the upper part of the peduncle. The general arrangement of parts is manifestly just the same as in a typical angiospermous flower, with a central pistil, hypogynous stamens, and a perianth. The resemblance is still further emphasized by the fact, long known, that the interseminal scales are confluent at their outer ends, to form a kind of pericarp or ovary wall. When to these general features we add the practically exalbuminous character of the seed, with its highly organized, dicotyledonous embryo, the indications of affinity with the higher flowering plants become extremely significant. The comparison was drawn by Dr. Wieland in 1901, immediately on his discovery of the hermaphrodite flower. The flower, with its great stamens 10 cm. long in some species, must have been a striking object when it opened. As, of course, we can know nothing of the coloration of the perianth

\* This was reproduced in my *Forest Flora of Chota Nagpur*, p. 44. The original was published in the *Journal of the Microscopic Society*, April, 1907, p. 139.



and other parts, we cannot tell how brilliant its appearance may have been; the bright tints of the carpels and ovules in some recent cycads suggests the probability that the attraction of colour was not wanting to the more elaborate flowers of the older *Cycadophyta*."

215. In this case, again, there is difficulty in tracing any homology between the sporophylls of the gynæceum and the carpels of an Angiospermous ovary. The sporophylls are apparently the stalks of the ovules which thus each bear but a single terminal macrosporangium. However, it again has to be remembered how very imperfect is the material; how, of the many millions of plants existing in the mesozoic epoch, but a few score are known, and it seems quite possible that other groups of allied *Cycadophyta* existed at that time with quite differently constructed gynæcium. As to the rest of the flower, it seems reasonable to read into it a real homology with some of the large-flowered Angiosperms, and as the gynœcium is at least apocarpous, there is an extraordinary similarity between such *Bennettitean* flowers, and such as one would expect in an early type of flower among the *Ranales*, especially the *Magnoliaceæ*.

216. In a most interesting paper on the origin of the Angiosperms by Newell Arber and John Parkin, the *Nymphæaceæ*, *Magnoliaceæ* and other polycarpicæ among Dicotyledons, *Alismaceæ*, *Butomaceæ*, and *Palmaceæ* among Monocotyledons are taken as exhibiting many primitive features, while the *Piperales*, *Amentiferaæ*, *Araceæ*, etc., with very simple flowers, are regarded as derived from phyla with more complicated ones by a process of reduction. The dicotyledons generally exhibit such a network of cross alliances that it is almost impossible, if more than one origin is ascribed to them, e.g. partly from a stock resembling the *Bennetiteæ*, or the more generalized *Williamsoniæ*, and partly from a stock allied to the *Gnetales*, to separate in many cases the derivatives of one stock from the other. One fact especially appears to me to be in favour of the theory of the Englerian view of the relative primitiveness of the *Casuarinaceæ*, *Juglandaceæ*, etc., and on the other hand, to militate against the position here assigned to the *Ranales*, is the existence in the former of single erect orthotropous ovules, and in the latter of anatropous or amphitropous ovules. The last are evidently a much more recent type.

217. On the whole, if the Angiosperms are derived from a single stock, the view taken by Arber & Parkin appears to meet most of the facts, and Scott states that "it is interesting to note that Arber & Parkin's hypothetical reconstruction of the flower of a hemi-angiosperm agrees almost exactly as regards the structure of the stamens, with the subsequently discovered *Williamsonia mexicana* of Wieland.

That there are striking analogies between the Angiosperms and the *Cycadeoids* is undeniable. It is also true that the analogies become accentuated if we take into consideration the older and more generalized *Williamsonians* rather than the more specialized *Bennettiteans*. But, after all, a wide gap remains. We cannot be certain that there is anything more than parallel development. . . . But it may be that a real affinity exists, that the *Cycadeoids* and the Angiosperms are branches of a common stock."

This is the view taken in the following synopsis, which starts with the *Ranales*.

218. The arrangement, however, adopted for the Dicotyledons in the body of the Flora is, with a few exceptions,\* that of Bentham & Hooker in the *Genera Plantarum*, which, in its turn, is based on that of A. P. de Candolle. This is the arrangement used in most English herbaria and most English systematic works on the flowering plants. For that reason English field botanists find it convenient for new floras to follow the same sequence. But although the arrangement of the *Genera Plantarum* also begins with the *Ranales*, or rather part of the *Ranales*, there are several objections to the system as a natural arrangement, the chief of which is the artificial group of the *Apetalæ*. Petals may be present or not in the same species, and, although exceptions occur to the characters of groups in any arrangement, the apetalous division undoubtedly separates entirely nearly allied families. Moreover in many other instances the arrangement does not apparently profess to be phylogenetic. It if were, specialized families like the *Papilionaceæ* should not be treated before their more generalized allies, like the *Mimosaceæ*. The arrangement of the *Genera Plantarum* even put the Gymnosperms between the Dicotyledons and Monocotyledons.

219. The more modern and most serious competitor to the Hookerian system at present in the field is that German system of Endlicher, adopted more or less closely by Engler in *Die Natürlichen Pflanzenfamilien*, and by Strasburger, Warming and other European botanists. This is supposed to be phylogenetic (as far as a linear system can be), but Engler begins the Angiosperms with the Monocotyledons, and Dicotyledons with Peppers, *Amentiferæ*, etc., which he believed to be primitive, whereas, as discussed above, other botanists consider that the apparent simplicity of their flowers is a derived character. Moreover Engler begins the Angiosperms with the Monocotyledons, whereas it appears that if the *Cycadophyta* are somewhere near the line or origin, the Dicotyledons are the more primitive type. In the following synopsis of Angiospermous families therefore the arrangement starts with *Ranales*.

220. Unfortunately there is no systematic work at present published which commences the phylogenetic arrangement of the Angiosperms with the *Ranales*. Recently Mr. Hutchinson has taken up such a classification in the *Kew Bulletin* (see Nos. 2 and 7 of 1923, and 2 of 1924), and I should have reproduced it here in place of the present synopsis, but his groups are not at present sufficiently defined, and it seems to me that the adoption of the two main parallel phyla, a woody one and a herbaceous one, is unsatisfactory. At present, also, the classification is not in a form likely to help the field botanist. I have, therefore, fallen back in the main on the classification adopted in my *Flora of Chota Nagpur*, which I am glad to see in many respects

\* E.g., the *Euphorbiaceæ*, in view of the frequent presence of petals, are treated in the *Thalamifloræ*, the *Samydaceæ* are combined with the *Flacourtiaceæ*, the *Placoidæ* or *Aizoaceæ* are placed near their allies, the *Portulacaceæ*.

corresponds with that of Mr. Hutchinson. But that classification which was carried into the body of the Flora attempted to conserve, for the convenience of those who know the Hookerian system, more of that system than now seems necessary for a mere conspectus of families. I have therefore further modified it, and where possible have adopted many of the views of Mr. Hutchinson.

221. The Monocotyledons follow the Dicotyledons, and there seems little doubt that their nearest allies among the Dicotyledons is to be found in the *Ranales*, although some botanists here, again, treat the points of resemblance as parallel developments.\* If there be an affinity, as I believe, it is natural to commence the Monocotyledons with the families which best show it, viz. the apocarpous *Alismaceæ* and their allies. Erect orthotropous ovules are very rare in Monocotyledons (e.g. some *Araceæ*).

### CONSPECTUS OF ORDERS AND FAMILIES.

222. The vegetable kingdom may be divided into five† main divisions, viz. *Mycetozoa*, *Thallophyta*, *Bryophyta*, *Pteridophyta*, and *Phanerogamia*. Included in the large division of the *Thallophyta* are the fungi, a group of importance to the forester, but not sufficient is known of the fungi of Bihar and Orissa to deal with them. The *Bryophyta* include the mosses and liverworts—a group, so far as is known, of little importance in our area. The descriptions are therefore limited to the *Pteridophyta* or Vascular Cryptogams (Ferns and Fern allies) and to the *Phanerogams* (Flowering or Seed Plants).

#### 223. I. PTERIDOPHYTA (pp. 87-89).

Distinct alternation of sexual and asexual generations. Sexual generation represented by a small thalloid expansion (prothallium), rarely tuberous, without differentiation into stem and leaves, occasionally not even becoming free of the spore. It bears archegonia and antheridia on the same or different individuals, and after fertilization of the oosphere of the archegonium (which then becomes an "oospore") gives rise by repeated segmentation of the oospore to the embryonic asexual plant. The asexual generation becomes well developed and relatively large (it is the Fern, Club Moss, Horsetail, etc., as popularly known) and is usually clearly differentiated into stem or rhizome, leaves and roots, and has an internal vascular system. It bears spores inside "sporangia" situated on the back of or on the margin or at the base

\* This is the view of Rendle, who states "the resemblance cannot be regarded as indicating any affinity. It is rather a coincidence." (*Classification of Flowering Plants*, i, p. 213.)

† Some biologists would add, and start with, a sixth main division, the *Schizomycetes*, which include the well-known bacteria or bacilli. The position of the *Mycetozoa* in the vegetable kingdom is sometimes disputed. They appear to be derived from naked amoebæ.

of leaves or modified leaves (sporophylls). These spores may be all similar homosporous, or they may be of two kinds—macrospores (or megaspores), which only produce female prothallia (*i.e.* prothallia bearing archegonia, but not antheridia), and microspores, which only produce male prothallia (*i.e.* prothallia bearing antheridia only). The *Pteridophyta* are divided into 3 principal classes (*vide* p. 80, 81), viz.:

1. Leaves simple, close, and small relatively to the axis. Sporangia at the base of the small sporophylls which are grouped into a terminal spike, p. 87.....1. *Lycopodineæ*.
2. Leaves minute, whorled, reduced to teeth and connate below into a sheath, sporangia borne on the underside of modified peltate sporophylls or sporangiophores, which form a cone-like termination to the stem or shoots, p. 87.....2. *Equisetineæ*.
3. Leaves large relatively to the axis and usually compound. Sporangia on the margins or backs of the leaves or modified leaves or in sporocarps at base of the leaves, p. 88.....3. *Filicineæ*.

CLASS I.—LYCOPODINEÆ.

224. Order I. LYCOPODIALES. Selaginellas and Club Mosses. (Only one existing order).

Sporophyte with simple or usually 2-chotomously branched stem and small crowded simple leaves. Sporangia solitary at the base of the leaves or in their axils, arising from a group of cells. Sporophylls similar to the barren leaves or dissimilar and always at the summit of the stem or its branches, the growth of which they terminate. The aggregate of sporophylls may be called a "flower." Spores similar, producing monœcious prothallia, or dissimilar (macrospores and microspores). The macrospores produce prothallia which bear archegonia only, and never become free of the spore, and though not as much reduced as in the Phanerogamia, are only sufficiently exposed through a fissure in the spore for the archegonia to become fertilized by the antherozoids (or spermatozoids) of the male prothallium. The microspores form a prothallium which completely fills the spore, and the mother-cells of the spermatozoids are produced from certain of its cells representing rudimentary antheridia.

Isosporous. Leaves multifarious without ligule

Fam. *Lycopodiaceæ*. (p. 1273).

Heterosporous. Leaves often 4-farious and differing in shape and size, with a microscopic ligule

Fam. *Selaginellaceæ* (p. 1275).

CLASS II.—EQUISETINEÆ.

225. Order I. EQUISETALES. Horse-tails. (Only one existing order.)

Sporophyte (asexual generation) with rhizome and usually a copiously branched\* stem with articulate internodes and whorls of very small tooth-like leaves. Branches usually whorled. Sporangia arise as

\* Fertile (cone-bearing) stems are often unbranched, while the barren ones of the same species may be branched. In our species both are branched.

pluricellular protuberances on the underside of peltate sporophylls which are arranged in a cone-like terminal spike or flower, 5—10 sporangia on the underside of each sporophyll. Spores (in existing genera) of one kind only producing well-developed, usually dicecious independent prothallia.....Fam. *Equisetaceæ* (p. 1272).

### CLASS III.—FILICINEÆ.

226. Leaves well developed relatively to the stem, often very large and compound, alternate, circinate in vernation (except in *Salviniaceæ* and *Ophioglossaceæ*). Sporangia on the margins or backs of the leaves, which either resemble the barren ones or are specially modified, rarely (*Hydropteridæ*) the sporangia grouped inside sporocarps formed of leaf segments so much modified as to appear as special non-foliar organs at the bases of the leaves. Fertile leaves not confined to a definite part of the shoot and not determining its growth (exc. *Ophioglossaceæ*).

#### A. HOMOSPOROUS FILICINEÆ. The Ferns.

Spores of one kind only, in sporangia which are not included in sporocarps (though sometimes grouped into synangia) and are borne on evident leaves or on segments of leaves modified into sporangiophores.

##### 1. Eusporangiate Ferns.

The sporangia arise from a group of cells. Either very large ferns with stipules and grouped sori, or small ferns with usually a single annual leaf dividing into a barren foliaceous part and an inflorescence-like sporangiophore.

##### a. Order I. MARATTIALES.

Very large ferns with stipular appendages at base of fronds. Sori grouped, or sporangia connate and sori formed into chambered synangia. Annulus 0 or apical and rudimentary.

Fam. *Marattiaceæ* (p. 1265).

##### b. Order II. OPHIOGLOSSALES.

Small ferns without stipules. Rhizome very short, subterranean. Leaf usually solitary and dividing into a barren foliaceous part and an inflorescence-like spore-producing spike or panicle with large marginal 2-valved sporangia without annulus, sometimes sunk in the tissue.....Fam. *Ophioglossaceæ* (p. 1266).

##### 2. Leptosporangiate Ferns.

#### Order III. POLYPODIALES.

The sporangia arise from a single epidermal cell (archesporium) and are usually collected into small groups (sori), but the individual sporangia are always free and the sori are not united into regular

groups or chambered synangia. Stipules never present. Fertile part of frond similar to the barren, or if dissimilar then fronds several. Sporangia usually situated on the veins, not sunk in the mesophyll, sorus often surrounded by or roofed over by an indusium. Annulus usually present (consisting of a single row of cells or disciform).

a. Sporangia sessile, often few, in the sori or not in definite sori. Indusium 0 or a continuation of the leaf margin. Annulus 0 or incomplete, or if complete, transverse or disciform (vertical and complete in some *Parkeriaceæ*).

i. Sporangia not in regular sori, in our species solitary in the axils of large imbricating involucres, which are arranged in a spiciform manner 2-seriatim on the lobes of the leaf segments. Annulus disciform or coronate, apical. Frond of indefinite growth, scandent (in our species)

Fam. *Schizæaceæ* (p. 1264).

ii. Sporangia very few in the sori, dorsal, without indusium. Annulus equatorial or oblique. Rhizome widely creeping. Fronds 2-chotomous of indefinite growth.

Fam. *Gleicheniaceæ* (p. 1263).

iii. Sporangia not in sori, arising in acropetal succession in parallel rows and covered by the revolute leaf margin. Marsh ferns with dimorphic fronds.....Fam. *Parkeriaceæ* (p. 1263)\*

b. Sporangia stalked, in well-marked sori or continuous rows, with complete oblique or vertical annulus. Indusium present or absent.

Tree ferns. Sporangia opening more or less transversely with complete oblique annulus, stalk short. Sorus naked or surrounded by a cupular involucre.....Fam. *Cyatheaceæ* (p. 1235).

Dwarf ferns. Sporangia very numerous in the sori, with a vertical incomplete annulus, stalk usually long. Indusium present or absent, membranous when present, rarely herbaceous.†

Fam. *Polypodiaceæ* (p. 1236).

B. HETEROSPOROUS FILICINEÆ.

Order IV.—HYDROPTERIDEÆ. Water ferns.

Floating or marsh plants. Leptosporangiate. Sporangia contained in capsules or sporocarps derived from much modified leaf segments, arising from the shoot at the base of the foliage leaves or on a pedicel springing from the petiole. Spores of two kinds, microspores and macrospores. Prothallia often rudimentary and remaining attached to the spore.

Annual floating aquatics with simple leaves.

Fam. *Salviniaceæ* (p. 1269).

Marsh plants with creeping rhizome and erect long-petioled 4-foliolate leaves.....Fam. *Marsiliaceæ* (p. 1270).

\* Probably a very primitive family.

† In this large family the groups with the sori marginal are probably the more primitive. See note on p. 78 on phyletic drift.

## 227. II. PHANEROGAMIA or SPERMOPHYTA.

(The Flowering or Seed Plants.)

The alternation of sexual and asexual generations is concealed in the formation of the ovule and seed. A "seed" is formed when the ripe macrospore is not liberated from the macrosporangium but remains enclosed in it and there produces rudimentary prothallium, archegonia or rudimentary archegonium, and finally an embryo of the next asexual generation which appears to be sexual from its containing and becoming amalgamated with the sexual generation. The prothallium (which in the *Selaginellaceæ* also does not become free of the spore) remains entirely in the macrospore, now termed the "embryo-sac." Usually only one embryo-sac is formed in each macrosporangium or "ovule." This ovule consists of one or two integuments enclosing a central small-celled tissue, the "nucellus," in which the *embryo-sac* arises. After fertilization of the oosphere in the embryo-sac the ovule undergoes changes resulting in the ripe seed, which consists of at least three parts—the seed-coat or testa, the endosperm (unless this has been consumed by the growing embryo), and the embryo itself. The endosperm is a tissue in the embryo-sac which represents the prothallium in the Gymnosperms. In the Angiosperms the prothallium and its archegonium with oosphere are represented by a few cells only and the endosperm or albumen is not formed until after fertilization, when it is apparently derived from the growth and division of the nucleus of the embryo-sac and not from the prothallial cells. The microspores of the Phanerogams are called "pollen-grains," which, instead of motile spermatozoids, develop a "pollen-tube," the contents of which reach the ovule by transportation of the whole pollen-grain by means of wind, insects, etc.

228. The seed-bearing plants or Phanerogams are divided into two sub-divisions:—

- A. Ovules before fertilization not enclosed in an ovary formed by the cohesion of the female sporophylls or carpels. Endosperm or prothallium developed before pollination and developing archegonia. Cotyledons 2—many. Flowers always 1-sexual.

I. GYMNOSPERMÆ (p. 90).

- B. Ovules produced inside an ovary formed of the cohering carpels or of one carpel with coherent margins and having at the summit the stigma on which the pollen-grains germinate. Endosperm not homologous with the prothallium but developed after pollination together with the embryo. Cotyledons 1—2.

II. ANGIOSPERMÆ (p. 91).

## 229. SUB-DIVISION I. GYMNOSPERMÆ.

(See above.)

- A. Stems rarely branched and then very sparingly. Leaves very large, pinnate and fern-like, but coriaceous. Flowers dioecious, naked, cone-like.....Class I. CYCADINÆ.

Exceptions:—

The carpels of *Cycas* are arranged round the main axis and not in evident cones.

Only one existing family.....Fam. I. *Cycadaceæ* (p. 1227).

b. Stems copiously monopodially branched. Leaves small, simple, acicular or scale-like, rarely lanceolate or ovate. Flowers mostly cone-like, naked. Ovules usually basal on the sporophylls.

Class II. CONIFERÆ.

This embraces several orders and families poorly represented in our area and therefore treated as one family

Fam. 2. *Coniferæ* (p. 1229).

c. Habit various. Leaves opposite. In our species broad-leaved climbers with the male and female sporophylls in whorls on a spike with annular bracts. Around the erect ovule and outside its one or two integuments is an investing covering open at the top, which is variously regarded as an open ovary or a fused perianth (see p. 82).....Class III. GNETINEÆ.

Only one family.....Fam. 3. *Gnetaceæ* (p. 1234).

## 230. SUB-DIVISION II. ANGIOSPERMÆ.

(See p. 90.)

Plants of very various habit. Flowers 1—2-sexual, usually furnished with a perianth. Carpels or female sporophylls infolded so that the edges unite or several carpels in one whorl united to one another, in both cases to form a one- or more-celled closed chamber or "ovary". Ovules enclosed in the ovary so that the pollen-grains are unable to come directly into contact with the ovule, and fertilization is effected by the pollen-tubes growing through a special conducting tissue of the carpel, which is often prolonged into a "style" bearing the "stigma" or organ for reception of the pollen-grains (if the style is absent the *stigma* is sessile; each carpel forms a stigma, but these may become connate into one). Macrospore (embryo-sac) before fertilization or pollination contains nuclei, but no distinct prothallial tissue or recognizable archegonia. The endosperm is formed after fertilization. The Angiosperms contain two classes:—

a. Plants of which the embryo has *two seed leaves* or cotyledons.

These often expand as the first green leaves of the plant (epigeal germination) as in the mustard, bean, castor oil, *Grewia*, *Gmelina*, etc., or they remain in the seed (hypogeal germination), and are then usually very thick, e.g., the Mohwa tree (*Bassia*), etc. Rarely there are 3 cotyledons, e.g. *Terminalia arjuna* in some cases, *Cansjera* (f. Griffiths), and exceptionally in many other plants. Exceptionally the cotyledons remain undifferentiated, e.g. *Loranthus* spp.....Class I. DICOTYLEDONES (p. 92).

b. Plants of which the embryo has only one cotyledon or seed leaf, which may become free from the seed and forms the first green leaf, e.g. *Agave*, or remains with its tip entirely or partially



enclosed in the seed from which it absorbs the endosperm or albumen, e.g. *Dioscorea*, Palms, Grasses, etc. Embryo sometimes undifferentiated, e.g. *Orchidaceæ*.

Class II. MONOCOTYLEDONES (p. 147).

The fact that the number of cotyledons is correlated with a number of other characters which render it usually easy to distinguish a Dicotyledon from a Monocotyledon shows that these two classes are natural.

231. Class I. DICOTYLEDONES.

The Dicotyledons comprise the great majority of flowering plants and practically all our forest trees. They usually have the venation of the leaf reticulate or much branched. Externally the arborescent forms are easily distinguished from the arboreous monocotyledons by the relatively copious branching of the stem. Anatomically the stem is generally well distinguished by the vascular bundles being in a ring and, on secondary growth in thickness taking place, from the woody tissue uniting outside the pith into a solid cylinder enclosed by a distinct cylinder of bark. In between the two is a very thin tissue, the "cambium," which continually adds more wood to the inner cylinder. The flowers of dicotyledons when not reduced usually have their parts in 4's or 5's or sometimes 2's, but 3's are common among the *Ranales* and in a few other families. The leaves are petioled or sessile, but rarely have a long sheathing base as is so common in the Monocotyledons.

232. The following is the division of the Dicotyledons according to the *Genera Plantarum* of Bentham & Hooker (*vide* p. 85), and in accordance with which work (with few exceptions) the sequence of the families in the body of this flora is arranged:—

I. *Polypetalæ*.—Flowers dichlamydeous. Petals free\*—

SERIES A: *Thalamifloræ*.—Calyx usually free from the ovary. Petals 1—2 or many-seriate. Stamens many or definite, inserted on the torus or receptacle, which is usually small or elongate or with a short gonophore. Ovary superior. Families 1 to 28 (exc. 19).

SERIES B: *Discifloræ*.—Calyx mostly free from the ovary. Petals 1-seriate. Stamens usually definite, inserted on a more or less swollen or broadened part of the receptacle known as a "disc." Ovary usually superior or immersed in the disc. Families 31 to 51.

SERIES C: *Calycifloræ*.—"Calyx-tube" (really an elongation of the outer zone of the torus and here usually referred to as the hypanthium) more or less investing or adnate to the ovary, petals 1-seriate inserted on the calyx-tube (hypanthium). Stamens many or definite, usually inserted on a disc lining the calyx-tube. Ovary usually included in the calyx-tube, or inferior.

Part Fam. 14, Fam. 19, Fam. 30, and Families 52 to 76.

II. *Gamopetalæ*.—Petals more or less combined into a lobed corolla, pistil never apocarpous, or if carpels distinct, then styles united and carpels only 2. The calyx is very frequently gamosepalous below, and often persistent. Petals or corolla-lobes in a single series and usually 4 or 5 (see exceptions), or corolla 2-lipped. Stamens usually isostemonous, or fewer, often adnate to the corolla-tube. Carpels as many as the petals or very often reduced in number. Leaves rarely compound.

\* Exceptions omitted.

This group, which also is not quite natural, being derived from several distinct groups of *Choripetalæ*, is adopted in the following synopsis of families (p. 134) as being generally easily recognizable.

Families 77 to 108.

III. *Monochlamydeæ* or *Apetalæ*.—Perianth simple with the lobes or segments similar to one another and usually calycine, sometimes minute or altogether wanting

Families 107 to 128.

(To this group also belong the *Euphorbiaceæ*. Fam. 29.)

The following is the more phylogenetic arrangement referred to on p. 87.

### 233. Series I. CHORIPETALÆ (pp. 98—133).

Flowers when dichlamydeous without the corolla being produced at the base into a petaloid tube, or if corolla somewhat tubular at the base from the connate petals then stamens not reduced to 4 together with a reduction of the carpels to 2, and ovules with 2 integuments. Corolla often 0.

See also a few polypetalous genera in the *Gamopetalæ*, viz. *Embelia* (*Myrsinaceæ*), *Symplocos* (*Styracæ*), *Azima* (*Salvadoraceæ*), *Olea* and *Linociera* (*Oleaceæ*), and a few apetalous genera in the *Gamopetalæ* (p. 134).

Exceptions to *Choripetalæ*:—

Corolla gamopetalous in some *Mimosaceæ*, *Crassulaceæ*, *Caricaceæ*, *Cucurbitaceæ* and *Hicaceæ*. Petals sometimes connate at the base in *Cissampelos* (connate into a 4-lobed cup), *Tamarix*, *Pittosporum*, *Malvaceæ* (connate and adnate with the staminal tube), *Rutaceæ* (adnate with the staminal tube), *Meliaceæ*. *Cansjera*, loosely connate in *Olex* and *Alangioidææ*.

Hypanthium sometimes coloured and tubular, and simulating a gamopetalous corolla in *Woodfordia*, *Loranthus*, also in *Nyctaginaceæ* and others in which there is only one perianth whorl.

### 234. CONSPECTUS OF THE CHORIPETALOUS GROUPS.

I. Flowers mostly hypogynous; acyclic, hemicyclic or cyclic. If perigynous or epigynous then 3-merous mostly 3-merous or hemicyclic or with parietal placentation. Disc 0. Stamens often many or 3-merous or anthers opening by valves. Ovary apocarpous or 1-celled, or if syncarpous and several-celled ovules many and parietal or, if few, stamens or carpels 3 or many, or ovules campylotropous. Seeds usually albuminous with small or curved embryo. Leaves simple.

Exceptions:—

The *Aristolochiaceæ* have flowers epigynous mostly 3-merous, but in our genus the perianth is oblique and entire. Fls. epigynous in *Hernandiaceæ*, but anthers opening by valves.

Fls. perigynous and disc present in *Moringa*, but ovary 3-merous with parietal placentation. Its affinities are, however, very doubtful, and it has compound leaves. Fls. epigynous in *Opuntiales* but acyclic.

Flowers epigynous in *Begoniaceæ* and *Cucurbitaceæ*. The flowers are 1-sexual. The female has usually 3 parietal placentæ, which may, however, meet in axis or in some *Begoniaceæ* placentæ sub-basal.

Disc sometimes well developed in *Capparidaceæ* and in *Passifloraceæ* with ovary on a gynophore and placentation parietal. A crenate disc occurs in *Tamarix* which has a 3-carpellary 1-celled ovary with sub-parietal placentation, but the position of *Tamaricaceæ* is very doubtful. Disc often present in *Passifloraceæ* with

ovary on gynophore, 1-celled with parietal placentæ. A fleshy disc is present in some *Guttiferaceæ*. A disc of glands or scales occurs also in *Flacourtiaceæ*.

Ovule 1 orthotropous in *Polygonales*. Ovules 1—2 axile in each cell and stamens neither 3 nor many in a few *Malvales* and *Euphorbiales*.

Leaves often pinnate in *Clematis* (*Ranunculaceæ*), dissected in *Fumariaceæ*, rarely pinnate in *Cruciferae*, digitate in some *Capparidaceæ*, *Bixaceæ*, a few *Malvaceæ* (*Bombaceæ*) and *Sterculia*, few *Cucurbitaceæ*, also in very few *Euphorbiaceæ* (*Manihot*, *Bischofia*; while several *Phyllanthæ* have branchlets simulating pinnate leaves).

Leaves are 2—3-pinnate in the anomalous family *Moringaceæ*.

A. Flowers acyclic or hemicyclic or ovary apocarpous and stamens indefinite, or anthers opening by recurved valves, or flowers in general 3-merous or  $n \times 3$ -merous.\* Flowers dichlamydeous or sepals passing into petals or petaloid, more rarely haplo-homoichlamydeous, then often perianth in two 3-merous whorls. Leaves often glandular and aromatic.

Orders: I. *Renales* (p. 98); II. *Aristolochiales* (p. 101); III. *Opuntiales* (p. 101). See also *Podostemonaceæ* and *Saxifragaceæ*.

B. Flowers cyclic and ovary syncarpous. Stamens definite or indefinite, anthers never opening by valves and flowers not 3-merous except often in the gynæceum.

Exceptions:—

Perianth sometimes 3-merous in *Argemone*, which has all the other characters of *Parietales*. Ovary apocarpous with whorled carpels in some *Phytolaccaceæ*.

1. Ovule only 1 in the ovary or several on a free central placenta, or if ovary partially 2—5-celled from the base then ovules amphitropous or campylotropous, rarely ovule 1 orthotropous. Flowers regular, usually monochlamydeous, stamens definite and epitepalous, rarely indefinite. Stipules usually scarious. Embryo usually curved.

Note.—The ovary may be monocarpellary in some *Nyctaginaceæ*, and in many of the families is apparently 3—2-carpellary (with a single ovule).

Orders: IV. *Caryophyllales* (p. 102); V. *Polygonales* (p. 104). See also some X. *Urticales* (part).

Exceptions:—

Stamens indefinite in some *Nyctaginaceæ* and some *Portulaca*.

Ovary 1—many-celled in *Aizoaceæ*.

Carpels whorled in *Phytolaccaceæ* with 1 ovule in each carpel.

2. Ovules more than 1, usually many in the ovary, parietal on 2 or more placentæ, more rarely axile, very rarely basal and erect in each cell of a several-celled ovary (*Guttiferaceæ*). Flowers dichlamydeous, often  $n \times 2$ -merous, usually regular. Stamens many or definite. Leaves penninerved.

Orders: VI. *Theales* (p. 105); VII. *Parietales* (p. 107).

Exceptions:—

Flowers monochlamydeous in a few *Flacourtiaceæ*, irregular in *Fumariaceæ*, *Violaceæ* and *Moringaceæ*. Leaves palmnerved or digitate in some *Capparidaceæ* and *Bixaceæ*. Ovules 2 collateral pendulous in each cell in *Shorea*, in which respect it approaches *Malvales* (*Tiliaceæ*).

\*  $n$  is usually 2.

3. Ovules axile or from the inner angles 1—2 or 2-several in each cell of a several-, frequently 3-celled ovary which is frequently 3-lobed or 2-many-coccos, or capsular with 3—5 valves in fruit. Stamens often many, rarely definite, often monadelphous at least at base, sometimes filaments entirely connate into a column. Leaves never pinnate, sometimes digitate, usually simple but palmilobed or palminerved. Hairs very often stellate. Sap often mucilaginous or milky.

a. Flowers mostly 2-chlamydeous and 2-sexual:—

Order VIII. *Malvales* (p. 112).

b. Flowers mostly monochlamydeous and 1-sexual:—

Order IX. *Euphorbiales* (p. 113).

Exceptions:—

Flowers reduced to single stipitate stamens or single 3-celled ovaries (in compound inflorescences) in some *Euphorbiales* and ovary sometimes reduced to 2 carpels (see other exceptions under the Orders).

Ovary 1-celled in *Waltheria* (*Sterculiaceæ*) and in *Antidesma* (*Euphorbiaceæ*). Flowers slightly zygomorphic in some *Sterculiaceæ*.

Fruit drupaceous in some *Tiliaceæ* and *Euphorbiaceæ* or sometimes sub-baccate in *Euphorbiaceæ*.

Ovary nearly apocarpous in a few *Sterculiaceæ* and separating into follicles in fruit.

4. Ovules 1—2 from near the base or 1—2-pendulous from near the apex of the 1-celled superior ovary or (*Salicales*) many parietal ascending. Flowers always much reduced and achlamydeous or monochlamydeous, often 1-sexual with stamens isostemonous and opposite the tepals (if any) or fewer.

Groups of doubtful affinity.

a. Monochlamydeous with epitepalous stamens or in some *Moraceæ* with the flowers enclosed in pseudocarps, the stamens reduced to 1 or few.

Order: X. *Urticales* (p. 113).

b. Achlamydeous or perianth (in *Casuarinaceæ*) perhaps represented by the 2 median scarious tepals or (in *Salicaceæ*) by a cupular or glandular disc.

Orders: XXIV. *Salicales* (p. 133); XXV. *Casuarinales* (p. 133).

• II. Flowers hypogynous cyclic, never 3-merous, with a conspicuous variously shaped disc, or becoming perigynous or epigynous with reduction of one of the perianth whorls. Ovary syncarpous of 2-several carpels, cells with 1—2 ovules. Stamens diplostemonous or fewer. Leaves frequently pinnate or 1—3-foliolate or sometimes digitate. Ovary never on a gynophore (exc. *Proteaceæ*), but sometimes reduced to 1 cell and then ovules pendulous anatropous from an incomplete, axis, neither parietal nor on a free central placenta, if basal in the cells then anatropous, usually axile or pendulous.

Exceptions:—

Disc 0 in many *Elzagnales* and *Santalales*, in which the perianth is always submonochlamydeous or monochlamydeous or 0.

Disc of glands only in *Linaceæ* but fls. hypogynous, diplostemonous, ovary 3—5-celled with 1—2 axile ovules in each cell.

Disc obscure in *Malpighiaceæ* but stamens diplostemonous, fls. often irregular, ovary 3-celled with 1 axile ovule in each cell. Fruit of samaras.

Disc of glands or obscure in *Geraniaceæ* but leaves often compound, and torus raised between the lobes of the ovary.

Disc 0 in *Balsaminaceæ* and one whorl of stamens suppressed. Fruit a 3-valved capsule with valves elastically recoiling from the placentiferous axis and flowers irregular.

Disc 0 or confluent with the ovary in *Nicaceæ*.

Ovules many in each cell in some *Biophytum* and *Averrhoa* (*Geraniaceæ*), and then leaves pinnate and stamens diplostemonous. Ovules many superposed in each cell in *Impatiens* but capsule with 5 elastically recoiling valves. Ovules many in each cell in *Swietenia* and *Cedrelæ* (*Meliaceæ*), but leaves pinnate and other characters normal. Ovules sometimes several in each cell in *Citrus*, *Ægle* and *Feronia* (*Rutaceæ*), but leaves 1-foliolate or pinnate and also gland-dotted.

Ovules sometimes amphitropous or campylotropous and embryo sometimes spiral in *Sapindaceæ*.

Our species of *Proteaceæ* (*Grevillea*) has not only the ovary on a stipes, but the ovules are amphitropous and laterally affixed. The affinities are doubtful.

- A. Stamens diplostemonous (or obdiplostemonous) or by reduction fewer than diplostemonous but more than isostemonous and then often 8 and flowers often irregular. Leaves often pinnate or gland-dotted, and fruit often lobed or coccous.

Orders: XI. *Geraniales* (*Gruinales*) (p. 115); XII. *Sapindales* (p. 118).

Exceptions:—

Stamens and carpels often numerous in some *Ochnaceæ* and *Rutaceæ*, but disc conspicuous or ovary deeply lobed or leaves glandular. Stamens 12—15 in *Peganum* (*Zygophyllaceæ*) and ovules many in each cell, ovary deeply 2—3-lobed.

The epipetalous stamens are suppressed in *Impatiens*, the flowers are spurred as in many other *Geraniales*, and the capsule valves after debiscence remain attached at the top to the axis. St. only 2—3 in the hermaph. flower of *Ailanthus*. Stamens sometimes only 1—2 perfect in *Anacardiaceæ* or isostemonous.

- B. Stamens isostemonous or 3 only, rarely 2—3-times the number of the sepals and then flowers sub-monochlamydeous and ovary inferior. Disc often very pulvinate, occasionally tubular (*Leea*). Ovary 2—5-celled with 1—2 ovules in each cell, more rarely 1-celled with 1—2 basal or pendulous ovules. Leaves simple, rarely 1—2-pinnate or digitate (some *Ampelidaceæ* and most *Umbellales* and *Grevillea*).

Exceptions:—

Ovules sometimes 3 pendulous from an incomplete axis in some *Olax* or from a central column in *Santalaceæ*. Ovules 2—10 in each cell in *Hippocrataceæ*, 1 erect in each cell in *Rhamnaceæ*. Ovary 3—16-celled in *Ilex*, irregularly many-celled in *Siphonodon*.

Ovary 1-celled superior or half-inferior with 1 pendulous ovule from the top in *Opilia* (*Olacaceæ*); 1 ovule pendulous from a very short basal placenta in *Cansjera*, which has a gamopetalous corolla; 1-celled with 2 ovules pendulous from the top in *Natsiatum* (*Icacinaceæ*), a climber with palminerved leaves and valvate petals connate at the base and 2 linear diverging stigmas; 1-celled with a single basal anatropous ovule in *Elæagnus*. Ovary 1-celled with 2 collateral sub-apical amphitropous ovules in *Proteaceæ*. Leaves often pinnatifid or pinnate in *Proteaceæ*.

Perianth irregular coloured, ovary inferior, ovule and placenta not differentiated in *Loranthus*.

1. Calyx usually well developed, flowers dichlamydeous, ovary usually superior (inferior in few *Rhamnaceæ*), more than 1-celled.

Orders: XIII. *Celastrales* (p. 120); XIV. *Rhamnales* (p. 121).

2. Calyx scarcely or slightly developed, but tube or hypanthium sometimes accrescent in fruit (perianth in female of *Balanophora*).

a. Ovary more than 1-celled, inferior:—

Order: XV. *Umbellales* (p. 122).

b. Ovary 1-celled, sometimes imperfectly 3-celled at base:—

i. Ovary superior in flower or half superior or inferior, flowers sometimes irregular.

Orders: XVI. *Alangiiales* (p. 123); XVII. *Olacales* (p. 123); XVIII. *Santalales* (p. 124).

3. Flowers haplochlamydeous, the calyx (probably) only represented and usually well developed, sometimes coloured and irregular. Stamens epitepalous. Ovary superior.

Orders: XIX. *Elæagnales* (p. 125); XX. *Proteales* (p. 125). ( See also X. *Urticales*, p. 113).

III. Flowers dichlamydeous, perigynous or epigynous with the sepals, petals and stamens on the edge of the hypanthium which is often produced above the ovary or on a disc lining the hypanthium. Stamens diplostemonous to many. Ovary apocarpous to syncarpous; if apocarpous flowers cyclic not 3-merous and embryo large, if reduced to one carpel or if syncarpous and 1-celled then stamens 9—many and usually ovules many. Leaves simple or compound. ← I.

Exceptions:—

Flowers nearly hypogynous in some *Leguminosæ* and *Rosales* and then leaves compound and embryo large. Fls. hypogynous in some *Podostemonaceæ*.

Flowers hypogynous in some *Droseraceæ* and ovules many on parietal placenta, and the seeds have a small embryo. This family is therefore sometimes placed in the *Parietales*. Parietal ovules occur however also in the *Saxifragaceæ*, which the *Droseraceæ* more resemble in habit and inflorescence than any of the *Parietales*.

Petals are wanting in a few *Combretaceæ* and the ovules sometimes only 2, pendulous, these are trees or shrubs with opp. or sub-opp. leaves, diplostemonous stamens and large embryo. Petals are rudimentary or obsolete in a few *Ammannia* (*Lythraceæ*). Ovary is 3-merous or 3-celled in a few genera and whole flower is 3-merous in *Sonerilla*, but other characters are those of this group.

A. Stamens often more or less connate. Ovary apocarpous and often reduced to a single carpel, or if apparently syncarpous with the carpels separately adnate to the inside of the hypanthium or loosely connate or the styles free or carpels separating in fruit.

Orders: XXI. *Rosales* (p. 126); XXII. *Leguminosæ* (p. 129).

Exceptions:—

Corolla gamopetalous in some genera, especially in *Mimosaceæ*, see exceptions under *Choripetalæ*.

Carpels early connate in *Eriobotrya* and *Pyrus* (*Rosaceæ*), forming an inferior 2—5-celled ovary with styles connate, ovules 2 in each cell, but stamens many.

Carpels 2 connate into a 1-celled ovary in *Vahlia* (*Saxifragaceæ*) with 2 pendulous placenta and many ovules. The fruit dehisces apically between the styles into its constituent carpels. Stamens only 5.

Stamens isostemonous and nearly hypogynous and ovary nearly free 1—3-celled with distinct styles and 3—5-valved capsule in *Droseraceæ*.

Carpels connate in *Myriophyllum*, but separating into cocci in fruit.

Stamens fewer than diplostemonous, usually by abortion, in some *Cæsalpiniaceæ*, and then fruit a pod with several seeds with large embryo. Stamens isostemonous

or diplostemonous in *Sonerilla* (*Melastomaceæ*) and *Lawsonia* (*Lythraceæ*), variable in number and often reduced in the marsh genus *Ammannia* (*Lythraceæ*), isostemonous in *Ludwigia* and *Trapa* (*Onagraceæ*, the last an aquatic).

- b. Stamens free, rarely connate at base. Ovary syncarpous with connate styles. Albumen 0. Hypanthium often beaked above the ovary and then expanded into a calyx-tube. Leaves very often opposite.

Order: XXIII. *Myrtales* (p. 130).

## 235. DESCRIPTIONS OF ORDERS AND FAMILIES OF THE CHORIPETALÆ.

### Order I. RANALES.

Flowers mostly regular and 2-sexual, *acyclic or hemicyclic*, or if cyclic then the whorls *mostly 3-merous*. Stamens hypogynous, *usually many*, or if definite often in 3-merous whorls or anthers opening by valves. *Gynæcium apocarpous*, carpels usually many, but sometimes reduced to one. Ovules anatropous or amphitropous. Seed with *copious albumen* and usually *small embryo*.

Leaves mostly alternate and simple, often *with sheathing bases* in herbaceous families. Stipules rare.

Exceptions:—

Fls. dioecious in *Menispermaceæ* and sometimes 2- or 4-merous but then carpel 1 with 3 *stigmas*.

Fls. epigynous in *Hernandiaceæ* with 4—7-partite perianth (sometimes 2- or 3-partite) and stamens opposite the perianth segments and isomerous, but leaves peltate as in *Menispermaceæ*, anthers opening by valves as in *Lauraceæ*. Ovary 1-carpellary, 1-ovuled.

Perianth often perigynous and monochlamydeous (rarely wanting) in *Lauraceæ*.

Ovary sometimes syncarpous in *Nigella* (*Ranunculaceæ*), *Nymphæaceæ* (Water Lilies), and then fruit sub-capsular or with the torus forming a pseudo-berry. Carpels connivent and forming a pseudo-berry in *Anona*. Syncarpous but 3-carpellary and 1-celled in *Lauraceæ*.

Leaves opposite and sometimes pinnate in *Clematidææ*. Stipulate in *Magnoliaceæ*. Albumen scanty in *Ceratophyllaceæ*, 0 in *Lauraceæ* and *Hernandiaceæ*.

I. Woody families. St. hypogynous. Anthers not opening by valves. Carpels free or cohering in axis.

1. *Ranunculaceæ* (part); 2. *Magnoliaceæ*; 3. *Dilleniaceæ*;
4. *Anonaceæ*.

II. Herbaceous families.

St. numerous hypogynous.

1. *Ranunculaceæ*.

St. often sub-perigynous. 6. *Nymphæaceæ*.

St. often in 3-merous whorls and few. 5. *Menispermaceæ*.

Aquatic with much reduced 1-sexual fls. 7. *Ceratophyllaceæ*.

III. Woody, rarely herbaceous, with anthers 2- or 4-celled, opening by lids or valves, fls. hypogynous to epigynous.

8. *Berberidaceæ*; 9. *Lauraceæ*; 10. *Hernandiaceæ*.

**1. Buttercup and Clematis Family (see 1a)**

Herbs with simple or sometimes compound, frequently deeply cut and palmately-nerved, radical or alternate leaves with a sheathing petiole. Stipules 0. Flowers partly acyclic with usually many stamens and an indefinite number of carpels forming an apocarpous ovary. Fruit mostly of achenes or follicles. Sepals sometimes petaloid.

*Ranunculaceæ* (p. 3).

**1a. Tribe Clematidæ.**

As above, but mostly woody climbers with opposite leaves, petiole not sheathing.....*Clematis* and *Naravelia* (pp. 3, 4).

Exceptions:—

Petals 0 in *Clematis* and *Thalictrum* and calyx petaloid. Carpels connate except at tip in *Nigella*.

**2. Magnolia Family.**

Trees with simple leaves and the leaf-buds enclosed in convolute deciduous stipules which leave an annular scar as in many *Moraceæ*. Flowers large solitary partly acyclic. Sepals often petaloid and passing gradually into petals, in 3-merous whorls. Torus much elongate in fruit with spicate carpels sometimes more or less connate, dehiscent or indehiscent.....*Magnoliaceæ* (p. 8).

**3. The Dillenia Family. —> Theales.**

Trees or shrubs with large very strongly pinnately-nerved leaves and sheathing petioles. Flowers large or very large. Sepals and petals definite, mostly 5. Stamens many, sometimes connate below. Carpels 5—20 cohering in the axis. Fruit indehiscent, enclosed in the large fleshy accrescent calyx.....*Dilleniaceæ* (p. 6).

This family forms a connection with the *Theales*, in which it is sometimes placed.

**4. Custard-apple Family.**

Trees, shrubs or woody climbers. Leaves sometimes dotted, sometimes aromatic. Buds naked, stipules 0. Fls. small or medium, rarely large, often sub-solitary. Perianth of 3 trimerous whorls, one or more whorls often fleshy or coriaceous or petaloid, inner valvate. Stamens many with adnate anthers. Carpels few or many, stalked and umbelleted in fruit. Seeds large with copious albumen and small embryo, the albumen deeply usually laminately ruminant.....*Anonaceæ* (p. 9).

Exceptions:—

Carpels cohering into a fleshy fruit in *Anona*, but marked externally by more or less distinct areoles.

**5. The Moonseed Family.**

Slender, rarely woody climbers, with simple palmately-nerved, sometimes peltate entire leaves. Fls. small or minute, 1-sexual, in a many-fl., often umbellate, inflorescence. Perianth sepaloid, of several, usually



4, *trimerous whorls*. St. and carpels mostly in 3-merous whorls. *Fruiting carpels* 3—12, rarely only 1, *drupaceous* with usually a characteristic horse-shoe-shaped endocarp. Embryo moderate-sized in albumen  
*Menispermaceæ* (p. 16).

Exceptions:—

Male of *Cissampelos* is 4-merous with connate petals. *Stephania* has sometimes 5-merous whorls.

## 6. The Water-lily Family.

*Aquatics* with usually a rhizome and large floating or extruded often peltate leaves involute in veneration. *Flowers very large, acyclic*, at least as to petals and stamens, which are seated on a fleshy disc surrounding the carpels. Carpels several or many, whorled or connate into a many-celled ovary with a peltate stigma or free and scattered in the broad torus. Embryo outside a copious albumen or albumen 0 and plumule large.....*Nymphæaceæ* (p. 21).

## 7. The Hornwort Family.

*Submerged aquatics* with slender stems and whorled leaves 2-several times forked with filiform segments. *Flowers minute, monoecious*, usually solitary. *Perianth* of 6—12 narrow subvalvate segments. *St.* 12—30 on a convex torus. *Ovary* of one ovoid 1-celled carpel with a subulate style and a solitary pendulous straight ovule. Fruit small, indehiscent, beaked with the style. Seed with scanty albumen. Embryo straight with 2 cotyledons, radicle very short inferior.  
*Ceratophyllaceæ* (p. 883).

## 8. The Barberry Family.

Often *spiny shrubs* with scaly buds. Leaves simple or compound often spinous, rarely stipulate. *Fls.* small or medium, yellow, racemose. *Perianth* of four 3-merous whorls. *Stamens* 3—6 opposite the petals, anthers with adnate cells dehiscing by recurved valves. *Carpel* with a large sessile orbicular stigma. *Ovules* several basal. Fruit baccate.  
*Berberidaceæ* (p. 20).

## 9. The Laurel Family.

*Trees, rarely shrubs* (see exc.). *Leaves* alt., rarely opp. or sub-verticillate, *entire*, usually with a characteristic aromatic or camphoraceous smell due to minute glands often visible as translucent dots; exstipulate. *Flowers* small, green or yellowish, *regular* 1—2-sexual, mostly 3-merous throughout. *Tepals* usually 2-seriate, often connate below, rarely 5 or rudimentary or 0. *Stamens* in 2—4 trimerous whorls, one whorl often reduced to staminodes, *hypogynous* or *perigynous*, anthers with 2 or 4 cells dehiscence by small lids. *Ovary* syncarpous, 3-carpellary, 1-celled. *Ovule* 1 pendulous anatropous. Fruit baccate drupaceous or nearly dry. Seed exalbuminous. Embryo with large plano-convex cotyledons, radicle superior minute.....*Lauraceæ* (p. 830).

Exceptions:—

*Cassytha* is a parasitic filamentous leafless green climber with a thallostoria.

**10. The Hernandia Family.**

*Woody plants with alternate sometimes clustered often peltately attached and palmately nerved, entire or lobed leaves, exstipulate, usually with oil glands, cystoliths or capitate hairs. Flowers small 1—2-sexual clustered in axillary or pseudo-terminal cymes or panicles, regular with 3-many (4—7 in our species), rarely 2-(in female) partite perianth, tepals usually 2-seriate. Stamens as many as and opposite the tepals, sometimes with as many alternating glands, anthers opening by lateral recurved lids. Ovary inferior 1-celled with 1 pendulous anatropous ovule. Fruit indehiscent sometimes crowned by the wing-like tepals. Seed with convolute cotyledons.....Hernandiaceæ (p. 838).*

**Order II. ARISTOLOCHIALES.**

Position very doubtful.\* Fls. cyclic, homoiochlamydeous, epigynous, reg. or zyg. Perianth petaloid. Gynæcium and andrœcium mostly 3-merous. Ovules many parietal.

**11. The Snake-root Family.**

*Herbaceous or shrubby climbers with alt. usually palminerved leaves and base of petiole dilated or decurrent, exstipulate. Leaves often with secretory cells giving rise to translucent dots. Flowers 2-sexual regular or zygomorphic 3-merous (or perianth 1—2-lipped when zygomorphic) with green or coloured gamophyllous perianth with inflated base, lobes valvate. Stamens 6—12 subsessile in a ring round the base of the style with which they are often combined into a column or gynostenium; if free then filaments short and thick. Ovary inferior or partially so, 4- or 6- rarely 5-celled, stigma rayed. Ovules many, anatropous on parietal placentæ which are free or meet in the axis, or placentæ axile. Fruit capsular or coriaceous and bursting irregularly, in our species ribbed and septically 6-valved and the dehiscence carried down into the pedicels. Seeds many with copious albumen and small or minute embryo.....Aristolochiaceæ (p. 823).*

**Order III. OPUNTIALES.**

*Fleshy plants with the leaves often reduced to scales and bearing hairs, bristles or spines in their axils. Flowers hemicyclic, heterochlamydeous with many spirally arranged tepals, the sepals passing into petals and with the stamens seated on a large tubular hypanthium in which is sunk the ovary. Ovary of 4 to many carpels, 1-celled with parietal placentation.*

Apparently allied to the *Mesembryanthemæ* (*Aizoaceæ*).  
Families: 12. *Cactaceæ*.

\* I follow Hurchinson in placing them in the neighbourhood of the *Ranales* in view of their commonly 3-merous flowers, etc.

## 12. The Cactus Family.

*Succulent*, sometimes very fleshy plants, *without milky juice*, with columnar, clavate, spherical or terete, compressed or angled stems and branches, rarely (*Pereskia*) with well-developed leaves. Fls. usually large. *Perianth regular or somewhat zygomorphic, with many tepals from a tubular hypanthium. St. vrry many inserted at various levels in the same hypanthium. Ovary inferior 1-celled with several parietal placentæ. Ovules many anatropous. Seeds many with curved embryo more or less terete or clavate and scarcely differentiated or with 2 thin or fleshy cotyledons. Albumen scanty or copious.....Cactaceæ (p. 418).*

## Order IV. CARYOPHYLLALES (Carvembryœ).

Herbs, rarely shrubs, with simple entire exstipulate leaves, or stipules scarious. *Flowers regular, sometimes heterochlamydeous, but usually reduced and haplochlamydeous, solitary or cymose or in abbreviated cymules aggregated into spikes and panicles. Perianth usually polyphyllous and hypogynous and usually persistent in fruit, sometimes gamophyllous and perigynous. Stamens sometimes numerous, usually diplostemonous or fewer, if isomerous then opposite the sepals (petals wanting), sometimes perigynous. Ovary of 2—5 carpels connate into a 1-celled ovary with basilar or central columnar placentation. Ovules often reduced to one, campylotropous or amphitropous. Embryo curved around the mealy albumen.*

This order (*i.e.* its theoretical extinct allies) would appear to be the origin of *Primulales* among *Gamopetalæ*.

### Sub-order CARYOPHYLLALES proper.

Mostly dichlamydeous with often showy flowers. Stamens indef. or definite. *Ovules several.*

13. *Aizoaceæ*; 14. *Portulacaceæ*; 15. *Caryophyllaceæ*.

### Sub-order CHENOPODIALES.

Haplochlamydeous with usually small flowers. Stamens definite. *Ovule 1.*

16. *Nyctaginaceæ*; 17. *Phytolaccaceæ*; 18. *Chenopodiaceæ*; 19. *Amarantaceæ*.

Exceptions:—

Leaves sometimes 0 in the fleshy species of *Chenopodiaceæ*.

Ovary incompletely 3—5-celled with many ovules, flowers mostly heterochlamydeous, petals often with a ligula, stamens often on a column in *Caryophyllaceæ*.

Ovary 1—many-celled in *Aizoaceæ*.

Stamens numerous in some *Nyctaginaceæ* and fruit nut-like.

Carpels sometimes whorled in *Phytolaccaceæ* with 1 ovule in each carpel and fruit sometimes then coccous.

The *Nyctaginaceæ* are included in *Thymeleales* by Hutchinson, who also includes the *Elatinaceæ* here rather than in *Theales*. The embryo is sometimes curved in *Elatinaceæ*, which has, however, completely axile placentation and little or no

albumen. Their fruit is a septicidal capsule which occurs nowhere else in *Caryophyllales*.

On the other hand a septicidal capsule is not very far removed from a coccous fruit which sometimes occurs and the habit of *Elatinaceæ* is rather that of *Caryophyllales* than of *Theales*.

**13. The Fig-marigold Family.** ← *Opuntiales*.

*Herbs or undershrubs* with sometimes fleshy, alt. opp. or pseudoverticillate leaves, stipules scarious or 0. Fls. in our genera small. *Tepals* 5—3. *St.* 3—10 or indefinite, free or in bundles or connate below, in a ring, *hypogynous* or *perigynous*. *Ovary* free superior to inferior 1-several-celled with as many styles as carpels. *Ovules* 1-many in each cell. *Fruit* usually capsular, sometimes circumsciss. *Seeds* many or few—1 in each carpel, hilum sometimes appendaged. *Embryo* curved or annular.....*Aizoaceæ* (p. 49).

The Fig-marigolds (*Mesembryanthemæ*) are sometimes separated as a distinct family chiefly by their large usually brilliantly coloured petals and indefinite stamens. They are chiefly succulent plants, native of the hot sandy plains of S. Africa, but are sometimes grown in gardens in India. *M. crystallinum* is the Ice plant.

**14. The Purslane Family.**

*Succulent herbs or undershrubs* with alt. or opp. or subverticillate simple entire leaves with often bundles of hairs (stipular?) in their axils. Fls. regular, opening only in sunshine. *Sepals* 2 only (bracts?), free or somewhat connate. *Petals* 4—6 free or somewhat connate. *St.* variable in number, sometimes opposite the petals, inserted with them. *Ovary* 1-celled, free or sunk in the torus, of 2—8 carpels. *Ovules* 2—many, on a central basal placenta. *Fruit* opening by valves or circumsciss.

*Portulacaceæ* (p. 47).

**15. The Carnation Family.**

*Herbs* with stems often tumid at the nodes and opposite entire exstipulate leaves or stipules scarious. *Sep.* 4—5 free or connate. *Pet.* 4—5 or 0, free, clawed, usually on an internode above the insertion of the sepals. *Stamens* normally diplostemonous, sometimes reduced in number, inserted with the petals, free or monadelphous or in a perigynous ring. *Ovary* free 1-celled or 3—5-celled at the base, with 2—5 free or connate styles. *Placentation* central. *Fruit* capsular. *Embryo* mostly curved with narrow incumbent cotyledons.

*Caryophyllaceæ* (p. 44).

**16. The Bougainvillea Family.**

*Woody or herbaceous* with opp., rarely alt., entire exstipulate leaves. *Flowers* small or medium, often showy from being subtended by an involucre of coloured bracts, at other times minute, in heads, cymes or umbels. *Perianth* gamophyllous usually petaloid with the tube persistent and accrescent, 3—5-lobed, plaited in bud. *St.* 8—30 hypogynous, anthers didymous. *Ovary* free, 1-carpellary, style involute in bud with simple or multifid stigma. *Ovule* 1, erect, somewhat campylotropous. *Fruit* thin-walled, enclosed in the hardened perianth-tube. *Seed* erect

albuminous with embryo either curved or spiral or straight with crumpled or folded cotyledons.....*Nyctaginaceæ* (p. 793).

### 17. The *Phytolacca* Family.

*Shrubs or herbs with alt. leaves. Stipules small or 0, never ochreate. Fls. racemose. Tepals 4, rarely 5 imbricate, sepaloid or petaloid. Stamens 4, rarely 5, opp. the tepals or diplostemonous, rarely more, hypogynous or sub-hypogynous, filaments often persistent. Carpels 1, or several in a whorl, free or connate, superior, 1-ovuled, stigmas usually sessile and recurved. Seed erect, often arillate, albuminous. Embryo peripheral annular. Cotyledons sometimes unequal, outer embracing the inner.....Phytolaccaceæ* (p. 811).

### 18. The Spinach and Beet Family.

*Herbs or small shrubs, often halophilous and fleshy, sometimes with a coating of wax or globular trichomes. Leaves alternate, mostly entire exstipulate, sometimes 0 in fleshy species. Flowers usually green, 1-2-sexual, often dimorphic, sometimes ebracteate. Perianth herbaceous or membranous, persistent and of 3-5 free or connate tepals, imbricate in bud, or sometimes 0. Stamens 5 or fewer, opp. the tepals, hypogynous or perigynous. Ovary 1-celled with usually 2, more rarely 3-4, very seldom 5 stigmas (1-5-carpellary). Ovule 1 campylotropous with 1-2 integuments, on a basal funicle. Fruit a utricle, often enclosed in the accrescent perianth. Seed albuminous or not. Embryo curved, annular or spiral.....Chenopodiaceæ* (p. 807).

### 19. The *Amaranth* Family.

*Herbs, rarely shrubs or undershrubs with opp. or alt. exstipulate usually entire leaves. Fls. small, green or coloured, of chaffy texture and often shining, sometimes 1-sexual, in dense heads or spikes or paniced clusters. Bracts and 2 bracteoles nearly always present and resembling the perianth in texture. Tepals 5 persistent, imbricate. Stamens 1-5 opposite the tepals or diplostemonous with the alternate ones reduced to staminodes, filaments often united into a ring or cup at base. Ovary usually free sometimes adnate to the perianth in fruit, of 1-3 carpels, 1-celled. Styles 0-3, rarely 4. Ovules 1, rarely (*Celosieæ*) several, campylotropous, erect basilar, or pendulous from a slender basal funicle. Fruit a utricle, rarely baccate capsular or nut-like. Seed compressed, testa hard. Embryo annular, or horseshoe-shaped, albumen mealy.....Amarantaceæ* (p. 795).

## Order V. POLYGONALES.

*Herbs, rarely shrubs, often with swollen nodes. Leaves simple entire, usually alternate, frequently dotted and with connate or tubular membranous stipules which sheath the terminal bud. Flowers 1-2-sexual, small, regular, bracteate, in spikes or heads, mostly 3-5-merous and haplo- or homioichlamydeous or much reduced and perianth 0. Stamens hypogynous or slightly perigynous, 5-8 or sometimes reduced to 2, when isomerous then opposite the tepals. Ovary 1-celled of 3-1 carpels*

or carpels free, with 1 (rarely more) basal erect orthotropous ovule. Embryo in copious albumen.

The *Piperaceæ* have possibly only superficial resemblances to the *Polygonaceæ*, with which they are united. The structure of the stem with scattered bundles, somewhat like the monocotyledons\* and water-lilies, sometimes apocarpous ovary, minute embryo and other characters may possibly point to their being allied to the *Ranales*, in which combination of orders Hutchinson places them. The straight ovule, however, is very unlike any of the *Ranales*, as is the inflorescence.

Families: 20. *Polygonaceæ*; 21. *Piperaceæ*.

## 20. The Dock and Rhubarb Family.

Herbs, rarely shrubs, occasionally scandent (twining or with tendrils). *Stipules mostly membranous and ochreate. Fls. usually 2-sexual, jointed on the pedicel, usually clustered, clusters often spicate or paniced. Perianth of 3-6 free or connate persistent tepals imbricate in bud. St. 5-8, rarely more or fewer, opp. the tepals. Ovary free, 2-3-gonous with 1-3 styles. Fruit a nut, usually enclosed in the sometimes accrescent perianth. Embryo various, radicle superior.....Polygonaceæ (p. 811).*

## 21. The Pepper Family.

Herbs or shrubs often climbing by means of adventitious roots, aromatic with secretory cells. Leaves often palmately nerved. *Stipules connate and intrapetiolar or adnate or 0. Fls. minute, achlamydeous, 1-2-sexual in bracteate spikes, bracts usually peltate or adnate to rachis. St. 2-6 rarely 1 or 7-8, hypogynous. Ovary 3-4-carpellary, 1-celled, or of 3 or more carpels free or connate only below, stigmas sessile. Ovules 1 or more, orthotropous. Fruit baccate, or from apocarpous ovaries coccous or follicular. Seeds globose. Embryo minute, enclosed in a sac of endosperm at one end of the copious floury perisperm. Cotyledons minute or obsolete, radicle superior.*

*Piperaceæ (p. 825).*

## Order VI. THEALES (Guttiferales).

(←—Dilleniaceæ.  
—→ Myrtales and Ebenales.)

*Woody, more rarely herbaceous, often resinous (juice then frequently yellow). Leaves opposite or usually alternate and penninerved, entire, often dotted.† Flowers regular, cyclic, mostly 5-merous or perianth 2-6-merous, hypogynous. Stamens many but frequently in 5 bundles or somewhat connate or in a central mass (flowers then 1-sexual), often several-seriate. Ovary syncarpous and several-celled with axile*

\* The bundles are usually in irregular rings with wood and bast normally orientated and mostly open. The resemblance to those of the Monocotyledons and water-lilies is therefore only superficial.

† Secretory cavities appearing as translucent or black opaque dots.

*placentation*; if 1-celled then ovules on the sutures of the carpels, not on their midrib. *Styles usually free and ending in a point*. Fruit never coccous. Albumen scanty or 0.

Exceptions:—

Flowers of *Theaceæ* sometimes hemicyclic.

Fls. of *Guttiferaceæ* often with sepals in decussate pairs as in *Parietales*. Ovules sometimes apparently parietal in some *Hypericaceæ*, but the placentæ sutural, not on midrib of carpels, and stamens in bundles.

Leaves of some *Hypericaceæ* and of *Guttiferaceæ* are opposite.

*Elatinaceæ* are small herbs.

Families: 22. *Hypericaceæ*; 23. *Elatinaceæ*; 24. *Theaceæ* (*Ternstroemiaceæ*); 25. *Guttiferaceæ*; 26. *Dipterocarpaceæ*.

The *Dilleniaceæ* are sometimes placed in this order, but they are mostly acyclic and ovary mostly apocarpous.

The *Tamaricaceæ* are placed in this order by Engler as a sub-order. The *Ochnaceæ* are placed in this order by Engler and by Hutchinson. I have kept them in *Geraniales* on account of their lobed ovary and (in our species) coccous fruit, well-developed disc, free filaments, elongate basifixed anthers.

## 22. The Tutsan Family. (—→ *Parietales*.)

Herbaceous or woody with frequently resinous juice. Leaves entire, exstipulate. Flowers yellow, regular. Sep. and pet. 4—5. *St. many in 3—5 bundles*. Carpels 3—5 united into a 1-celled or 3—5-celled ovary with 3—5 free or united styles. Ovules few or many parietal or, in several-celled ovaries, axile from the intrusion to the centre and then recurving of the placentæ. Capsule septicial, or dehiscent through the placenta in 1-celled ovaries, or septicial-septifragal.

*Hypericaceæ* (p. 53).

## 23. The Water-pepper Family.

Usually small marsh herbs with opposite or whorled simple stipulate leaves. Fls. very small. Sep. and pet. 3—5, free, imbricate. *St. isostemonous or diplostemonous with versatile anthers*. Ovary with 3—5 cells and styles. Ovules many axile. Capsule septicial or loculicidally septifragal. Seeds and embryo straight or curved.....*Elatinaceæ* (p. 51).

## 24. The Tea Family.

Woody plants with usually evergreen exstipulate leaves and small or showy, sometimes dioecious fls. Fls. solitary or clustered subtended by 2 sepal-like bracts. Sep. 4—7, free or slightly connate. Pet. 4—9, imbricate or contorted in bud, free or connate below. Stamens many, outer in bundles and connate with the bases of the petals. Ovary free sessile 3—5-celled. Ovules 2—many in each cell, axile. Frt. baccate or capsular. Seeds large, few. Albumen scanty or 0.

*Ternstroemiaceæ* or *Theaceæ* (p. 57).

## 25. The Gamboge Family.

Woody plants with resin canals containing a yellow milky juice. Leaves evergreen opposite entire with the secondary venation often of very numerous fine parallel nerves nearly at right angles to the midrib. Fls. often rather large, 1—2-sexual. Sep. 2—6 imbricate or in decussate

*pairs*. Pet. 2—6 *imbricate or contorted*. St. many free or *monadelphous* in a dense central mass or *in bundles*, anthers dehiscing by pores or slits or transversely. Disc fleshy, sometimes lobed. Ovary 1—many-celled. Stigmas radiating free, connate or peltate. Ovules 1—2 or many, axile or basal and erect. *Seeds large, often arillate*, albumen 0. *Guttiferaceæ* (p. 54).

**26. The Sal Family.**

Trees with *resinous substances in the leaves, wood or bark*. Leaves alt. Stipules caducous. *Fls. paniced*. Sep. 5 *connate below, often unequal*. Pet. 5 *contorted*, sometimes connate at base. St. usually a multiple of 5. Ovary slightly sunk in the broad concave torus, 3-celled with 2 ovules in each cell, usually only one developing, style and stigma simple. Fruit a nut more or less enclosed in the calyx, of which 2 or more sepals develop into linear wings. Seed exalbuminous with 2 large fleshy cotyledons.....*Dipterocarpaceæ* (p. 57).

**Order VII. PARIETALES.**

(←—*Theales*.)

Herbs, more rarely woody. Flowers cyclic regular to zygomorphic (if zygomorphic then ovary 3—2-carpellary) and whorls very often 2-merous or 4-merous, hypogynous to epigynous. Sepals and petals usually present and free, or sometimes connate. Stamens many or few, never in threes (apparently sometimes 3 in *Cucurbitaceæ* owing to 2 pairs being connate). Ovary syncarpous, sometimes on a gonophore, of 2—3 or rarely more *carpels* forming a 1-celled ovary with *parietal placentation*. Placentæ on the *midrib or mesial line of the carpels*,\* which sometimes nearly meets in the axis, or scattered all over the walls of the carpel (as in *Carica*), or on the edges of the carpel (e.g. *Cruciferae*) and ovary sometimes divided by a replum. Leaves mostly simple alternate.

Exceptions (see also brackets under the sub-orders).

Leaves decomposed in *Moringaceæ* (position of which is very doubtful), palmately compound in some *Passifloraceæ* and *Cucurbitaceæ*.

Flowers irregular in many *Fumariaceæ*, *Violaceæ*, *Moringaceæ*, and slightly so in a few others.

Stamens often connate in pairs (and an odd one, with 1-celled anthers) in *Cucurbitaceæ*: united into a tube below in some *Flacourtiaceæ*.

\* This, apparently, is not the view of the text-books, which, so far as I know, never refer to placentation on a mid-rib, although they necessarily admit cases of ovules scattered all over the wall. The theory of mesial placentation is based on the position of the stigmas, which it is assumed are median and over the midrib of the carpel as is evident in most cases. Were such mesial placentation constant it would form a valuable character for the *Parietales*, but some families in the order have the ovules distinctly on the margins of the carpels. As there are all grades of ingrowing of the margins until they meet in the axis, there appears in many cases to be little significance in the so-called parietal placentation where marginal as in distinction to purely axile, and I fear that the order *Parietales* is a very heterogeneous group.



Corolla often gamopetalous in *Cucurbitaceæ* and *Caricaceæ*.

Ovary several-celled by intrusion of the placentæ in some *Flacourtiaceæ* and placentæ, nearly meeting in several other cases, the cell often filled with pulp. Placentæ adnate to axis in *Begoniaceæ*.

### Sub-order RHŒADINÆ (p. 108).

Perianth whorls 2-(—4)-merous often a tetramerous corolla placed diagonally, stamens many or few. Ovules truly parietal or apparently on the carpellary margins and often margins united by a replum (in *Cruciferæ* and some *Capparidaceæ*).

27. *Papaveraceæ*; 28. *Capparidaceæ*; 29. *Cruciferæ*; 30. *Fumariaceæ*.

### Sub-order CISTINEÆ (p. 109).

Sep. and pet. 4—5. St. many. Ovary superior with 2—5 placentæ. 31. *Bixaceæ*.

### Sub-order FLACOURTINEÆ (p. 109).

Fls. often 1-sexual and sometimes perigynous. Petals often falling, sometimes with a ligule (*Turneraceæ*). Placentæ 3. Stamens 5 or more numerous in 1—many series.

32. *Flacourtiaceæ*; 33. *Violaceæ*; 34. *Turneraceæ*; 35. *Pittosporaceæ*.

### Sub-order TAMARISCINEÆ\* (p. 110).

St. iso- or diplostemonous on the margins of a crenulate disc. Carpels 3. Placentation sub-basal.

36. *Tamaricaceæ* (position doubtful).

### Sub-order MORINGINEÆ\* (p. 110).

Sep., pet., and st. on the margins of a perigynous disc. Fls. irregular, calyx petaloid. Carpels 3.

37. *Moringaceæ* (position doubtful).

### Sub-order PASSIFLORINEÆ\* (p. 111).

Fls. regular or nearly so. Stamens very many to definite. Ovary of 3 carpels united into an inferior or rarely superior in (*Passifloraceæ* and *Caricaceæ*) ovary, placentæ sometimes meeting in 6r adnate to axis. Mostly herbs climbing by tendrils. *Carica* a small tree with latex.

38. *Caricaceæ*; 39. *Passifloraceæ*; 40. *Cucurbitaceæ*; 41. *Begoniaceæ*.

### Sub-order RHŒADINEÆ (p. 108).

#### 27. The Poppy Family.

Herbs with milky juice. Flowers regular. Sepals 2 or 3. Petals 2+2 or 3+3. Stamens many. Ovary 1-celled with 2-several parietal

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\*These sub-orders have little in common either with preceding or with one another.

*placentæ* often (*Papaver*) projecting as lamellæ from the mid-ribs of the carpels (the lamellæ immediately under the stigmas), stigmas where many radiating and often connate into a disc. Fruit capsular. Seeds many small, albuminous.....*Papaveraceæ* (p. 23).

**28. The Caper Family.**

Woody or herbaceous. Leaves simple or digitate, stipules when present sometimes converted into prickles. Fls. regular. *Sep.* 4. *Pet.* 4. *St.* 4 or 4—8 (if 6 then not tetradynamous) or many. Ovary usually on a gynophore, 1-celled with 2—4 parietal *placentæ*. Replum sometimes present in 2-celled capsules. Ovules many *campotropous*. Fruit capsular or baccate. Seeds exalbuminous. *Embryo* curved or spiral.  
*Capparidaceæ* (p. 30).

**29. The Mustard and Cabbage Family.**

Herbs with exstipulate alt. leaves. Fls. regular or outer (in a corymb) radiant. *Sep.* 4 free. *Petals* 4. *St.* 6, of which 2 are shorter solitary opposite the lateral sepals and 4 longer paired opposite the median sepals (*tetradynamous*) very rarely stamens only 4 or 2. Ovary of 2 carpels, septate longitudinally by a replum.....*Cruciferaæ* (p. 24).

Exceptions:—

Some cultivated forms of *Brassica* have several carpels and a similar number of valves to the fruit.

**30. The Fumitory Family.**

Herbs with watery juice, often rambling or climbing. Leaves usually lobed or dissected. Fls. irregular, racemose. *Sepals* 2 very small and deciduous. *Pet.* 2+2, 2 outer larger. *St.* 6 in two bundles opposite the outer petals. Ovary 1-celled. *Placentæ* 2. Ovules 2 or more parietal, or 1 placenta sterile and ovule 1.....*Fumariaceæ* (p. 24).

**Sub-order CISTINEÆ (p. 108).**

**31. The Arnatto Family.**

Woody plants with palminerved or palmately-lobed large leaves and usually minute caducous stipules. Flowers large, regular 2-sexual, paniced. *Sep.* 4—5 free. *Pet.* 4—5 free, large. *St.* many. Ovary 1-celled with parietal placentation and many *anatropous* ovules. *Carpels* 2—5. Style slender. Fruit a 2—5-valved capsule. Seed sometimes comose or arillate. Albumen copious. *Embryo* usually curved.....*Bixaceæ* (p. 35).

**Sub-order FLACOURTINEÆ (p. 108).**

**32. The Flacourtia and Casearia Family.**

Woody plants with usually penninerved leaves\* frequently dotted. Stipules small caducous. Fls. small often 1-sexual. *Sepals* 4—several hypogynous or sub-perigynous. *Petals* small or 0, 1—3-times as many as *sepals* or indefinite. Torus often with glands. *St.* definite or

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\* Although the leaves are mostly penninerved the cotyledons are often palmi-  
nerved.

indefinite, if isomerous with petals then opposite to them, *often perigynous*. Ovary superior to inferior, 1-celled with 2—8 (usually 3—5) placentæ or as many-celled. Seeds 1 or more, sometimes arillate.

*Flacourtiaceæ* (p. 36).

### 33. The Violet Family.

Herbs with entire stipulate leaves. *Fls. irregular. Sep. 5 persistent imbricate. Pet. 5 hypogynous, lower dissimilar. St. 5 hypogynous or slightly perigynous. Anthers often crested. Ovary 1-celled with many anatropous ovules on 3 parietal placentæ, style 1. Fruit a 3-valved loculicidal capsule. Seeds albuminous.....Violaceæ* (p. 33).

### 34. The Turnera Family.

Herbs or shrubs with alt. leaves usually 2-glandular at the base. Stipules small or 0. *Fls. regular, yellow, 2-sexual. Hypanthium short usually swollen at the insertion of the stamens. Sep. 5. Pet. 5, inserted at the base of the hypanthium. St. 5 more or less perigynous. Ovary free 1-celled with 3 parietal placentæ and 3 styles. Ovules many anatropous. Fruit a 3-valved capsule bearing the seeds in the middle of the valves. Seeds oblong curved with a membranous aril, fleshy albumen and terete embryo.....Turneraceæ* (p. 400).

### 35. The Pittosporum Family.

Woody plants. Leaves alt. or sub-verticillate, exstipulate. *Fls. regular, 2-sexual. Sep. 4—5. Petals 4—5, coherent at base, hypogynous. St. isomerous. Ovary sessile, incompletely 2—3-celled by the projection of the parietal placentæ. Style 1. Ovules anatropous 2 or more on each placenta. Fruit capsular, 2—3-valved, the valves bearing the seeds along their mesial line. Embryo minute near the hilum, in fleshy or leathery albumen.....Pittosporaceæ* (p. 41).

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## Sub-order TAMARISCINEÆ (p. 108).

### 36. The Tamarisk Family.

Woody plants with scale-like leaves. *Fls. regular, spiked or racemed. Sep. and pet. 5, rarely 4, imbricate, free or connate below. St. iso- or diplostemonous, on the margin of a crenulate disc which is sometimes sub-perigynous; anthers versatile. Ovary free 1-celled, styles or sessile stigmas 3—5. Ovules usually many, anatropous. Capsule 2—3-valved, placentæ either at base or mesial on the valves. Seeds comose. Albumen 0 (in our genus). Embryo straight.....Tamaricaceæ* (p. 52).

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## Sub-order MORINGINEÆ (p. 108).

### 37. The Horseradish Tree Family. Affinities very doubtful.

Small trees with alt. 2—3-pinnate deciduous leaves. *Fls. zygomorphic, 2-sexual. Sep., pet. and st. on the margin of the disc which lines a cupular perigynous hypanthium. St. in 2 whorls, the episepalous ones*

often reduced to staminodes, *anths.* 1-celled. Ovary 1-celled with 3 *placentæ*. Ovules numerous, 2-seriate on each placenta, anatropous with ventral raphe. *Fruit pod-like, 3-valved.* Seeds on the central line of each valve, 3-winged or wingless. Albumen 0. Embryo straight with thick cotyledons.....*Moringaceæ* (p. 235).

**Sub-order PASSIFLORINEÆ** (p. 108).

**38. The Papaya Family.**

Small tree with usually a simple crown of very large *palmately-lobed* leaves and *milky juice*. Fls. monœcious or diœcious, or male and hermaphrodite. Corolla of male gamopetalous, of female larger, polypetalous. *St.* 10 in two whorls, fem. with staminodes. Ovary 1- or 5-celled superior with short style and 3—5 *palmately-branched stigmas*. Herm. fls. with 5 hypogynous stamens or *stam.* 10 perigynous or 10 epigynous. Ovules *very numerous*, scattered all over the walls of the ovary. Seeds albuminous.....*Caricaceæ* (p. 402).

**39. The Passion-flower Family.**

Climbing by means of tendrils, rarely twining. Leaves *palmate or palmately-divided* and palmnerved, frequently with few large glands or glandular areoles on under-surface or petioles. Hypanthium usually well-developed tubular or campanulate with 3—5 sepals. Corona of 1—many-seriate filaments or paleæ usually present on a broad zone of the hypanthium inside the corolla, a thick annular disc sometimes inside the corona. Stamens 5, alternating with the petals. Ovary sometimes sub-sessile but *usually on a gonophore with the stamens*, 1-celled with 3 (*rarely 4*) *placentæ*. *Seeds arillate*.....*Passifloraceæ* (p. 401).

**40. The Gourd Family.**

*Climbing by means of tendrils.* Leaves simple, often palmately lobed or pedately divided, rarely subpinnatifid; *venation palmate or pedate*. Fls. small to very large, *monœcious or diœcious*. Calyx and corolla inserted on a variously shaped often elongate hypanthium which is constricted above the ovary, poly- or gamophyllous. *St.* inserted inside or on the hypanthium, normally 5, but often 2 prs. connate so that there are apparently 3; *anthers 1-celled, cells straight or vermiform*. Ovary 1-celled with 3 (—5) *placentæ*, sometimes *placentæ meeting in the axis*. Ovules usually many. Fruit a berry or finally with hard rind and sometimes opening by a stoppel. *Seeds exalbuminous with straight embryo*.....*Cucurbitaceæ* (p. 402).

**41. The Begonia Family.**

Succulent herbs with unequal-sided leaves and often persistent stipules. Fls. *monœcious, bilateral*, rarely quite regular. *Male perianth* of 2 *outer valvate opp. tepals* and 2 or 0 *smaller inner ones*, fem. per. of 2—5, rarely 6—8 tepals, if more than 2 then imbricate, the 2 *outer more or less covering the inner*. *St. many*. Ovary *inferior, 2—4, usually*

3-celled with 2—4 free or partially connate styles. Ovules very many on axile or sub-axile placentæ. Fruit usually capsular, often winged. Albumen scanty or 0.....*Begoniaceæ* (p. 418).

### Order VIII. MALVALES.

Woody or herbaceous, with usually tenacious bast, alt. simple or palmately compound usually stipulate leaves with palmate (rarely pinnate) venation and hairs usually stellate. Flowers usually regular, rarely zygomorphic, usually 5-merous and dichlamydeous, bracteoles often present as an epicalyx. Calyx valvate gamosepalous or (most *Tiliaceæ*) free and corolla hypogynous. Stamens usually many, often mono- or poly-adelphous, more rarely diplostemonous or with one whorl suppressed, anthers 1—2-celled. Ovary of 2—many carpels with axile placentation, often showing a tendency to become coccous, or follicular in fruit, otherwise usually capsular and 3—5-celled.

Exceptions:—

Stellate hairs few or absent in some *Bombaceæ*, *Corchorus*, few *Hibiscus*.

Petals 0 in *Sterculia*.

Carpels reduced to one in *Waltheria*.

Fruit drupaceous in *Grewia*, *Elæocarpus*.

Families: 42. *Tiliaceæ*; 43. *Sterculiaceæ*; 44. *Malvaceæ*.

#### 42. The Jute Family.

Woody or herbaceous. Leaves rarely deeply lobed. Flowers regular, often small, without an epicalyx. Calyx with free sepals (connate below in *Brownlowia*), deciduous. St. many, not united into a tube, more rarely 10 or 5, anthers 2-celled. Ovary 2—10-celled. Ovules anatropous. Fruit drupaceous or capsular. Seeds 1—many, exarillate, usually albuminous.....*Tiliaceæ* (p. 87).

#### 43. The Sterculia Family.

Woody rarely herbaceous. Flowers regular or zygomorphous, often polygamous. Calyx persistent gamosepalous. Epicalyx rarely present. Stamens usually obdiplostemonous with the alternate whorl often reduced to staminodes, rarely 5 only but sometimes many, monadelphous or united into a tube at the base. Anths. 2-locular and extrorse. Ovary usually 5-celled. Fruit mostly capsular, sometimes follicular.

*Sterculiaceæ* (p. 77).

#### 44. The Mallow and Cotton Family.

Woody plants or herbs. Leaves simple with palmate venation or digitate. Fls. regular. Calyx usually persistent and gamosepalous. Epicalyx usually present. St. many united into a tube or (Tribe *Bombaceæ*) more or less free and pentadelphous, anthers ultimately 1-celled, cells often sinuous. Ovary of 5—(rarely 3—) many carpels separating into cocci when ripe and leaving a persistent columella, or fruit capsular. Ovules 1—more axile curved. Seeds with scanty or 0 albumen. Cotyledons foliaceous, usually crumpled or folded and palmately nerved.....*Malvaceæ* (p. 59).

**Order IX. EUPHORBIALES.**

Habit very various, sometimes fleshy, aquatic in *Callitriche*. Leaves simple, sometimes palmate or palmately nerved, alternate, usually stipulate. Flowers usually much reduced, sometimes to a single stamen or single ovary but sometimes heretochlamydeous; 1-sexual, regular, often 2-3-merous. Stamens definite or indefinite, anthers 2- or 4-locellate, sometimes cells confluent into one. Ovary most often of 3 carpels, sometimes carpels 2, connate into an entire or lobed 3-2-celled ovary with 1-2 ovules axile, or pendulous from the inner angle of each cell. Fruit of 2-valved cocci or pyrenes or capsular, rarely baccate or drupaceous with a 3-1-celled stone. Seeds albuminous. Cotyledons usually large and flat and often palminerved.

Exceptions:—

Leaves opposite in *Trewia* (though alt. in the seedling); opp. or sub-verticillate in *Callitrichaceæ*.

Leaves 3-foliolate in *Bischofia*.

Stamens 1-3 in *Tragia* which has stinging hairs, 2-5 in *Antidesma* spp., 2-3 in *Sapium*.

Fruit sub-baccate in *Kirganelia*, *Flueggea*, *Bischofia*, etc., but not truly so as there is a thin endocarp which may be dehiscent or pericarp finally hardened.

Ovary 1-celled in *Antidesma* with usually 3-2-lobed styles.

Embryo terete in *Callitriche* with long radicle.

Families: 45. *Euphorbiaceæ*; 46. *Callitrichaceæ*.

**45. The Croton and Castor-oil Family.**

Woody, herbaceous or fleshy, sometimes with milky juice, stellate hairs frequent. Fls. reduced to a single pedicelled stamen or ovary in *Euphorbia*, *Pedilanthus* and *Synadenium*, in which case the flowers are arranged in an involucrate inflorescence resembling single flowers. Perianth dichlamydeous, monochlamydeous or 0, usually 3-5-merous. St. many, or 3-5, frequently in a central column. Ovary of 3 carpels and 3-celled (rarely 2-merous), or sometimes carpels several round a central columella (as in *Malvaceæ*).....*Euphorbiaceæ* (p. 100).

Possibly a composite family derived from different sources, among which the *Celastrales* and *Rhamnales* have been suggested. The alliance of some tribes with the *Malvales* seems undoubted. There also appear to be affinities with some of the *Sapindales*.

**46. The Water Starwort Family.**

Small weak often aquatic herbs with opposite or sub-verticillate (when floating) leaves which are narrow entire and 3-nerved. Hairs sometimes stellate. Fls. monœcious, reduced to a single stamen or a single naked ovary, usually solitary axillary. Ovary of 2 carpels each divided by a partition to form a 4-celled 4-lobed ovary with 2 simple stigmatose styles. Ovules 1 in each cell, pendulous, with only 1 integument. Fruit splitting into 4 cocci or drupels. Seeds albuminous. Embryo central terete.....*Callitrichaceæ* (p. 154).

**Order X. URTICALES.**

Woody or herbaceous, often with tough long bast fibres (as in the *Malvales*) and frequently with palmate venation (as in that order).

Leaves simple, stipulate. Latex cells and tubes abundant in some families (as in the *Euphorbiales*) and stinging hairs (with same structure as those of *Jatropha*) found in *Urticaceæ*. *Inflorescence rarely in simple spikes, usually in cymes or clusters, often developing into large pseudocarps from the aggregate fleshy axes. Flowers always much reduced, small greenish (rarely red) regular, 1—2-sexual. Male usually 4—5-merous with isomerous epitepalous stamens or stamens fewer in some Moraceæ. Female with a 2—5-toothed or -partite perianth, or perianth rarely 0. Ovary superior 1-celled of 1—2 carpels with simple or 2-fid stigma. Ovule 1 erect or pendulous. Fruit usually small indehiscent with large embryo in scanty albumen. Embryo straight, curved or spiral, sometimes with one cotyledon conduplicately folded over the other.*

**Exceptions:—**

Leaves palmately divided in *Cannabis* and seedling leaves of some *Moraceæ* pinnatifid.

Flowers when crowded inside an aggregate fleshy axis (forming a receptacle as in Figs) sometimes with a minute hyaline gamophyllous perianth of uncertain number of leaves and stamens often only 1 or 2.

Perianth 4—8-tepalous and stamens isomerous or more in *Ulmaceæ*.

Families: 47. *Ulmaceæ*; 48. *Cannabinaceæ*; 49. *Urticaceæ*; 50. *Moraceæ*.

**47. The Elm Family.**

Trees with 2-farious leaves frequently with cystolith-cells (sometimes visible as translucent dots); stipules lateral or intrapetiolar. Flowers usually polygamous or dioecious in axillary clusters or cymes, or female sometimes solitary. Perianth 4—8-merous, lobes free or connate. Anthers erect in bud. Ovary of 2 median carpels, usually 1-celled; stigmas 2 large, or style 2—4-fid. Ovule 1 pendulous. Fruit indehiscent, often samaroid or drupaceous. Albumen 0 or scanty. Embryo straight or curved with flat or folded cotyledons.....*Ulmaceæ* (p. 846).

**48. The Hemp and Hop Family.**

Shrubby or herbaceous without milky juice, often resinous. Leaves opp. and alt. palmately nerved or palmately divided; stipules persistent free. Flowers dioecious, males cymose, females in contracted cymes or heads with large bracts. M. perianth with 5 imbricate tepals, filaments straight in bud. Fem. perianth entire, much reduced. Ovary 2-carpellary, 1-celled, with 2 large feathery stigmas. Ovule 1, pendulous anatropous. Fruit an acheme. Embryo curved or spiral. Albumen present or not.....*Cannabinaceæ* (p. 849).

**49. The Nettle Family.**

Herbs or undershrubs, rarely shrubs or small trees, sap watery. Leaves opposite and alternate, often palminerved (usually 3-basal-nerved); dots due to cystoliths frequent. Stipules membranous, sometimes intrapetiolar. Flowers monœcious or dioecious, cymose or clustered, cymules or clusters often in higher inflorescences. Perianth sometimes 2—3-merous especially in the female, when the perianth is frequently

gamophyllous and closely invests the ovary. *Filaments incurved in bud* with anthers reversed, dorsifixed. *Ovary superior*, probably 1-carpellary only, 1-celled with simple or 0 style and *papillose plumose or penicillate stigma*. *Ovule 1 sub-basilar, erect, orthotropous*. Fruit small indehiscent, usually invested by the perianth and sometimes accrescent and fleshy. Seed albuminous. Embryo straight.....*Urticaceæ* (p. 850).

### 50. The Fig and Mulberry Family.

*Woody plants, nearly always with milky juice contained in laticiferous tubes, cystoliths often present*. Leaves very rarely opposite, rarely deeply cut; stipules deciduous, often large and sheathing and leaving a prominent annular scar at the node like that of many *Magnoliaceæ*. *Flowers small or minute, dioecious or monoecious, cymose, more rarely spiciform, the cymes often dense and in some genera with their axes coalescent into a common floral receptacle, in some genera very fleshy and bearing the numerous minute flowers scattered outside or by peripheral growth inside the receptacle (figs.)*. Tepals usually 4, seldom 2, 3, 5, or 6, free or connate, female perianth often accrescent in fruit. *Ovary 2-carpellary, 1-celled*. *Ovule 1 pendulous from apex, amphitropous with micropyle superior, rarely basal and orthotropous*. Fruit often aggregated into large fleshy pseudocarps with the enlarged receptacle. Seed albuminous or not. Embryo mostly curved with unequal cotyledons, thick flat or one folding the other.

*Moraceæ* (p. 859).

## Order XI. GERANIALES.

(← *Malvales*.)

Herbaceous or woody, frequently with resin passages or secretory cells or glandular. Leaves simple or very commonly pinnate, occasionally digitate, often dotted or aromatic. *Flowers regular, rarely irregular (see exceptions), 2-sexual, 3-5-merous, hypogynous*. Sepals often connate at the base. *Torus raised in centre into the centre of the ovary, or disc well developed and hypogynous, annular or tubular or of glands only*. *Stamens inserted outside the disc, free or connate into a tube, diplostemonous or obdiplostemonous, one whorl sometimes reduced to staminodes (or absent in *Balsaminæ*)*. *Ovary of 3-5 rarely more or of 2 carpels, syncarpous but frequently lobed and carpels sometimes nearly or quite free (coccous) in fruit*. Fruit various, often coccous or splitting into pyrenes or drupaceous. *Ovules 1-2 in each cell, usually pendulous with ventral raphe and superior micropyle*.

Exceptions:—

Disc often feebly developed or 0 in sub-order *Gruinales* and flowers often irregular and spurred in the same sub-order and stamens only 5 in *Impatiens*.

Fls. 3-7-merous in some *Meliaceæ, Rutaceæ, Burseraceæ* and *Anacardiaceæ*.

Stamens sometimes only 2-3 in hermaphrodite flower of *Simarubaceæ*, 5 in few *Anacardiaceæ* (reduced to 1 perfect in *Mangifera* with staminodes), and very few *Meliaceæ*, many in some *Ochnaceæ* and few *Rutaceæ* (only 2-5 in *Toddalia*).

Carpels sometimes 1 only or 3-6 free in *Anacardiaceæ*, often numerous in *Ochnaceæ* and some *Rutaceæ* (*Citrus*).



Ovules numerous in each carpel in some *Meliaceæ* (Tribe *Swietenieæ*), 3—more in *Balsaminaceæ*, some *Oxalidaceæ* (e.g. *Averrhoa*), some *Zygophyllaceæ*, few *Rutaceæ*.

Ovule only one in each cell in *Anacardiaceæ* with inferior micropyle and dorsal raphe. The family is usually placed in the *Sapindales*.

### Sub-order GRUINALES (p. 116).

Disc usually poorly developed (well developed in *Ochnaceæ* and *Zygophyllaceæ*) or perhaps represented by the connate base of the stamens or of glands, sometimes 0. Torus often projected as a cone or beak into the centre of the ovary. Corolla sometimes spurred and irregular (some *Geraniaceæ*, *Balsaminaceæ*, *Tropæolaceæ*). (The *Malpighiaceæ* might also be included here.) Fruit various but often 5-ridged or -coccous, carpels sometimes adnate to the beak, when this is present, and elastically recoiling when ripe.

Families: 51. *Ochnaceæ*; 52. *Linaceæ*; 53. *Zygophyllaceæ*; 54. *Geraniaceæ*; 55. *Balsaminaceæ*.

The *Ochnaceæ* are perhaps related to the *Theales*.

### Sub-order RUTALES (p. 117).

Hypogynous disc tubular or well developed. Flowers often polygamous. Leaves very frequently pinnate.

Families: 56. *Rutaceæ*; 57. *Meliaceæ*; 58. *Simarubaceæ*; 59. *Burseraceæ*; 60. *Anacardiaceæ*.

### Sub-order GRUINALES (p. 116).

#### 51. The *Ochna* Family. (Description mainly confined to *Ochna*.)

Glabrous trees or undershrubs with alt. *simple stipulate leaves*. *Fls.* usually *showy yellow*, sometimes umbelled. *Sep.* *persistent* and often *deeply coloured in fruit*. *Pet.* 5—10. *St.* *many on the large disc* which is yet larger in fruit and is projected into the centre of the ovary as in *Geraniaceæ* (drupels adnate to a central column); *anthers* *elongate basifixed opening by terminal pores* or longitudinally. *Ovary* *deeply 3—10-lobed*, the lobes becoming *drupels in fruit*.....*Ochnaceæ* (p. 175).

#### 52. The Flax Family.

Shrubs or herbs with alt. *simple entire leaves*, sometimes stipulate. *Sep.* 4—5 free or connate below. *Petals* fugacious. *Alternate stamens* usually *reduced to staminodes*; *fil.* *united at the base* into an hypogynous or sub-perigynous ring. *Ovary* *3—5-celled*, not lobed, *styles* 3—5. *Fruit* *drupaceous or septicidally separating into 3—5 cocci*, the cocci not adnate to a central column. *Seeds* with little or 0 albumen. *Embryo* straight, rarely slightly curved.....*Linaceæ* (p. 155).

#### 53. The Beancaper Family.

Woody or herbaceous, sometimes thorny, with *opposite*, rarely *alternate* (*Peganum*) usually *pinnate* (sometimes with 2 lfts. only) *stipulate leaves*. *Sep.* and *pet.* 5, rarely 4, free or united at the base. *St.* (12—15

in *Peganum*) outside disc, often appendaged at base with a scale. Ovary more or less 4—5-furrowed with 4—5 cells, rarely only 2—3- or 5—12-lobed and -celled. Ovules 1—several axile pendulous in each cell. Fruit capsular or of cocci, or (*Balanites*) drupaceous with a hard 5-angled endocarp with only 1 cell developing. Seeds albuminous or not. Embryo with large cotyledons and straight superior radicle.  
*Zygophyllaceæ* (p. 158).

**54. Geranium Family.**

Herbs or undershrubs, rarely trees, with simple or compound, stipulate, often palminerved leaves. Fls. regular or somewhat zygomorphous or spurred. Pet. 5, usually alternating with glands. St. 10 (in our genera), outermost opposite the petals. Ovary 3—5-lobed or -celled, with 1—2 or 2—many ovules in each cell pendulous. Fruit capsular or of beaked cocci adnate for their whole length to a central column from which they separate when ripe, or baccate with the berry 5-ridged. Embryo often green in albumen.....*Geraniaceæ* (p. 160).

**55. The Balsam Family.**

Herbs with simple exstipulate penninerved leaves and usually showy ebracteate zygomorphic flowers. Sep. 3 rarely 5, imbricate, large posterior differing from the others, petaloid and spurred. Pet. 5 or with two pairs connate. St. 5 with short broad filaments and connate anthers hooded over the stigma. Ovary 5-celled, often lobed. Ovules pendulous axile, raphe dorsal. Fruit a succulent capsule with the valves elastically opening upwards. Albumen 0.....*Balsaminaceæ* (p. 163).

**Sub-order RUTALES** (p. 116).

**56. The Orange Family.**

Trees or shrubs abounding in oil-glands which usually render the leaves copiously translucent-dotted, rarely glands only marginal. Leaves simple or usually 1-foliolate or pinnate, alt. or opposite, exstipulate. Pet. 4—5, rarely fewer or (some *Auranticeæ*) more. St. hypogynous, diplostemonous or many, inserted around a crenate or lobed sometimes elongate disc. Ovary entire or lobed, 4—5-celled (1-celled in *Feronia*) or more-celled (several *Auranticeæ*). Ovules usually 2, rarely 1 or more than 2 in each cell. Fruit various, rarely splitting into cocci, usually a copiously glandular berry. Seeds never winged. Albumen 0 (*Auranticeæ*) or fleshy.....*Rutaceæ* (p. 163).

**57. The Mahogany and Toon Family.**

Woody plants without translucent glands (exc. *Chloroxylon*). Leaves alt. usually pinnate, exstipulate. Fls. regular, mostly in axillary panicles. Sepals 3—6 often connate. Petals as many, often cohering. St. 4—12, usually diplostemonous, more or less united (exc. in the tribe *Cedreleæ*) into a petaloid tube outside the disc. Disc frequently tubular. Ovary 2—5 rarely 6-celled. Ovules 2 or many in each cell, rarely solitary. Seeds sometimes arilled or winged. Albumen thin or absent.  
*Meliaceæ* (p. 178).

**58. The Bitter-bark Family.**

Woody with bitter bark and alternate usually large *odd-pinnate leaves*. Stipules 0 or deciduous. *Fls. small, 3—5-merous*, often polygamous. *Sep. connate below, deciduous. Pet. valvate. Disc simple or lobed. St. 10*, sometimes 2—3 only in the herm. fl. *Ovary deeply 2—5-lobed. Ovule 1 in each cell. Fruit of as many samaras as fertile lobes of the ovary*.....*Simarubaceæ* (p. 174).

**59. The Myrrh Family.**

Trees or shrubs often secreting fragrant oleo-resins in the bast or cortex. *Leaves alternate odd-pinnate or reduced to three leaflets of which the lateral may become nearly or quite obsolete. Fls. often polygamous. Sep. 3—6*, often minute, *connate below. Pet. 3—6. St. inserted on the margin of or underneath the disc, free. Ovary usually 3*, sometimes 2—5-celled. *Ovules 2 in each cell, axile, pendulous. Fruit drupaceous, sometimes nearly dry, with usually 3 (1—5) free or united 1-seeded pyrenes. Albumen 0. Cotyledons usually twisted plicate or crumpled*.....*Burseraceæ* (p. 176).

**60. The Mango Family.**

Woody plants with *resin canals and tannin sacs* in the bast and often other parts. Leaves alternate (rarely opposite in *Nothopegia*), simple 3-foliolate or odd-pinnate with frequently strong secondary nerves. *Fls. polygamous, small, usually 3—5-merous, perfect stamens sometimes few (1 in some Mangifera). Calyx sometimes sub-perigynous, usually from a shallow hypanthium lined with a disc free at the margins. Stamens inserted near the margin of, or on, the disc. Ovary of 1 or 3—6 free or more or less connate carpels, with 1 ovule in each carpel or ovary-cell, pendulous, either from an ascending basal funicle or lateral or sub-apical with dorsal raphe. Fruit usually a 1-celled and 1-seeded often oblique drupe. Embryo large and fleshy, often curved.*

*Anacardiaceæ* (p. 227).

Exceptions:—Drupe several-celled in *Spondias*.

The *Anacardiaceæ* are usually placed in the *Sapindales*. They differ from the rest of the *Geraniales* in the inferior micropyle and dorsal raphe and from the *Burseraceæ* in the solitary ovule and mostly 1-seeded oblique drupe. Although both families have resin-canals in the bast and sometimes in the pith and cortex the *Burseraceæ* usually contain a bland fragrant balsam, gummy in appearance; in the *Anacardiaceæ* the contents are usually acrid\* and often milky in appearance though sometimes gummy.

**Order XII. SAPINDALES.**

Woody, very rarely (*Cardiospermum, Polygalaceæ*) herbaceous with *simple or compound exstipulate*, very rarely stipulate, alternate or opposite leaves. *Fls. usually small and more or less reduced or irregular in one or more of the whorls, often polygamous. Corolla sometimes 0 or if perianth regular and complete then stamens usually declinate or*

\* The extremely acrid juice of some species is however often found in special superficial cells, perhaps these are the tannin-sacs of *Salicoider* (*Anatomy of the Dicotyledons*), and are often found in leaves and pericarp.

fewer than diplostemonous, very commonly 8. Disc often unilateral and outside the stamens. Ovary commonly 3-celled or sometimes only 2-celled, very often lobed. Ovule 1—2 in each cell, usually axile or pendulous from the inner angle. Raphe usually dorsal. Fruit often samaroid. Albumen usually 0. Embryo often curved or spiral.

Exceptions:—

Disc 0 or inconspicuous in *Polygalaceæ* and *Malpighiaceæ* (which are often included in separate orders or placed in the *Geraniales*) and in male flower of *Dodonæa*.

Flowers regular with diplostemonous stamens in some *Malpighiaceæ*, but then ovary 3-celled and fruit of 3 samaras.

Stamens outside the disc in herm. fl. of *Dodonæa*.

Ovules several in each cell in some *Staphylleaceæ*.

Families: 61. *Malpighiaceæ*; 62. *Polygalaceæ*; 63. *Sapindaceæ*; 64. *Staphylleaceæ*; 65. *Sabiaceæ*.

### 61. The Malpighia Family.

Shrubs, mostly sarmentose or scandent by means of the (first erect then) spreading or reflexed opposite leaves, sometimes twining, or erect (outside our area). *L. simple entire*. Fls. regular or irregular, 2—1-sexual. Sep. 5 with a gland at the base of one or all. *Pet. 5 long-clawed, the fifth often different*. *St. diplostemonous*, hypogynous or sub-perigynous, often declinate or 1 or more sometimes larger. Carpels generally 3, connate into a 3-celled, sometimes deeply lobed or angled ovary. Ovule 1 in each cell pendulous with often long ascending and curved funicle, raphe ventral and micropyle superior. Fruit of 1—3 winged samaras. Embryo curved, circinate or straight.

*Malpighiaceæ* (p. 156).

### 62. The Milkwort Family.\*

Herbs, rarely woody with *alt. simple leaves*. Fls. irregular, clustered or racemose, bracteate. *Sepals 5 free, imbricate, of which 2 inner are often large and petaloid*, sometimes all petaloid. *Petals 5 or 3 of which anterior (keel) is usually modified*. *St. 8 or sometimes 4—5, combined into a split tube or free, anthers mostly 1-celled and opening by a pore*. Ovary compressed 2-celled. Ovules 1 pendulous in each cell. Fruit mostly a 2-celled thin capsule. Seeds with a strophiole. Albumen abundant.....*Polygalaceæ* (p. 41).

### 63. The Soap-nut Family.

Woody plants, rarely (*Cardiospermum*) climbing herbs, with *alt. pinnate* or rarely only 1—3-foliolate leaves. Fls. small or medium, usually polygamous and more or less irregular, rarely quite regular. *Calyx 4—8-lobed or -sepalous*. *Petals as many as or fewer than the sep.* or 0, often bearded or squamate at the base. *Stamens usually 8 (4—10), often unilateral and inserted inside, rarely outside, an annular or unilateral often lobed disc*, which is sometimes absent in one of the sexes. Ovary entire or lobed, sometimes excentric, usually 3-celled. Ovules 1

\* The English name and the scientific name (derived from the Greek meaning much milk) is due to its supposed virtue as a lactagogue, not from its having any milky juice.

rarely 2 in each cell. Fruit entire 1-lobed or winged. *Seeds often arillate*, albumen 0. *Embryo usually with curved or convolute cotyledons*.....*Sapindaceæ* (p. 218).

#### 64. The Staphylea Family.

Differs from the *Sapindaceæ* by the 5 *stamens only*, inserted outside the disc opp. the sepals. Ovary of 3 carpels free or connate, styles 3 short. *Ovules 2 or more in each cell*. Fruit baccate or of 3 dehiscent carpels.....*Staphyleaceæ* (p. 217).

#### 65. The Meliosma Family.

Woody, sometimes scandent, with alt. simple or odd-pinnate leaves. Fls. small, with 5—3 *sepals and petals*, often 2 *petals reduced to scales*. *St. as many as the petals and opposite to them* but frequently only 2 fertile and the others modified, inserted on or at the base of the disc. Ovary superior free, 2- rarely 3-celled, sometimes 2-lobed. *Ovules 2, rarely 1, in each cell, axile, superposed*. Fruit *drupaceous* and 1-seeded or of 2—3 *drupels*. Albumen 0, cotyledons conduplicate with long often spiral hypocotyl.....*Sabiaceæ* (p. 225).

### Order XIII. CELASTRALES.

Woody plants with *simple* alt. or opposite *leaves, often stipulate*. Flowers small *regular* mostly 4—5-merous. Petals sometimes connate below, usually imbricate, rarely 0. *Stamens isomerous and alternate with or sometimes fewer than the petals usually inserted on a well-developed disc, and hence often perigynous* and sometimes enclosing the ovary. Ovary 2—5- often 3-celled with 1—2 *erect or ascending ovules* axile in each cell. Style short or 0. Seed albuminous or not.

Exceptions:—

The *Icacinaceæ* have a feebly developed disc and sometimes valvate petals; moreover 5 staminodes sometimes occur opposite the petals and ovules pendulous, so that it is as near the *Rhamnales* and *Oleales* as to *Celastrales*. The ovary is apparently 1-celled by suppression of the other two cells.

Ovary 3—16-celled in *Ilicaceæ*. Ovary with many cells in *Siphonodon* and these irregularly disposed.

Ovules 2—10 in each cell in *Hippocrataceæ*.

Disc 0 or confluent with the ovary in *Ilicaceæ*.

Families: 66. *Celastraceæ*; 67. *Hippocrataceæ*; 68. *Ilicaceæ*; 69. *Icacinaceæ*.

N.B.—The *Salvadoraceæ* are included in this alliance by Hutchinson, but see remarks under *Gamopetalæ* (p. 134) and *Oleales* (p. 137).

#### 66. The Spindle-tree Family.

Often thorny, sometimes scandent. Leaves opp. or alt. usually with small stipules. Fls. usually cymose, 2—1-sexual. Sep. small 4—5 often connate. *Disc well-developed*. *St. inserted on or under the outer margin of the disc*. Ovary free or immersed in the disc, rarely half-inferior, 2—5-celled. *Ovules 2 in each cell* erect from the axis. Fruit capsular, drupaceous or baccate. *Seeds mostly arillate*. Embryo axile with large usually green cotyledons and short radicle.....*Celastraceæ* (p. 192).

Exceptions:—

*Siphonodon* is an anomalous genus, with numerous irregularly disposed cells and 1 pendulous ovule in each cell.

**67. The Hippocratea Family.**

Woody, usually climbing or sarmentose with simple opp. rarely alt. leaves. Stipules small caducous or 0. *Fls. small or very small, clustered or cymose. Disc usually very large, sometimes concealing the ovary. St. 3 (rarely 2 or 4) with flattened filaments, inserted on the inner side of the disc and sometimes appearing as though on the ovary. Ovary on or sunk in the disc, 3-celled with 3-lobed stigma. Ovules 2—10 in each cell, anatropous. Fruit of three compressed almost free dry carpels or samaras, or baccate. Seeds winged or not. Albumen 0. Cotyledons large, often connate or fused.....Hippocrateaceæ (p. 197).*

**68. The Holly Family.**

Leaves *alternate* usually coriaceous. Stipules minute or 0. *Fls. usually dicecious or polygamous, in axillary cymes or fascicles. Calyx 3—6-partite or lobed, persistent. Pet. 4—5, rarely 6—8, connate at the base or free in the fem. St. usually adhering to base of corolla or free hypogynous. Disc 0. Ovary 3—16-celled, style short or 0. Ovules 1—2 collateral and pendulous with dorsal raphe and superior micropyle, funicle often cupular. Fruit a drupe with 1-seeded pyrenes. Albumen fleshy, embryo minute.....Ilicaceæ (p. 191).*

**69. The Icacinia Family.**

Woody or softly woody plants, often climbing, with alt. very rarely opp. leaves (palminerved in our species) exstipulate. *Fls. 1—2-sexual, mono- or dichlamydeous. Calyx small hypogynous, 4—5-merous, imbricate, not enlarging in fruit. Pet. 5 rarely 4 or 0, free or connate, valvate or slightly imbricate. St. alternating with the pet., inserted inside the small disc, or disc 0, anthers 4-celled. Carpels usually 3, rarely 2 or 5 united into an incompletely 3- or 5-celled ovary, each cell with 2 ovules but through early abortion becoming 1-celled. Ovules at the apex of the cell pendulous anatropous, never on a free placenta, funicle usually thickened above the micropyle, raphe dorsal. Fruit drupaceous, always 1-celled and 1-seeded. Seed with thin coriaceous testa, usually albuminous.....Icacinaceæ (p. 188).*

NOTE.—Some of the italicized characters above are for discrimination from the *Oleaceæ* sometimes united with this family.

**Order XIV. RHAMNALES.**

Woody plants or herbaceous climbers closely allied to the *Celastrales* with *alternate* simple or sometimes *digitate* or *pinnate* (*Vitaceæ*) often palminerved leaves with or without stipules. Flowers small, mostly similar to the *Celastrales* but *stamens opposite to the petals* and often connate into a tube. *Petals valvate sometimes very minute* or 0. *Ovary frequently 3-celled, sometimes quite inferior. Ovules 1—2 in each cell.*

Exceptions:—

Ovary sometimes 6-celled in *Leea*. Some erect species of *Leea* are herbaceous, but with woody rootstock.

L. opp. or sub-opp. in *Scutia*.

Families: 70. *Rhamnaceæ*; 71. *Ampelidaceæ* (*Vitaceæ*).

### 70. The Buckthorn and Jujube Family.

Woody plants, sometimes scandent by *reflexed prickles* or by *tendrils*, rarely by their coiled twigs (as in *Hippocrataceæ*). *Leaves simple*, frequently with several (3—5) principal nerves or strongly penninerved. *Stipules* changed into prickles or small and deciduous. *Fls.* usually cymose. *Calyx* with 4—5 *triangular valvate lobes* often perigynous, more rarely epigynous. *Pet.* smaller sometimes minute and often concealing the minute stamens which stand opposite to them, *under or on the margin of the disc*. Ovary free or united with the hypanthium and half-inferior or (Tribe *Gouaniæ*) inferior, 3—2. (rarely 4-) celled with 1 basal erect ovule in each cell. *Frt.* 1-celled and 1-seeded (samaroid in *Ventilago*) or with a 2—4-celled endocarp or 3-valved, sometimes 3-winged. Seed with fleshy, rarely 0 albumen and large erect embryo.

*Rhamnaceæ* (p. 199).

### 71. The Vine Family.

Herbs or soft-wooded shrubs, climbing by tendrils, or erect with stems jointed at the nodes. L. *simple palmately-nerved, digitate, or pinnately compound*. *Fls.* in umbels or panicles, hypogynous or perigynous; calyx sometimes truncate; *pet. valvate* sometimes calyptrate. *St.* free or at base of the petals, or sometimes connate into a tube, on or outside the disc which is sometimes tubular. *Ovary free or sunk in the disc, 2—more rarely 3—6-celled, with 2 collateral ovules in each cell*.....*Vitaceæ* or *Ampelidaceæ* (p. 206).

## Order XV. UMBELLALES.

(—→ *Rubiales* and *Asterales*?)

Woody or herbaceous. *Leaves* alternate mostly compound, if simple then very often with palmate venation. *Flowers* mostly in umbelliform cymes, small, regular or outermost in an umbel radiant, with valvate petals, 4—5-merous with isomerous stamens alternating with the petals, calyx often much reduced or 0. *Disc epigynous*. *Ovary* completely inferior of 2—5 (very commonly 2) carpels and as many cells, or ovary many-celled in some *Araliaceæ*. *Styles* usually free. *Ovule* 1, pendulous in each cell, anatropous, raphe ventral, micropyle exterior. Embryo in albumen.

Exceptions:—

*Stamens* many in the exotic genus *Tupidanthus* (sometimes cultivated).

Families: 72. *Araliaceæ*; 73. *Umbelliferæ*.

### 72. The Ivy and Panax Family.

Woody, often scarcely branched, sometimes scandent by adventitious roots, frequently prickly. *Leaves usually palmately compound* or

1—more-pinnate. Stipules adnate to the petiolar sheath or 0. *Fls. in dense umbels* which are usually racemed or paniced. *Petals* 5 or 6—7 or more, *inserted with the stamens round or under the margin of an epigynous disc.* St. alt. with the petals. *Ovary* 2—many-celled. *Fruit coriaceous or drupaceous* with 1 or more ovarian cells usually suppressed. Albumen uniform or ruminant. Embryo minute.....*Araliaceæ* (p. 432).

Exceptions:—

St. many in *Tupidanthus*.

### 73. The Carrot and Parsnip Family.

*Herbs with compound* (simple in *Bupleurum* and *Hydrocotyle*) and often much dissected leaves with a sheathing petiole, exstipulate, rarely stipulate. *Fls. in simple or compound umbels or heads* mostly 2-sexual. *Petals* 5 inserted under the large epigynous disc. St. 5 alt. with the petals. Disc usually tumid and 2-lobed and surrounding the base of the styles. *Ovary* 2-celled. *Fruit* 2-coccus, usually ridged or sulcate and with oil-canals in the pericarp. Seed 1 in each coccus or mericarp. Embryo small in copious albumen, radicle superior, cotyledons linear.

*Umbelliferae* (p. 422).

## Order XVI. ALANGIALES.

Small trees or shrubs with alternate leaves often triple-nerved and dotted, simple, exstipulate. Flowers regular, small or medium. *Calyx* superior, toothed or truncate, sometimes accrescent in fruit. *Petals* 4—10 valvate, free or cohering at the base. *Stamens* opposite to and sometimes adnate to the petals, as many or 2—6 times as many, with narrow elongate anthers, inserted on the top of the hypanthium with the petals and outside an epigynous disc. *Ovary* inferior 1-celled, or 2—3-celled at the base. *Ovule* 1 pendulous or 1 pendulous into each partial cell, with laterally placed micropyle. Fruit a drupe. Seed with embryo the whole length of the fleshy albumen which is sometimes ruminant, cotyledons leafy.

Family: 74. *Alangiaceæ* (*Cornaceæ* in the *Flora*, from which it should perhaps be separated).

### 74. The Alangium Family.

Leaves entire or lobed often palmately nerved, sometimes translucent dotted (due to clustered crystals of oxalate of lime). Flowers usually white, in axillary fascicles, or cymes. *Calyx* usually feebly developed, annular, or with 4—10 teeth. *Pet.* 4—10 linear or lanceolate. *Cotyledons* foliaceous palmately-nerved, thin with cordate base and long terete radicle.....*Cornaceæ* (Tribe *Alangioidæ*) (p. 436).

## Order XVII. OLACALES.

Shrubs or undershrubs, often root parasites with green *alt. simple exstipulate* leaves. Flowers regular, small or medium. *Calyx* (or calyculus, cp. *Santalales*) minute and sometimes toothed or a rim which becomes accrescent in fruit or 0. *Petals* 3—6 valvate (exceptionally



imbricate), free or connate. *Stamens opposite to or opposite the edges of the petals*, as many or 2—3 times as many, some often unfertile. *Ovary free or enclosed in the accrescent calyculus*, 1-celled or 2—5-celled below and 1-celled above. *Ovules 1 pendulous from the apex of the cell* or if more then on the free part of the incomplete axis and *one pendulous into each partial cell*. Fruit drupaceous, 1-seeded with the placenta embedded in the side of the seed (as in some *Cornaceæ*). Embryo small in albumen.

Family: 75. *Olacaceæ*.

### 75. The Olax Family.

Characters as above.....*Olacaceæ* (p. 189).

## Order XVIII. SANTALALES.

Shrubs or undershrubs, more rarely herbs, mostly *hemi-parasites with simple opp. or alt. exstipulate leaves*, or rarely *leaves absent* but branches green or (*Balanophora*) a colourless leafless parasite. *Flowers regular or irregular*, 2—1-sexual, small or showy, green or colourless, *haplochlamydeous* or sometimes with a small outer calyculus (or calyx) of small teeth. *Tepals 2—6 in one or two whorls*, free or connate. *Stamens opposite the tepals*, isomerous, free or adnate to the tepal. *Ovary inferior*, 1-celled (rarely 3-celled in *Balanophoraceæ*). *Ovules 1—3 pendulous from a free central placenta or placenta fused with the ovary* or (*Balanophoraceæ*) 1 in each cell pendulous from the top. Fruit drupaceous or baccate or (*Balanophora*) minute and crustaceous. Seed often adherent to the pericarp. Embryo sometimes minute and undivided. Albumen present.

Exceptions:—

Perianth sometimes 0 and stamens sometimes connate into a central mass in *Balanophoraceæ*. The *Balanophoraceæ* are fleshy leafless root parasites often without perianth in one or both sexes and flowers crowded in a spadix-like peduncle. *They are very doubtfully allied to the other families.*

Families: 76. *Santalaceæ*; 77. *Loranthaceæ*; 78. *Balanophoraceæ*.

### 76. The Sandal-wood Family.

Woody or herbaceous (very slender in *Thesium*), often hemiparasites. *Leaves entire, sometimes scale-like*, nerves inconspicuous. *Flowers small regular*, 1—2-sexual. *Perianth perigynous or epigynous*, 3—8-merous, lobes frequently with a tuft of hair behind the anthers. *Stamens adnate to them*, rarely at the base of the perianth. *Disc perigynous or epigynous*. *Ovary nearly free or adnate to the hypanthium*, 1-celled, stigma entire or 3—6-lobed. *Ovules 2—3, adnate to or pendulous from a central column*. Fruit a drupe or nut. Seed globose or ovoid, testa thin or obsolete, *albumen copious*. *Embryo usually terete*.

*Santalaceæ* (p. 843).

### 77. The Mistletoe Family.

*Green parasitic shrubs* attaching themselves by means of haustoria to the branches of their hosts. *Leaves simple entire*, sometimes

reduced to scales. *Flowers* regular or zygomorphic, 1—2-sexual, usually bracteate and often 2-bracteolate. *Hypanthium* adnate to the ovary and sometimes growing up as an entire or toothed ring or "calyculus" above it. *Perianth* sepaloid or petaloid of 4—6 *tepals* free or connate into a tube below, *valvate* in bud. *St.* usually adnate to the tepals. *Ovary* inferior 1-celled, stigma simple. *Ovule* and *placenta* not differentiated, completely filling the ovary, with usually 1, rarely 2—3 embryo-sacs. *Fruit* baccate, rarely drupaceous, with a viscid inner layer (by means of which it becomes attached to the future host).

*Loranthaceæ* (p. 840).

**78. The Balanophora Family.**

*Fleshy brownish or yellowish root parasites* with *leaves* 0 or reduced to scales; stomata absent. *Flowers* monoecious or dioecious, small or minute, crowded on spadix-like peduncled globose or elongate heads with very stout peduncles arising from a tuberos simple or branching rootstock. *Male perianth* of 3—8 *valvate tepals* or 0, *stamens* isomerous and opp. the *tepals* or connate in a central mass, or in the naked flowers 1—2 only, *anthers* 2—many-celled, opening by slits, pores or irregularly. *Fem. per.* much smaller, minutely toothed and confluent with the ovary or altogether absent. *Ovary* 1—3-celled. *Ovule* 1 in each cell, pendulous, naked or with a single integument or reduced to an embryo-sac. *Fruit* minute 1-seeded, the seed adherent to the pericarp, albuminous. *Embryo* minute, undifferentiated.

Alliance very doubtful.....*Balanophoraceæ* (p. 845).

**Order XIX. ELÆAGNALES.**

Trees or shrubs often with silvery scales or rarely stellate indumentum. *Leaves* alt. or opposite, entire, faintly penninerved. *Flowers* spiked or racemose or at the nodes, 1—2-sexual. *Perianth* haplochlamydeous tubular 2—4-lobed or rarely truncate, in the fertile flower constricted above the ovary and upper part deciduous. *Stamens* in 2-sexual flowers perigynous, in male fls. at the base of the perianth, either 4 alternate with the lobes, or 4 opposite to the lobes and also 4 alt. with them, filaments free. *Ovary* sessile in the base of the perianth, 1-celled, style terminal, stigmatose on one side. *Ovule* 1 erect from the base, anatropous. *Fruit* nut-like, but enclosing perianth sometimes fleshy. *Albumen* scanty. *Embryo* straight with fleshy cotyledons, radicle inferior.

Family: 79. *Elæagnaceæ*.

**79. The Oleaster Family.**

Characters as above.....*Elæagnaceæ* (p. 839).

**Order XX. PROTEALES.**

*Woody plants* with alternate simple or compound exstipulate leaves of hard texture. *Flowers* cyclic, haplochlamydeous, regular or zygomorphic,

often showy, 2-sexual, mostly 4-merous (except in the gynæceum), with the stamens opposite and adnate to and often sessile on the perianth lobes. Perianth inferior, segments at first valvately cohering into a cylindrical tube gibbous at the base, finally free recurved. Hypogynous glands or scales often alternating with the stamens. Ovary apparently of 1 carpel only, 1-celled, often on a gynophore and oblique, style terminal with thickened tip, stigma sometimes lateral. Ovules 1 to several and 2-seriate. Fruit nut-like or capsular. Seed exalbuminous, cotyledons often unequal.

Position altogether doubtful. Engler places them near *Urticales*, Warming near the *Elæagnales* and *Thymelæaceæ*, and he also mentions relationship with the *Leguminosæ*. Lindley places them in his *Daphnales* (which includes Laurels), and Hutchinson also thinks them allied to *Thymelæaceæ* which he considers allied to his *Lythrales*. They are a large group in the dry regions of Australia and the Cape.

Family: 80. *Proteaceæ*.

### 80. The *Grevillea* Family.

Characters as above.....*Proteaceæ* (p. 839).

## Order XXI. ROSALES.

(*Ranales* ←).

Herbaceous or woody with simple or compound leaves often with sheathing bases (as in *Ranales*) or adnate stipules or stipules free or 0. Flowers regular large to small (much reduced in *Podostemonaceæ*), cyclic or sometimes hemicyclic, perigynous to epigynous, if hypogynous then hypanthium lined by a disc bearing the stamens, heterochlamydeous, petals free, rarely petals united or 0. Stamens very many to definite and few. Ovary apocarpous of 2 to many carpels or more or less syncarpous, but then styles usually free. Ovules 1 to many in each carpel, when ovary syncarpous then placentæ often much swollen, placentation usually axile or on ventral suture of carpels or ovules pendulous. Fruit very various, sometimes of achenes or follicles.

Exceptions:—

Corolla gamopetalous in our species of *Crassulaceæ*.

Carpel 1 only in *Prunus* and *Pygeum* and then ovules 2 pendulous.

Ovary 1-celled with 2 pendulous placentæ with several ovules in *Vahlia*.

Ovules parietal in some *Droseraceæ*. The *Podostemonaceæ* are moss-like aquatics and their systematic position is extremely problematical; the flowers are naked or 3-merous in our species (see description of family) and hypogynous.

N.B.—Some of the *Rosales* (in the broad sense here adopted) appear closely allied to the *Ranales*, but most families are highly evolved and depart widely from them. Hutchinson places *Rosales* widely apart from *Saxifragales* (emend.), but puts near to them the *Cunoniales* (which includes the woody *Saxifragaceæ* of most authors). With these *Cunoniales-Rosales* phyla he places the *Hamamelidales* (also placed in *Rosales* by Engler), from which phylum he considers is derived the *Amentiferæ*. Some of the *Hamamelidaceæ* do indeed show a remarkable resemblance to the *Amentiferæ*, e.g. the giant *Tetrameles* which occurs in the foothills of the Himalayas not far from our area. Another alternative alliance of the *Amentiferæ* appears to be some of the *Euphorbiaceæ* and *Urticaceæ*, or again an independent phylum derived from a Gnetaceous stock. The anatomy on the whole rather

favours the second alliance, but here the *Salicaceæ* are considered with Hutchinson to be allied to the Hamamelidaceous stock. As no *Hamamelidales* occur in our area the *Salicales* appear to follow on very unnaturally.

**Sub-order ROSALES proper.**

Herbaceous to woody. Fls. mostly 2-sexual. Leaves alternate. Albumen scanty or 0. Embryo large.

Family: 81. *Rosaceæ*.

**Sub-order SAXIFRAGINEÆ.**

Usually herbaceous and scapigerous or leaves exstipulate. Fls. 2-sexual. Ovary 1—3-celled or apocarpous. Stamens definite isostemonous or diplostemonous. Albumen copious, embryo small, straight.

Families: 82. *Saxifragaceæ* (*sensu stricto*); 83. *Crassulaceæ*.

**Sub-order CUNONIALES.**

To this Hutchinson assigns the woody *Escalloniæ*, *Hydrangeæ*, etc., placed by Hooker & Bentham in the *Saxifragaceæ*. Only cultivated members occur in our area.

**Sub-order DROSERINEÆ.**

Family: 84. *Droseraceæ* (*q. v.*).

These are sometimes placed in the *Parietales* alliance.

**Sub-order PODESTEMONINEÆ.**

Family: 85. *Podestemonaceæ* (*q. v.*).

**81. The Rose Family.**

Woody or herbaceous with *stipulate alternate* simple or variously compound *leaves*. Fls. sometimes small, usually medium or large, *regular, perigynous or epigynous or nearly hypogynous*, cyclic or carpels sometimes acyclic. Calyx with 5—10 usually imbricate sepals, *the odd sepal superior (dorsal)*. *Petals free*, usually 5. *Stamens on the disc lining the hypanthium*, usually many, often incurved or circinate in bud. *Ovary with 5—many free carpels* (apocarpous) or *carpels more or less connate and adnate to the hypanthium*, rarely only 1. *Styles mostly free*. Ovules 1—2 or several. Fruit of achenes, drupels, a drupe or a pome, sometimes achenes free but included inside the fleshy hypanthium which becomes part of the fruit.....*Rosaceæ* (p. 350).

**82. The Saxifrage Family** (restricted to the herbaceous genera).

Herbs, often growing in patches. Leaves alternate (rarely opposite) entire or palmately divided. Stipules 0 or adnate to the often dilated petiole. *Flowers small or very small or medium, cymose and often scapose or axillary*. *Sep., pet. and st. usually on a disc lining the more or less perigynous or epigynous hypanthium*, sometimes almost hypogynous. *St. definite, 5 or 10, rarely 4 or 8, isostemonous or*

diplostemonous, connective frequently glandular at the back. Ovary of 2—5, usually 2, free or connate or partially free (at the top) carpels, often forming a 1-celled ovary at least below, placentæ ventral or central with numerous 2-seriate ovules. Fruit a thin 1—2-celled capsule, often with the cells divaricate when ripe. Seeds numerous, minute, embryo minute, terete or clavate, albumen copious.

*Saxifragaceæ* (p. 356).

*Saxifrages* differ from some closely allied *Rosaceæ* in the definite stamens in never more than 2 whorls, thicker placentation and albuminous seeds.

### 83. The Life-plant Family.

*Succulent herbs*, rarely suffruticose, with fleshy simple or pinnatifid or 3-partite alt. or opp. exstipulate leaves. Fls. small or medium or rather large. *Sep. and pet.* 4—5, free or gamophyllous. *St. isostemonous or diplostemonous, hypogynous or adnate to the corolla-tube. Hypogynous scales usually present*, one at the base of each carpel. *Carpels as many as the petals*, rarely only 3, free or connate below, narrowed upwards into *distinct styles or stigmas*. *Ovules many on the ventral sutures of the carpels*. Fruit of many-seeded follicles. Seed albuminous with terete embryo and short cotyledons.,

*Crassulaceæ* (p. 357).

Some exotic genera contain species with 3-merous flowers which then appear very closely allied to the *Ranales* except that the trimery varies to a 4-merous and 5-merous condition and there are frequently hypogynous scales opposite to each carpel; the anthers too are dorsifixed.

### 84. The Sundew Family.

*Small herbs* with radical leaves only or cauline leaves whorled or alt. either copiously covered with long glandular hairs secreting fluids by means of which they catch and digest small animals or diaphanous and glabrous and then with automatically closing laminæ. Fls. small regular in scorpioid cymes on slender scapes or (*Aldrovanda*) solitary on axillary peduncles, 4—5-merous with often reduction in the carpels. *Calyx persistent. Pet. free.* *St. isostemonous or in 2 or more isomerous whorls, hypogynous or somewhat perigynous. Carpels 2, 3, or 5 connate into a 1—more-celled free or nearly free ovary; placentæ parietal or meeting in the middle, or the ovules on a free central placenta, anatropous. Fruit capsular.....**Droseraceæ* (p. 358).

### 85. The Podostemon Family.

*Moss-like or thalloid aquatics* growing on rocks in streams. *Leaves when differentiated simple distichous*, generally with a sheath which may be stipular. Fls. on a 1—many-fl. scape or dichasial shoot system, sometimes arising from a sheath, mostly 2-sexual. *Perianth of small ovate or linear tepals or scales, sometimes 3-merous or 0. St. hypogynous, 1—many (3 in our species) hypogynous or perigynous, free or connate. Ovary 1—3-celled with a stout central placenta and very thin septa. Styles 1—3. Ovules many anatropous, axile (in one genus parietal). Fruit capsular, valves 2—3. Seeds many minute, exalbuminous. Embryo straight, radicle inferior...Podostemonaceæ* (p. 822).

**Order XXII. LEGUMINOSÆ.**

(← Rosaceæ.)

Woody or herbaceous with *alternate stipulate* compound or unifoliate rarely simple leaves. Flowers small to very showy, usually zygomorphic (always so in the gynoceum), perigynous, rarely hypogynous, with a disc lining the hypanthium. Calyx with 5 (—4) sepals or lobes, the odd one inferior (ventral), sometimes calyx 2-lipped or sub-entire. Petals free or ventral pair connate or corolla gamopetalous, if corolla regular then sepals and petals valvate in bud. Stamens indefinite or definite. Ovary apocarpous reduced to 1 usually elongate declinate carpel with usually several ovules in one or two series along the ventral suture. Fruit a legume (pod) which is rarely indehiscent.

Exceptions:—

Ovary short and the legume globose and 1-seeded in a few small herbaceous Papilionaceæ and pod septate in several genera.

Families: 86. Mimosaceæ; 87. Cæsalpiniaceæ; 88. Papilionaceæ.

**86. The Mimosa and Acacia Family.**

Trees or shrubs, rarely undershrubs, with 2-pinnate leaves (main pinnæ sometimes digitately arranged), pinnæ and leaflets sometimes reduced to one pair. Fls. small regular, 4—5-merous, conspicuous from being collected into dense heads or spikes. Calyx and corolla valvate, usually gamophyllous. St. free or monodelphous, diplostemonous or indefinite and often very numerous.....Mimosaceæ (p. 332).

**87. The Cassia Family.**

Woody plants, rarely herbs with pinnate or 2-pinnate leaves (or apparently simple or of 2 connate leaflets in many Bauhinia). Fls. large or small, more or less zygomorphic. Calyx generally 5-merous, sometimes spathaceous, perigynous or nearly hypogynous, hypanthium short or long. Petals 5, fewer or 0, imbricate, not papilionaceous, dorsal interior in bud and often different from the others. St. definite, diplostemonous or usually fewer by reduction, inserted on the hypanthium or disc lining it, rarely connate. Ovary free or somewhat adnate to one side of the hypanthium. Fruit often indehiscent and samaroid.

Cæsalpiniaceæ (p. 314).

**88. The Pea and Bean Family.**

Woody or herbaceous with simple, digitate or pinnate leaves, and small or large and showy distinctly zygomorphic (papilionaceous) flowers. Corolla imbricate with the dorsal petal (standard) exterior in bud, the others petal in pairs, the lowest pair often connate and forming the "keel." Stamens 10 monadelphous or diadelphous 9+1 or 5+5, or the 10th altogether absent.....Papilionaceæ (p. 235).

Exceptions:—

Stamens in *Sophora* free. Logically therefore this genus should be placed at the beginning of the Papilionaceæ.

## Order XXIII. MYRTALES.

(← *Rosales.*)

Woody, more rarely herbaceous (very rarely aquatic herbs). *Leaves simple entire* usually opposite or whorled, *frequently gland-dotted, usually exstipulate.* Flowers cyclic heterochlamydeous or rarely apetalous, mostly 4—5-merous and diplostemonous, or polystemonous from branching, regular with an elongated tubular hypanthium or if hypanthium short then completely adnate to the ovary. Calyx valvate more rarely (some *Combretaceæ*, *Myrtaceæ* and *Melastomaceæ*) imbricate or open in bud. *Ovary syncarpous 2—many-celled, rarely 1-celled. Styles connate. Ovules usually many, axile. Seeds 1—many. Albumen 0.*

Exceptions:—

Some *Lythraceæ*, *Onagraceæ* and *Melastomaceæ* are herbs. *Trapa* is aquatic. *Halorrhagidaceæ* are aquatic herbs with often multifid leaves and much reduced 2—4-merous flowers, 4 short styles and ovules 1 in each cell.

2—4-merous flowers are very common in *Onagraceæ*.

Leaves are alternate in *Lecythidaceæ*, sub-opp. or alt. in some *Combretaceæ* and few *Onagraceæ* and *Lythraceæ*.

Stipules present and interpetiolar in *Rhizophoraceæ*.

Fls. irregular in some *Lythraceæ*.

Perianth perigynous and ovary free in few *Lythraceæ*.

Petals sometimes suppressed in few *Combretaceæ* and few *Lythraceæ*.

Stamens haplostemonous in some *Onagraceæ*.

Ovary 1-celled in *Combretaceæ* and few *Onagraceæ*.

Ovules pendulous and few from the top, or lateral near the top, of ovary in *Combretaceæ*. Ovules pendulous from apex of cells in *Rhizophoraceæ*.

Families: 89. *Myrtaceæ*; 90. *Lecythidaceæ*; 91. *Melastomaceæ*; 92. *Lythraceæ*; 92a. *Punicaceæ*; 93. *Onagraceæ*; 94. *Halorrhagidaceæ*; 95. *Rhizophoraceæ*; 96. *Combretaceæ*.

## 89. The Myrtle and Jamun Family.

*Trees or shrubs with opp., very rarely alt., simple entire leaves usually evergreen and as well as other parts mostly copiously supplied with lysigenous oil-glands (appearing as translucent dots in the leaves). Leaves with an intra-marginal nerve. Fls. epigynous 4—5-merous (rarely petals 0) with numerous stamens often in 4—5 bundles. Ovary 2—many-celled with axile placentation, rarely 1-celled with basal placentation. Ovules many, rarely only 2—1 but usually only 1—few developing as seeds. Fruit various, baccate, drupaceous or opening by as many valves as there are cells. Embryo straight or curved.*

*Myrtaceæ* (p. 375).

## 90. The Kumb and Hijal Family.

*Woody plants (an undershrub in one species) with the characters of Myrtaceæ but the leaves mostly alternate or clustered at the ends of the branches and without oil-glands, often toothed and without a distinct intra-marginal nerve. Fls. usually large, 4—6-merous, rarely 2—3-merous. Androecium often elaborately developed with very many stamens. Fruit a berry, or fibrous, many-seeded, rarely (*Barringtonia*) 1-seeded.....**Lecythidaceæ* (p. 382).

**91. The Melastoma Family.**

Herbs or shrubs, rarely small trees, with *opp. or whorled entire leaves characterized (exc. Memecylon) by 3—7 principal nerves which reach almost to the apex and usually distinct scalariform secondaries. Fls. small or more often showy, regular, or somewhat irregular in the androecium, 2-sexual. Hypanthium usually united by vertical walls to the ovary or adnate. Sep. 3—6 or 0, pet. as many, contorted in bud. St. as many or more than the pet. inserted with them on the margin of the hypanthium. Anthers opening by pores or short slits. Ovary 3—6-celled or (Memecylon) 1-celled. Ovules very many, axile or free central. Fruit baccate or capsular opening by pores at the top or irregularly breaking up. Albumen 0.....Melastomaceæ (p. 384).*

Exceptions:—

The *Memecyleæ* with 1-celled ovary, comparatively few ovules, and 1-seeded berry constitute a very distinct sub-family. The fls. are 4-merous as in many true *Melastomeæ*.

**92. The Henna Family.**

Woody or herbaceous with *often 4-angled branches. Leaves simple entire mostly opposite, sometimes whorled or alt., sometimes dotted. Fls. from minute (in some herbs) to very large (in some trees), 2-sexual, regular or irregular, perigynous, 3—6-merous (sometimes more). Sep. 3—6 valvate, sometimes with an epicalyx of smaller intermediate. Petals as many or 0. St. indefinite or definite, perigynous, sometimes inserted inside the hypanthium. Ovary 2—6-celled (more in *Sonneratia*) or by early absorption of septa 1-celled with long simple style. Ovules very many on large axile placenta. Fruit membranous, coriaceous or capsular, sometimes 1-celled by absorption of septa. Seeds many, sometimes winged. Embryo straight (exc. *Sonneratia*).*

*Lythraceæ (p. 389).*

The *Blattaceæ* (including *Sonneratia*) are sometimes made into a distinct family.

**92a. The Pomegranate Family. (Included in Lythraceæ in the Flora.)**

*Shrubs closely allied to Lythraceæ with large 1—5-nate fls. terminating the shoots having a large flask-shaped hypanthium produced considerably beyond the ovary with 5—7 persistent sepals and 5—7 imbricate and crumpled petals in bud. St. very many covering the whole disc. Ovary adnate to the hypanthium, many-celled, the cells in 1—3 concentric more or less superposed whorls, with the very numerous ovules axile in some cells, in others parietal.....Punicaceæ (p. 389).*

**93. The Evening Primrose and Water Chestnut Family.**

*Herbs, rarely undershrubs, usually inhabiting wet places and sometimes aquatic. Leaves opposite or upper alt., rarely all alt. Fls. regular and typically 4-merous throughout, or sometimes slightly irregular, axillary, spiked or racemed. Hypanthium often much elongated with 2—5, usually 4, valvate sepals. Petals alternate with the sep., rarely 0. St. as many as or twice as many as the sepals, epigynous. Ovary adnate*



to and entirely enclosed by the hypanthium (exc. in *Trapa*), 1—6- or usually 4-celled; style simple with capitate or 2—4-lobed stigma. *Ovules many axile in each cell* or (*Trapa*) 1 in each cell, pendulous or half ascending. Fruit usually capsular (indehiscent in *Trapa*), many-seeded (1 in *Trapa*). Seeds with little or 0 albumen.

*Onagraceæ* (p. 397).

Exceptions:—

*Trapa* sometimes is placed in a separate family, the *Hydrocaryaceæ*, the characters of which will be recognized from the exceptions above.

#### 94. The Milfoil Family (*Myriophyllum* only).

*Aquatics with usually verticillate, more rarely opp. or alt. leaves pinnate with filiform segments or upper, rarely all, simple deeply cut or entire. Fls. small sessile or subsessile axillary or running out into spikes with the leaves reduced to bracts, monoëcious or polygamous, upper male, lower female and intermediate 2-sexual. Calyx lobes 4, rarely 2, very small, superior at times obsolete. Petals 4 or 2 often falling or reduced in the female, in the male and 2-sexual fl. much exceeding the calyx, imbricate, of delicate texture. Stamens 2, 4 or 8, epigynous in the 2-sexual fls., anthers long, 4-angled, basifixed. Disc small or 0. Ovary inferior, 4-rarely 2-celled, styles 4, very short, plumose. Ovule 1 in each cell, pendulous, anatropous. Fruit deeply 2—4-lobed, indehiscent or splitting into 4 drupels. Embryo straight, cylindric, surrounded by thin fleshy albumen.*

*Halorrhagidaceæ* (p. 359).

#### 95. The Mangrove Family.

*Trees or shrubs, usually littoral and often furnished with pneumatophores or aerial roots; generally quite glabrous with opp. entire coriaceous leaves and interpetiolar deciduous stipules which enclose the terminal bud and leave prominent stipular scars. Fls. regular, 2-sexual, or 1—many fld. axillary peduncles. Perianth often coriaceous. Calyx superior or half-superior 4—14-sepalous on a cupular or campanulate hypanthium. Pet. as many often 2-fid and lacinate. St. diplostemonous, rarely indefinite, perigynous or epigynous. Ovary free or adnate to hypanthium, 2—5, rarely 1-celled. Ovules 2 pendulous in each cell or in 1-celled ovaries pendulous from a central placenta, style 1. Fruit 1-seeded indehiscent or (*Weihia*) tardily dehiscent.*

*Rhizophoraceæ* (p. 360).

#### 96. The Myrabolan Family.

*Trees or shrubs, sometimes scandent, rarely undershrubs. Leaves opp. or sometimes sub-opp. rarely all alternate. Fls. usually small greenish (showy in some garden genera), capitate, spicate or racemed with the hypanthium enclosing and constricted above, or produced into a beak beyond, the ovary. Sep. and pet. 4—5, rarely 6—7, or pet. 0. St. diplostemonous. Ovary 1-celled, inferior with 2—7 ovules pendulous from the apex. Fruit 1-seeded, usually drupaceous, often 2—5-angled or winged.*.....*Combretaceæ* (p. 366).

**Order XXIV. SALICALES.**

*Woody plants with alternate simple stipulate leaves. Flowers dioecious, in the axils of the bracts of a spike (catkin), without perianth, or perianth perhaps represented by a disciform expansion or glands. Male flower with 2 to many stamens, without pistillode. Fem. fl. with superior 2-3 rarely 4-carpellary ovary; 1-celled with parietal placentæ and mostly many ovules, stigmas 2 (-4). Fruit a 2- (-3-) valved capsule, with very small seeds carrying a pencil of hairs near the base. Albumen 0.*

Family: 97. *Salicaceæ*.

**97. The Willow Family.**

Trees or shrubs with *perulate buds. Leaves alt. simple*, stipules deciduous or persistent. *Flowers dioecious* (very rarely otherwise), in close bracteate spikes (*catkins*), one much reduced fl. to each bract, bracteoles 0. *Perianth 0* or perhaps represented by the scales or glands or cupular disc, some of which are usually present. *Stamens 2 or more* with free or connate filaments. *Ovary of 2 rarely 3 connate carpels, 1-celled with parietal placentation. Ovules usually many erect anatropous* on the lower part of the placenta. *Fruit capsular, 2-4-valved. Seeds few or many, small, exalbuminous, with thin testa and a basilar pencil of hairs. Embryo straight, cotyledons plano-convex, radicle short inferior.....Salicaceæ (p. 881).*

See note p. 127 *re* affinities.

**Order XXV. CASUARINALES.**

Affinities very doubtful. Ovule with 20 or more embryo-sacs. Only one family.

**98. The Casuarina Family.**

*Woody plants with sulcate articulate branchlets and leaves reduced to subulate scales connate at the base and forming short sheaths at the nodes. Flowers very minute, monoecious. Males in slender terminal spikes formed of numerous whorled bracts adnate to the rhachis, each bract with a pair of lateral bracteoles, and a flower consisting of 1-2 median scarious tepals, stamen 1 with large anther. Fem. in heads with close whorls of small bracts subtending pairs of very small but accrescent lateral bracteoles with an ovary of 2 median carpels, 2-celled, but posterior cell barren or suppressed, stigmas 2 very long filiform. Ovules in the fertile cell 2, orthotropous, basal or sub-basal. Female inflorescence forming a cone in fruit, each achene enclosed in the pair of accrescent woody or coriaceous bracteoles which open when the seed is ripe. Seed with terminal wing, testa fused with wall of achene. Albumen 0. Cotyledons flat equal, radical very short superior.*

*Casuarinaceæ (p. 882).*

## 236. Series II. GAMOPETALÆ (SYMPETALÆ).

Perianth always cyclic, usually with distinct calyx and corolla. Calyx persistent and often enlarged in fruit, mostly gamosepalous. Corolla with a basal tubular zone on which the petals appear as lobes, or if tube very short or petals free then stamens fewer than the lobes or petals, and often adnate to them and carpels reduced to 4 or 2. Stamens usually adnate to corolla. Carpels often 2 median or oblique. Ovules with one thick integument and a very small nucellus.

Exceptions:—

Corolla with very short or 0 tube in some *Myrsinaceæ*, *Oleales* and *Plumbaginaceæ*. Cor. 0 in fem. fl. *Xanthium*.

Sepals nearly free in some *Sapotaceæ*, *Apocynaceæ*, *Asclepiadaceæ*, *Convolvulaceæ*. Calyx annular or of 8—12 small teeth in *Thunbergia*. Sep. and petals more than 5 in some *Ebenales*, *Jasminum*, (*Oleales*), *Cordia* and *Symphorema* (*Verbenaceæ*).

Stamens free from tube in *Plumbago*, some *Ebenaceæ*, some *Oleaceæ*.

Stamens several-seriate and many in many *Ebenales*. Carpels 4—9 or more in some *Ebenales* and *Primulales*.

Ovules with 2 integuments occur especially among *Primulales* and *Ebenales*.

237. The Gamopetalæ or Sympetalæ are retained here as one group in accordance with other systematic works, but they are probably derived from several different groups of the Choripetalæ.

The *Primulales* are possibly allied to the *Caryophyllales*, the *Ebenales* to the *Theales*, while the *Oleales* appear related to the *Celastrales*, etc., etc. The origin of the *Asterales* and *Rubiales* is probably to be looked for along the line of the *Umbellales*, near which family in fact they are put in the *Genera Plantarum*.

See also gamopetalous families under exceptions to *Choripetalæ*, para. 233.

## 238. CONSPECTUS OF THE GAMOPETALOUS ORDERS.

I. Pentacyclixæ, or less specialized Sympetalæ:—

Floral whorls normally 5, i. e. two whorls of stamens are present, or if only one whorl is developed, then ovary 5-carpellary and usually 1-celled. Flowers regular. Corolla-tube often short or sometimes 0. Ovary mostly superior, usually with more than 2 carpels.

Orders: XXVI. *Primulales*; XXVII. *Ebenales*.

II. Tetracyclixæ:—

Floral whorls normally 4, i. e. only one whorl of stamens is developed. Fls. regular or irregular. Corolla-tube usually distinct. Ovary superior or inferior. Carpels rarely more than two (some *Polemoniaceæ*, *Caprifoliaceæ*, and *Campanulaceæ*, few *Rubiaceæ* and very few *Convolvulaceæ* and *Verbenaceæ*).

A. Ovary superior:—

1. Flowers regular. Stamens isostemonous, or 2 only in *Oleaceæ*.

Exceptions:—

Flowers slightly zygomorphic in some *Polemoniaceæ*, irregular with fertile stamens fewer than the petals in a few *Gentianaceæ*.

Stamens slightly declinate or flowers somewhat irregular in a few *Solanaceæ* and *Boraginaceæ* but only in cultivated plants in our area.

Orders: XXVIII. *Oleales*; XXIX. *Gentianales*; XXX. *Polemoniales* (including *Solanaceæ*); XXXI. *Boraginales*.

2. Flowers irregular (zygomorphic). Stamens mostly fewer than isostemonous, often didynamous.

Exceptions:—

Corolla sometimes with subequal spreading lobes in a few *Acanthaceæ*, *Labiatae* and *Verbenaceæ*, regular and 6—12-merous in *Symphorema*.

The family *Solanaceæ* is sometimes included in the *Personales*.

Orders: XXXII. *Personales*; XXXIII. *Lamiales*.

B. Ovary inferior. Flowers regular or irregular:—

Orders: XXXIV. *Rubiales*; XXXV. *Campanales*; XXXVI. *Asterales*.

## 239. DESCRIPTIONS OF ORDERS AND FAMILIES OF THE GAMOPETALÆ.

### Order XXVI. PRIMULALES.

(←—*Caryophyllales*?)

*Herbs, shrubs or rarely small trees, very often glandular, with alt. simple existipulate leaves and regular 1—2-sexual flowers. Stamens opp. to the corolla lobes haplostemonous or sometimes diplostemonous with a very rudimentary first (alternating) whorl still present, adnate to the corolla or free. Ovary 1-celled with free central placentation, superior or half inferior. Ovules sometimes amphitropous. Seed usually albuminous. Embryo straight or curved.*

Families: 99. *Plumbaginaceæ*; 100. *Primulaceæ*; 101. *Myrsinaceæ*.

#### 99. The Plumbago Family.

*Herbs or shrubs with often fleshy leaves. Fls. capitate, racemed or paniced with the bracts often scarious and sheathing the calyx, bracteoles 2. Calyx inferior tubular 5—10-ribbed, mouth frequently funnel-shaped and scarious or sub-petaloid. Petals free or gamopetalous with a very short tube, or rarely tube linear. St. 5 opposite the petals and often adnate below to the tube. Disc 0. Ovary superior, styles 5 free or connate, stigmas sub-capitate. Ovule 1 pendulous from an ascending basal funicle. Fruit capsular membranous or with hardened apex, rupturing near the base or circumsciss, apex often 5-valved. Seeds cylindric, pendulous, albuminous or not. Embryo straight.....Plumbaginaceæ (p. 528).*

#### 100. The Primrose Family.

*Herbs with radical, alt., opp. or whorled leaves. Calyx inferior gamosepalous, usually 5-lobed. Corolla hypogynous, usually 5-lobed. Stamens on the corolla-tube sometimes with alternating staminodes. Ovary with undivided style. Ovules many, usually amphitropous, on a free*

central placenta. Capsule dehiscent by valves or circumsciss, few- or many-seeded. Seeds minute, usually angular, often sunk in the placenta. Albumen fleshy or horny. Embryo transverse.....*Primulaceæ* (p. 530).

### 101. The Ardisia Family.

Woody plants often with small red glands, especially on the margins of the leaves, including the floral leaves (schizogenous secretory cavities). Fls. regular 2-sexual or polygamo-dioecious, small or medium-sized. Calyx inferior or (*Mæsa*) more or less superior, 4—6, usually 5-lobed, persistent. Petals gamopetalous or rarely free (some *Embelia*), lobes contorted or imbricate. Stamens opposite the petals and more or less adnate to corolla (anthers transversely septate in *Ægiceras*). Ovary free superior, or half-inferior (*Mæsa*), style simple, with simple or shortly lobed stigma. Ovules few or many. Fruit baccate or sometimes (*Ægiceras*) finally dehiscent. Seeds mostly globose and with pitted or ruminant albumen. Embryo transverse, curved, sometimes sigmoid.

*Myrsinaceæ* (p. 532).

## Order XXVII. EBENALES.

(←— *Theales*).

Trees or shrubs with simple alt. or (some *Diospyros*) sub-opp. entire exstipulate leaves. Sap sometimes milky. Flowers medium or small, regular, 1—2-sexual. Corolla rarely with free petals or nearly free petals, lobes or petals often more than 5. Stamens diplostemonous or in several whorls or one whorl reduced to staminodes (haplostemonous by abortion). Ovary 3—10-celled. Ovules 1—few in each cell, pendulous or ascending. Albumen sometimes ruminant.

Families: 102. *Styracæ*; 103. *Ebenaceæ*; 104. *Sapotacæ*.

Exceptions:—

Stipules sometimes occur in *Sapotacæ*, but are very caducous.

### 102. The Storax Family.

Woody plants with alt. leaves. Fls. 2-sexual or polygamous, in axillary and terminal simple or compound racemes or spikes. Calyx perigynous or epigynous, or sometimes inferior, 4—5-toothed or almost obsolete. Petals 4—10, usually 5, sometimes free to the base, imbricate. Stamens 8—10 or many with free or connate filaments and more or less adnate to the corolla. Ovary 2—5-celled or septa not reaching apex of the ovary, style slender. Ovules 1 or few, mostly 2 in each cell, axile, pendulous or erect. Fruit drupaceous 1-, rarely 2—3-seeded. Seeds albuminous. Embryo straight or curved.....*Styracæ* (p. 546).

### 103. The Mohwa Family.

Trees with usually milky juice and young parts usually rusty tomentose. Leaves alt. coriaceous. Fls. 2-sexual usually (in our species) axillary and clustered, often from leaf scars; bracts and bracteoles 0 or minute. Calyx inferior, lobes 4—8 imbricate, or 2-seriate and outer

*series valvate*, persistent. *Cor.-tube shorter than calyx*, petals 2—4-times as many as calyx-lobes. *St.* on cor.-tube epipetalous, 1—3-times as many as cor.-lobes and 1—3-seriate or some reduced to staminodes. *Ovary sessile 2—8-celled with simple pointed style. Ovules 1 in each cell, axile. Fruit baccate 1—8-seeded.* Embryo straight with large fleshy cotyledons and exalbuminous, or albuminous with flat cotyledons, radicle inferior.....*Sapotaceæ* (p. 535).

#### 104. The Ebony Family.

*Woody plants without milky juice*, with alt., rarely sub-opp. or opp. leaves. *Flowers regular*, 3-merous or 4—5-, rarely 6—7-merous, usually *dicæcious*. *Males in 3—more-flowered cymes. Fem. solitary* or several on abbreviated lateral branches. *Calyx inferior gamosepalous, often accrescent or hardened in fruit. Corolla regular. St. inserted at base of corolla isomerous, or 2—3-times as many as its lobes, in fem. reduced to staminodes, rarely 0. Ovary sessile 2—16-celled, with 1—2 pendulous anatropous ovules in each cell; styles 2—8 free or connate at base with small or often flabellate stigmas. Fruit baccate, coriaceous or fleshy with as many cells as in the ovary or fewer by abortion. Seeds compressed, albumen copious often ruminant. Embryo axile, straight or curved, with flat cotyledons and superior radicle.*

*Ebenaceæ* (p. 539).

### Order XXVIII. OLEALES.

(←—*Celastrales*.)

Trees or shrubs *without milky juice*, with simple or pinnate mostly penninerved exstipulate leaves. *Flowers regular 2-sexual or polygamous. Calyx small inferior usually 4— (5—9)-lobed. Corolla usually 4 (5—9)-lobed. Petals sometimes nearly or quite free, valvate or imbricate. Stamens 2 or 4 (Salvadoraceæ). Ovary 2—1-celled. Ovules 1—2 in each cell, anatropous or amphitropous, pendulous or ascending from the angle of the dissepiment.* Seeds with or without albumen. Embryo straight.

Families: 106. *Oleaceæ*; 107. *Salvadoraceæ*.

The *Salvadoraceæ* are closely allied to the *Oleaceæ* and possibly to the *Celastraceæ*. They have often *minute stipules*, 4 stamens and a disc (?) of interstaminal glands. They have been shown by Hutchinson under the *Celastrales* (following Baillon), but in that case it would appear better to remove the whole *Oleales*. Sometimes a 3-celled ovary occurs in *Oleaceæ* (*Nyctanthes*) and the petals are sometimes free in *Linociera*.

#### 105. The Olive and Jasmine Family.

*Woody plants, rarely undershrubs*, with simple or pinnate, usually penninerved exstipulate leaves. *Flowers regular mostly in 3-chotomous cymes or panicles, rarely fascicled or racemed, 2-sexual, polygamous or rarely dicæcious. Calyx small. Corolla gamopetalous or tube very short in some genera, lobes or petals usually 4, sometimes 0. Stamens 2 on the corolla tube (hypogynous in apetalous species). Ovary free*

2-celled, stigma simple or 2-lobed. Ovules 1—2, rarely 3—4 in each cell, axile, near base and apex. Fruit capsular or baccate, dry or drupaceous. Seed 1, or 1 in each cell, albuminous or not. Radicle superior or inferior.....*Oleaceæ* (p. 548).

Exceptions:—

The calyx and corolla are often 5—9-lobed in *Jasminum*. Petals sometimes free in *Linociera*.

### 106. The *Salvadora* Family.

Often spinous or with olive-grey foliage. Leaves opp., entire, with minute stipules. Fls. small clustered or paniced, diœcious or polygamodœcious. Calyx inferior 3—5- often 4-fid. Corolla gamo- or poly-petalous, 4-merous, petals imbricate. St. 4, hypogynous or on the cor-tube, alt. with the petals, sometimes connate by the filaments. Alternating glands or staminodes sometimes present. Ovary free, 1—2 or imperfectly 4-celled, stigma entire or 2-fid. Ovules 1—2 in each cell, erect from the base, anatropous. Fruit a berry or drupe, mostly 1-seeded. Seed erect globose, exalbuminous.....*Salvadoraceæ* (p. 556).

## Order XXIX. GENTIANALES.

Trees, shrubs or herbs, often with milky sap, and with opposite or 3-nate simple entire exstipulate often palminerved leaves. Flowers regular 2-sexual, usually cymose. Calyx and corolla 4—5-merous, corolla usually contorted in bud. Stamens isomerous, adnate to the corolla at least at the base, sometimes combined into a column with the pistil. Carpels 2 combined into a 2- or (*Gentianaceæ*) 1-celled ovary, or distinct except in the styles. Ovules many, parietal or covering a large axile placenta.

Exceptions:—

Stipules or stipular lines sometimes occur in *Loganiaceæ*, which family is closely allied to the *Rubiaceæ*.

Leaves sometimes toothed in *Buddleia*.

Fls. irregular and stamens fewer than the petals in some *Gentianaceæ*.

Corolla often imbricate or valvate in *Loganiaceæ*.

Ovules only 1—8 in each cell in a few *Apocynaceæ*.

Families: 107. *Gentianaceæ*; 108. *Loganiaceæ*; 109. *Apocynaceæ*; 110. *Asclepiadaceæ*.

### 107. The *Gentian* and *Chiretta* Family.

Herbs, rarely aquatic, with opp. or occasionally alternate, simple (in our species) leaves. Flowers small or showy, regular, or irregular especially in the andrœcium, mostly in ebracteate cymes. Calyx inferior, 4—5-lobed. Corolla funnel-shaped or rotate, lobes imbricate or twisted to the right. Stamens on the tube, alt. with the lobes, sometimes unequal or some suppressed, anthers dehiscing longitudinally or by apical pores. Ovary free, 1-celled or more or less 2-celled by the intrusion of the parietal placenta. Style often short, stigmas 2. Ovules numerous. Fruit capsular, often membranous, rarely baccate. Seeds many small. Albumen copious.....*Gentianaceæ* (p. 594).

**108. The Strychnine Family.** (—→ *Rubiales.*)

Woody or herbaceous with opp. leaves often united by a stipulary line or sometimes petioles dilated at the base, more rarely stipules distinct. Fls. cymose, or cymes sometimes reduced to single flowers, sometimes capitate or paniced. *Calyx small inferior 4—5-toothed or -lobed.* Corolla 4—5-lobed or -partite. *Stamens on the tube, alternate with its lobes.* Ovary superior free 2-celled with simple style and capitate 2-fid or 2-partite stigma. Ovules 1 or more in each cell; *placentæ axile or in the inner basal angles,* sometimes peltate. Fruit a septicidal capsule or baccate, 1—many-seeded. Albumen copious, embryo straight. *Loganiaceæ* (p. 590).

**109. The Oleander Family.**

Woody or herbaceous plants *usually with milky juice* and often twining. Leaves opp. or whorled or (only in introduced species) alt., sometimes with stipular lines and glands. Calyx 5-, rarely 4-lobed. Corolla rotate or salver-shaped, rarely campanulate or funnel-shaped, *sometimes with a corona of scales.* St. as many as the cor.-lobes inserted on the tube with short filaments, *anthers often conniving and sometimes adhering by a point on the connective to the swollen top of the style,* but not forming a column with the style and stigma, and pollen granular. Disc often present. Ovary 2-celled (1-celled in the exotic *Allamanda*), or usually of 2 distinct carpels united by the style. Ovules 2—many in each carpel, rarely 1 only. Fruit of free or connate follicles, more rarely a berry or drupe. *Seeds often with a coma of silky hairs,* albuminous or not.....*Apocynaceæ* (p. 557).

**110. The Asclepias or Mudar Family.**

Climbing herbs, rarely erect shrubs, *abounding in milky juice,* rarely (*Sarcostemma*) leafless. In other respects the family differs from the *Apocynaceæ* essentially in the pollen, which forms one or two waxy more rarely granular masses (pollinia) in each anther-cell. Filaments usually connate in a column round the pistil, rarely (*Pèriploceæ*) filaments free. The flowers are frequently in umbelliform cymes and fruit of 2 (—1) follicles.....*Asclepiadaceæ* (p. 573).

**Order XXX. POLEMONIALES.**

Climbers or rarely erect, sometimes with milky juice. *Leaves alternate, mostly simple cordate and palminerved,* sometimes palmately compound, rarely pinnate or 0 (*Cuscuta*), exstipulate. *Flowers regular, completely gamopetalous,* with frequently an entire or only slightly lobed limb. *Sepals sometimes free.* St. 5, alt. with lobes of corolla (if any). *Disc usually prominent.* Carpels 2 or rarely 3—5, combined into a 2-celled, rarely 1- or 3—5-celled ovary. Style 1, stigmas 2 or styles very rarely 2 or 3—5. *Ovules 2 collateral erect or many in each carpel,* often amphitropous. Fruit capsular or baccate.

Families: 111. *Hydrophyllaceæ*; 112. *Polemoniaceæ*; 113. *Convolvulaceæ.* The *Solanaceæ* are sometimes included here.



Exceptions:—

Lower leaves sometimes opposite in *Polemoniaceæ*.  
Ovary deeply 4-lobed in *Dichondra*.  
Flowers slightly irregular in some *Polemoniaceæ*.

### 111. The *Nemophila* Family.

Herbs, sometimes glandular-hairy. Leaves simple or pinnate. Sepals shortly connate, imbricate. Corolla usually rotate, lobes imbricate. St. inserted near its base, alt. with the lobes, equal or not, anths. versatile. Disc seldom present. Ovary superior with broad base, 2-carpellary, 1—2-celled, often septum partial (edges of carpels not meeting in middle), placentæ therefore usually 2 in each cell, one from each of the partial septa, but usually much swollen so as sometimes to meet in the middle. Ovules many or sometimes only 2 to each carpel, sessile or funicled, anatropous or amphitropous. Fruit capsular, loculicidally 2-valved, or valves separating from the septum. Seeds albuminous. Embryo small, straight, axile.....*Hydrophyllaceæ* (p. 599).

### 112. The *Phlox* Family. (—→ *Personales*.)

Woody or herbaceous, sometimes scandent, often glandular. Leaves simple or pinnate, lower sometimes opposite. Fls. often showy, regular or somewhat zygomorphous, hermaphrodite, 5-merous, usually cymose (solitary in *Cobæa*). Calyx inferior, gamosepalous. Corolla gamopetalous, lobes twisted to right. Stamens on tube and alt. with its lobes, often unequal and sometimes declinate. Disc usually prominent. Ovary mostly 3-carpellary and 3 (—5)-celled. Style simple or 3-fid. Ovules very many, few or solitary in each cell, axile, more or less amphitropous. Fruit capsular, 3-valved, sometimes with partial false septa in the middle of the valves. Seeds as many as the ovules, sometimes winged, often with peculiar mucilage-cells in the testa, albumen enclosing the embryo, which is straight and axile with somewhat broad cotyledons.

*Polemoniaceæ* (p. 600).

### 113. The *Convolvulus* Family. (—→ *Boraginaceæ*.)

Herbaceous, rarely shrubby, usually twining to the left, often with milky juice. Leaves mostly simple and palm-nerved, sometimes palmately divided. Hairs sometimes forked. Fls. solitary or cymose, usually with 2 bracteoles. Sepals 5 free or connate, often unequal, persistent. Corolla rarely deeply lobed, lobes usually induplicate-valvate and whole limb plaited. Stamens 5, rarely 4, on the tube. Disc annular, rarely almost obsolete. Ovary 1- or usually 2-celled or by the formation of false septa often 4-celled, style terminal, rarely styles 2. Ovules 2 in each carpel, collateral, erect, basal, sessile, with 1 integument. Fruit capsular or baccate. Seeds 4—1, albumen 0 or scanty. Embryo curved or spiral with foliaceous plaited cotyledons which on expansion are often retuse or 2-lobed.....*Convolvulaceæ* (p. 611).

Exceptions:—

*Cuscuta* is a leafless parasite and flowers with infrastaminal scales.  
Leaves pinnately divided in *Quamoclit*.

Style from between the lobes of the ovary and fruit of nutlets in *Dichondra*, which connects this family with the *Boraginaceæ*.

Ovary 3-celled in *Pharbitis*, 4-celled in *Argyreia* and *Balatas*, 1-celled in *Hewittia*.

**Order XXXI. BORAGINALES.**

Woody or herbaceous with *alternate leaves*, often hispid, *not glandular*. *Leaves simple, alternate*, very rarely lobed, exstipulate. *Inflorescence usually in dichotomous cymes* with the *branches scorpioid* and *flowers unilateral*. *Flowers mostly small regular*. Calyx persistent. Corolla gamopetalous, usually salver-shaped or rotate, 5-, rarely 4- or 6-lobed. *Stamens isomerous*, rarely unequal. Disc often present, hypogynous. *Ovary of 2 median carpels, each carpel with 2 ovules*, carpels often divided by a secondary septum so that the ovary becomes 4-celled and is then often deeply 4-lobed with a gynobasic style and 1-ovuled loculi. *Ovules erect or oblique from the basal inner angle* of the loculus with the *micropyle superior* or facing the axis (ventral). Fruit drupaceous with 2-4-celled endocarp or splitting into pyrenes or of 4 nutlets. Seed with copious or little albumen or exalbuminous. Embryo straight or curved, *radicle superior*.

The *Boraginaceæ* and *Cordiaceæ* are sometimes united with the *Polemoniales*, sometimes with the *Lamiales*. The fruit of some of them (*Boragææ*) closely resembles that of *Labiataæ*, but there appears to be little else in common. They are more closely allied to the *Hydrophyllaceæ*.

Exceptions:—

Leaves sub-opposite or lower sometimes opposite in *Cordia*.

Families: 113a. *Cordiaceæ*; 114. *Boraginaceæ* (both united in *Boraginaceæ*, p. 600).

**113a. The Sebesten Family.**

*Woody plants*. Leaves sometimes sub-opposite, *often with cystoliths*. Flowers frequently 4-10-merous, but normally 5-merous. Style terminal twice partite or 2-fid (*Ehretia*). Fruit a drupe with 4-celled (or fewer) endocarp. Cotyledons plicate. Albumen 0.

*Cordiaceæ*, see *Boraginaceæ* (part).

Exceptions:—

Cotyledons ovate, not plicate in *Ehretia*, which is better put into the *Boraginaceæ*. It has a scanty albumen.

**114. The Borage and Heliotrope Family.**

*Usually herbaceous*, sometimes fruticose and scandent, *very often with hispid hairs*. Flowers 5-merous, *corolla very often with scales in the throat*. Style usually simple, rarely terminal (*Heliotropiææ*) but usually from between the lobes of a deeply divided ovary. Albumen sometimes present.....*Boraginaceæ* (part) (p. 600).

Exceptions:—

Styles 2 or 2-fid in *Coldenia*.

*Rhabdia* is a shrub with few axillary flowers.

## Order XXXII. PERSONALES.

(Polemoniales ←—.)

Small herbs or shrubs, rarely (*Bignoniaceæ*) trees, occasionally glandular. Leaves alt. or opposite exstipulate simple or more rarely pinnate. *Flowers irregular*, rarely (most *Solanaceæ* and few genera of other families) regular or sub-regular, *not twisted\* in bud*. *Posticous stamen nearly always rudimentary or altogether absent (exc. Solanaceæ)*, sometimes only 2 stamens perfect. *Ovary 2-celled*, superior, with many ovules on the axis. Seeds exalbuminous.

Exceptions:—

*Solanaceæ* have usually regular flowers but the tribe *Salpiglossidæ* have irregular flowers. Corolla nearly regular in a few genera of *Acanthaceæ*, *Gesneraceæ* and *Scrophulariaceæ*.

*Nicandra* has a 3—5-celled ovary.

*Oroxylum* (*Bignoniaceæ*) has 5 perfect stamens.

Ovary is 1-celled in *Orobanchaceæ*, *Lentibulariaceæ*, *Gesneraceæ* and *Martynia* (*Pedaliaceæ*).

Ovary is 4-celled in *Datura* and sometimes 4-celled by a secondary septum in some *Pedaliaceæ*.

Only 2 or few ovules occur in each cell in some *Acanthaceæ*.

Albumen sometimes scanty in *Gesneraceæ*, present in *Solanaceæ*, *Orobanchaceæ* and *Scrophulariaceæ*.

Families: 115. *Solanaceæ*; 116. *Scrophulariaceæ*; 117. *Orobanchaceæ*; 118. *Bignoniaceæ*; 119. *Gesneraceæ*; 120. *Lentibulariaceæ*; 121. *Pedaliaceæ*; 122. *Acanthaceæ*.

**115. The Datura and Nightshade Family.**

*Herbaceous or shrubby*, sometimes climbing or scrambling, juice not milky. *Hairs sometimes stellate*. *Leaves alt.*, sometimes in unilateral pairs with the two members of the pair unequal, simple, very rarely pinnate. *Flowers medium or large, regular and 5-merous (exc. in ovary), or with a tendency to zygomorphism and sometimes 6--7-merous, often in extra-axillary cymes or terminating a cymose branch-system*. Calyx persistent. Corolla with lobes rarely imbricate, usually plicate or the lobes valvate. *Stamens alternating with the lobes, sometimes unequal or some rudimentary*. Disc usually present. *Ovary obliquely 2-celled (3—5-celled in Nicandra, many-celled in some Lycopersicum) or rarely 4-celled or 1-celled by absorption of septum*. *Ovules very many on prominent or swollen axile placentæ (few in some exotic genera)*. *Fruit baccate or capsular*. *Seeds compressed discoid or subreniform*. *Embryo often curved and peripheral in the albumen*.

*Solanaceæ* (p. 635).

**116. The Mimulus and Veronica Family.**

*Herbs with opp. whorled or alt., often gland-dotted*, simple, very rarely compound leaves. Calyx persistent, 4—5-lobed or -sepalous.

\* The term "twisted" is not here used in the sense of contorted (where every lobe of the same whorl has one margin covered and one margin uncovered), but literally screw-like as often occurs in *Gentianales*. See Hole, *Manual of Botany*, p. 51 (1909).

Corolla rarely actinomorphic, lobes alternating with the sepals, imbricate, never plicate in bud. Stamens rarely 5 perfect, usually 4, often didynamous or sometimes only 2, anthers 2—1-celled. Disc annular or unilateral. Ovary with 2 median carpels, 2-celled with large swollen placentæ on the septum (axile), Ovules many, rarely few. Fruit capsular. Seeds usually numerous, albuminous. Embryo straight or slightly curved.....*Scrophulariaceæ* (p. 647).

**117. The Broomrape Family.**

Fleshy or scaly root-parasites or saprophytes with usually a simple stem and no true leaves. Fls. solitary spiked or racemed. Calyx spathaceous or 4—5-sepalous. Corolla hypogynous with curved tube and 2-lipped limb, upper lip arched, lower 3-fid, throat often with 2 villous folds. St. 4 didynamous, anthers 1—2-celled, more or less spurred. Ovary 2-carpellary, 1- rarely 2-celled, style long, tip curved, stigma capitate or 2-lobed. Ovules usually many, on 2 pairs of free or confluent parietal placentæ which sometimes meet in the axis. Capsule 1-celled, 2-valved or sub-indehiscent. Seeds few or many, minute with pitted or tubercled or rarely lax and reticulated testa. Albumen fleshy. Embryo ovoid simple or 2-fid.....*Orobanchaceæ* (p. 672).

**118. The Bignonia Family.**

Woody plants, often (in exotic species) climbing by tendrils developed from the leaves. Leaves opposite, rarely whorled, sometimes spiral in the crowded leaves at the ends of the branches in some species, 1—3 pinnate, rarely simple. Flowers large or medium, 2-sexual. Calyx spathaceous or 2—5-lobed. Corolla usually tubular (at least below), then ventricose, lobes subequal and imbricate (rarely valvate) in bud. St. didynamous, often with a 5th present as a staminode, rarely (*Oroxylum*) 5 perfect, mostly inserted anteriorly in the corolla. Disc usually conspicuous. Ovary 2-celled (in the exotic *Crescentiæ* 1-celled, style long. Ovules many in each cell. Fruit elongate, capsular and 2-valved with the valves separating from an often much swollen axis, rarely (exotics only) indehiscent. Seeds flat or 3-gonous, winged. Cotyledons flat or folded, often 2-lobed.....*Bignoniaceæ* (p. 680).

**119. The Achimenes Family.**

Herbs (in our area), sometimes reduced to single leaf and inflorescence. Leaves usually radical, opposite or alternate, simple, exstipulate. Flowers often large, sometimes much reduced, usually racemose, rarely cymose clustered or solitary. Calyx 5-merous, lobes valvate or open in bud. Corolla with long or short tube and usually 5 imbricate lobes. St. on the tube, usually didynamous, rarely 5 fertile, often only 2 fertile. Ovary superior (half-inferior in American genera), 1-celled, placentæ often 2-fid and parietal, sometimes meeting in axis and making ovary 2-celled. Ovules very many, anatropous. Fruit capsular (in our species). Seeds very many, minute. Embryo straight.

*Gesneraceæ* (p. 677).

**120. The Bladderwort Family.**

*Small often very delicate herbs, often rootless, sometimes twining inhabiting water or wet places, and in Utricularia usually with minute bladders on the creeping axis.\* Leaves often evanescent, either simple entire radical and rosulate or in water capillary and multifid.\* Fls. often small, on 1—many-fl. scapes. Calyx 2—5-lobed. Corolla 2-lipped and spurred, upper lip entire or emarginate, lower usually larger entire or 3—6-lobed. Stamens 2, inserted on the base of the corolla, anther-cells transversely confluent. Ovary superior, globose, 1-celled; style short. Ovules very many on a free basal placenta. Fruit a 2—4-valved capsule or irregularly breaking up. Seeds many.*

*Lentibulariaceæ (p. 674).*

**121. The Sesamum Family.**

*Herbs with the leaves opposite or the upper alternate, often (especially the lower) lobed or pinnatifid. Fls. usually axillary or racemose. Calyx 4—5-lobed. Corolla tubular below, ventricose above, lobes imbricate. Stamens didynamous or 2 only perfect, a 5th often present as a staminode. Ovary 2-, rarely 1-celled, or finally 4-celled by a secondary septum, not deeply lobed. Ovules few, or if many one-seriate only in each cell, axile or in one-celled ovaries on divaricate parietal laminae. Fruit capsular or drupaceous. Seeds wingless.....Pedaliaceæ (p. 692).*

**122. The Acanthus Family.**

*Herbs or shrubs, frequently undershrubs, only rarely aromatic. Leaves opp. (alt. in Elytraria and some Staurogyne), sometimes unequal in the pair, simple, frequently with linear cystoliths.† Flowers rarely solitary, bracteate and bracteolate (with few exceptions). Calyx 5- or 4-partite, rarely of several linear teeth (Thunbergia). Corolla lobes imbricate or twisted in bud. St. 4 or 2 on the tube, anthers 2—1-celled, cells sometimes remote or superposed. Disc usually evident. Ovary usually elongate, 2-celled, style filiform. Ovules 1—many in each cell superposed in two rows along the middle line of the septum (exc. Thunbergia, in which the two ovules in each cell are collateral). Capsule loculicidal, the septum splitting along the mesial line. Seeds usually seated on hardened curved funicles produced into an acute tip beyond them, mostly ovoid or compressed and orbicular.*

*Acanthaceæ (p. 694).*

**Order XXXIII. LAMIALES.**

*Woody or herbaceous, usually with glands and aromatic or foetid. Leaves opposite, rarely whorled or alternate, very rarely compound, exstipulate. Flowers irregular or subregular, mostly cymose, cymes often racemed or paniced. Calyx gamosepalous, persistent. Stamens 4 or 2 with or without a rudimentary 5th, very rarely more than 5 (see exceptions). Ovary of 2 carpels, often 4-celled by the formation*

\* According to Goebel the distinction between axis and leaf fails in *Utricularia*.

† Visible externally as translucent dashes or small raised lines. Cystoliths only absent in some *Thunbergiæ*, *Nelsoniæ*, *Acanthæ* and *Aphelandræ*.

of a secondary septum and frequently deeply 4-lobed, rarely 2-celled and entire or 6—8-celled. Style simple. Ovules usually 2 to each carpel, collateral, or 1 in each cell. Fruit of 4 1-seeded nutlets, or a drupe with 4 pyrenes or 1—4-celled endocarp, rarely with an 8-celled endocarp, sometimes with 2—4 valves on germination. Micropyle and radicle inferior. Albumen or scanty.

Exceptions:—

Leaves digitately compound in *Vitex*, pinnatisect in some *Lavandula* and few other *Labiatae*.

Flowers regular and 6—12-merous in *Symphorema*, and ovary sometimes 1-locular at apex, fruit sometimes 1-seeded by abortion of the other 3 ovules.

Families: 123. *Verbenaceae*; 124. *Labiatae*.

### 123. The Teak Family and Lantana Family.

Woody, more rarely herbaceous, sometimes scandent by sarmentose shoots, often fetid or quasi-aromatic from minute sunk glands, hairs often forked or stellate. Calyx persistent and often accrescent, usually 4—5-lobed or -toothed. Corolla usually 2-lipped and 5—4-lobed with the two posterior lobes connate. Stamens usually 4, rarely 2. Ovary of two connate carpels or more usually each carpel divided by a secondary septum into 2 cells. Style terminal. Ovules 2 to each carpel, usually attached to the infolded walls, more rarely basal or pendulous. Fruit drupaceous with a 4—1-celled stone or 4—1 pyrenes or partially connate drupels, sometimes quite dry.....*Verbenaceae* (p. 737).

Exceptions:—

Ovary 8-celled in *Duranta*.

Ovules between the 4 wings of a central column in *Avicennia*.

### 124. The Mint and Sage Family.

Herbs or undershrubs, rarely shrubs, usually with sweet or aromatic smell due to ethereal oils secreted in glandular hairs often sunk in pits in the epidermis and sometimes giving rise to translucent dots. Stems often 4-sided. Flowers more or less zygomorphic, solitary or in contracted cymes in the leaf axils, or upper leaves reduced to bracts and flowers or cymes forming a spike or thyrse. Calyx tubular, persistent. Corolla with 4—5 subequal spreading lobes or 2-lipped, lobes imbricate in bud. Stamens inserted in the tube, 2 or 4 perfect, subequal and spreading or declinate or didynamous. Disc prominent. Ovary free 4-lobed or -partite, consisting of two divided carpels, style arising from between the lobes. Ovules 1 in each cell erect anatropous. Fruit of 4 dry (in our area) indehiscent cocci or nutlets.....*Labiatae* (p. 761).

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### Order XXXIV. RUBIALES.

Leaves opposite or whorled. Calyx superior small. Stamens isomerous, free. Ovary inferior, usually 2 (2—8)-celled, 2—many-ovuled. Albumen copious.

**125. The Coffee and Gardenia Family.**

Woody or herbaceous with opposite or whorled leaves and *interpetiolar* or *intrapetiolar stipules* (stipules apparently wanting in the whorled leaves of the *Galieæ*). *Flowers* small to very large, *regular*, *2-sexual*. *Calyx* usually small with 4—5 *sepals*, rarely obsolete. *Corolla* 4—5-merous or rarely lobes up to 12. *St.* usually *isomerous* (sometimes fewer where the corolla-lobes are more than 5) inserted in the tube or at the mouth of the corolla. *Disc epigynous*. Ovary mostly 2-celled, rarely 3—9-celled, vary rarely (*Gardenia*) 1-celled (with parietal placentæ), style simple or cleft. *Ovules* 1 or more in each cell, usually on the *septum*. Fruit various. *Cotyledons* usually flat.....*Rubiaceæ* (p. 439).

**Order XXXV. CAMPANALES.**

*Herbs often with milky juice. Leaves simple alternate, rarely opposite, exstipulate. Flowers regular or irregular. Calyx superior, rarely obsolete. Stamens isomerous or rarely (Stylidaceæ) reduced to 2, free or connate with the style, anthers free or connate. Ovary completely inferior, usually 2—5-celled. Ovules many axile. Fruit usually capsular. Seeds albuminous, many, small or minute.*

Families: 126. *Campanulaceæ*; 127. *Stylidaceæ*.

**126. The Bell-flower Family.**

Herbs or undershrubs. Flowers axillary or racemose or spicate, regular or (*Lobeliæ*) irregular, 2-sexual. *Calyx* 4—6-partite, usually persistent. *Corolla* with valvate lobes. *Stamens* 4—6, inserted with the corolla and *alternating with its lobes* on the margin of an epigynous disc (on the corolla-tube in *Sphenoclea*), anthers free or connate. *Style* 1 with stigmas as many as the cells. *Ovules* on usually *swollen placentæ*. *Fruit capsular or baccate. Embryo erect.*

*Campanulaceæ* (p. 524).

**127. The Stylidium Family.**

*Fls.* 1—2-sexual *irregular* in corymbs, cymes or panicles. *Calyx* 2-lipped. *Stamens* 2, *filaments connate with the style into a column.* Ovary 2-celled. *Ovules* on the *septum*. *Fruit* a 1—2-celled, 2-valved *capsule*, valves sometimes cohering top and bottom.

*Stylidiaceæ* (p. 523).

**Order XXXVI. ASTERALES.**

Herbs, rarely shrubs. Juice sometimes milky. *Calyx* superior, small or obsolete or changed to a pappus. *Stamens isomerous, mostly syn-genesious. Ovary inferior 1-celled, 1-ovuled. Ovule erect. Seed exalbuminous.*

**128. The Daisy and Thistle Family.**

Leaves alt., more rarely opp., simple or pinnatifid, exstipulate, base of petiole often sheathing. *Flowers sessile in dense heads on a common receptacle surrounded by a calyx-like involucre of bracts.* Flowers *homogamous* or *heterogamous*, outer in a head often with ligulate

limb, inner usually regular tubular or campanulate, sometimes all either regular or ligulate or somewhat lipped. *Calyx reduced to scales or hairs or 0*, if present usually persistent and enlarged in fruit. Stamens 5 (rarely 4) inserted in the corolla tube, anthers very rarely free, finally exerted. Ovule basal anatropous with 1 integument. *Fruit dry indehiscent closely investing the exalbuminous seed*, often crowned by the pappus (modified calyx). Embryo straight.....*Compositæ* (p. 475).

240.

**Class II. MONOCOTYLEDONES.**

The Monocotyledons are few compared with the Dicotyledons, and they are usually herbaceous. The arborescent forms are easily distinguished from dicotyledonous trees by the comparatively slender stems, unbranched or but slightly branched, and not much more slender at the top than at the base. This is due to the parts of the stem from which the leaves have fallen ceasing to grow further in thickness, though in some cases perhaps there is a gradual slight increase in volume of existing tissue elements. Anatomically the closed fibrovascular bundles are seen to be scattered in a transverse section of the stem and there is no cambium ring, so that after the development of the primary bundle cylinder the arrangement of tissues within the epidermis or layer of periderm undergoes no further change. Exceptions to this general type of monocotyledonous tree-stem are only found in the arborescent *Liliaceæ*, such as *Aloe*, *Yucca*, *Dracæna* and *Cordylina*. In these a cambial layer finally appears, but none of these arborescent species are native in our area (though some are cultivated). The leaves of all of them are typically monocotyledonous. Exceptions to the generally unbranched character of the shoots are also found among the *Liliaceæ* (e.g. *Asparagus*, *Smilax*), some *Pandanus*, some grasses (especially the Bamboos), a few *Scitamineæ* (*Clinogyne*) and a few others.

The typical monocotyledonous leaf is simple, narrow, with parallel venation and a sheathing base; between the sheathing base and the blade may be a short petiole. Even the cotyledon has a sheathing base which wraps round the plumule. Sheathing bases sometimes occur in the Dicotyledons, especially in the *Ranales*, *Rosales* and *Umbellales*. Exceptions to the typical monocotyledonous leaf occur chiefly in the *Aroids*, *Dioscoreaceæ*, *Taccaceæ* and Palms. But none of these much resemble Dicotyledonous leaves. In the palms the leaves are often pinnate or flabellate, but the leaflets are monocotyledonous or flabellate and texture hard. The aroids and *Taccaceæ* have often pedate leaves; where broad and simple the venation is usually palmate with secondary nerves straight and transverse, rarely reticulate; the dicotyledonous leaves nearest in appearance to the *Dioscoreaceæ* are perhaps some of the *Convolvulaceæ*. The *Araceæ*, *Taccaceæ* and *Dioscoreaceæ* have, with few exceptions, tuberous root-stocks like so many other Monocotyledons. The parts of the flower in those Monocotyledons with a perianth are usually in threes. The inflorescence is very often enclosed, at least at the base, by a sheathing leaf-base or *spathe*.



241. SYNOPSIS OF ORDERS AND FAMILIES OF  
THE MONOCOTYLEDONS

## Order I. FLUVIALES (Helobiales).

*Aquatic or marsh plants. Flowers regular, often heterochlamydeous and with 3-merous whorls throughout, or stamens and carpels numerous, or flowers reduced. Ovary apocarpous and superior to (Hydrocharitaceæ) syncarpous and inferior. Fruit of follicles, achenes, capsular or membranous or nut-like. Seed without albumen. Embryo with large swollen hypocotyl.*

Families: 129. *Alismaceæ*; 130. *Naiadaceæ*; 131. *Hydrocharitaceæ*.

**129. The Water Plantain Family.**

Leaves radical. Fls. heterochlamydeous. Calyx and corolla 3-merous. Stamens hypogynous or perigynous. Carpels 3-6 or more, 1-celled, free. Fruit of achenes or follicles.....*Alismaceæ* (p. 884).

**130. The Naiad Family.**

Leaves opp. or alternate, submerged or floating. Flowers inconspicuous, 1-2-sexual, homiochlamydeous. Perianth of 3-4 tepals or tubular and hyaline or 0, rarely of 2-1 tepals. Stamens 6-1, hypogynous in the 2-sexual fls., sometimes connate in male. Carpels 6-1. Ovule 1 in each carpel, rarely (*Aponogeton*) 2 or more. Fruit of achenes, drupels or (*Aponogeton*) follicles.....*Naiadaceæ* (p. 887).

**131. The Vallisneria Family.**

Leaves submerged or floating. Flowers inconspicuous to showy, 1-2-sexual, enclosed in a spathe, female solitary, homio- or heterochlamydeous. Sepals 3. Petals sometimes 0. Stamens 3-12, rarely 2-1, sometimes one or two whorls of staminodes. Ovary inferior, placentæ parietal or almost axile, stigmas 3-12. Ovules anatropous or orthotropous. Fruit membranous or fleshy.

*Hydrocharitaceæ* (p. 893).

## Order II. SPADICIFLOREÆ.

The common characters of this order are, with the exception of the most reduced forms, numerous, frequently 1-sexual, flowers massed on a common simple or branched often fleshy axis, the spadix, which in the majority of cases is subtended by and at first sheathed by one or more large modified foliage leaves, "spathes," which may be persistent deciduous or caducous. The flowers of many show the normal monocotyledonous arrangement, but with a dry or inconspicuous perianth, in two 3-merous whorls and 3 free or connate carpels. From these are all gradations to flowers consisting of single stamens or ovaries. Trees, often with very compound leaves, or shrubs (sometimes woody climbers, e.g. rattans) or herbs with simple or compound leaves or plants reduced to minute floating thalloid bodies (Duckweeds).

Sub-order *Arales*. Fam.: 132. *Araceæ*; 133. *Lemnaceæ*.

Sub-order *Pandanales*. Fam.: 134. *Pandanaceæ*; 135. *Typhaceæ*.

Sub-order *Palmales*. Fam.: 136. *Palmaceæ*; 137. *Cyclanthaceæ*.

Each sub-order begins with the more normal and ends with the more reduced families.

#### Sub-order I. ARALES.

Herbaceous, rarely aquatic (minute aquatics in *Lemnaceæ*), usually tuberous or rhizomatous. L. usually broad and fleshy, simple or divided, not distichously appressed face to face. Spadix usually fleshy and bearing a coriaceous or fleshy spathe enclosing the spadix, at least when young.

#### 132. The Aroid Family.

*Herbs*, frequently tuberous or rhizomatous with annual shoots, sometimes perennial climbers, rarely aquatic, usually quite glabrous and somewhat fleshy. Leaves well-developed simple or palmately or pedately divided, rarely pinnatifid. Flowers crowded on a simple fleshy spadix with green or coloured persistent or deciduous sometimes petaloid spathe, usually monœcious with the female fls. below the male. Spadix often produced beyond the fls. Perianth of 4—8 segments or cupular or usually suppressed. Anthers in 2 sexual fls. 4—8, in 1-sexual fls. often reduced to 1—8, often united into synandria with the connective overtopping the cells. Ovary superior usually entire, 1—many celled. Ovules 1—several in each cell, anatropous or orthotropous. Fruit mostly baccate. Seeds albuminous with axile embryo.

*Araceæ* (p. 897).

Exceptions:—

In the semi-aquatic or aquatic genera *Cryptocoryne* and *Pistia*, the spadix is much reduced and the ovary is solitary or ovaries in a single basal whorl.

Leaves linear in *Cryptocoryne*. Flowers dioecious in *Arisæma*. Seed without albumen in *Pothos*.

#### 133. The Duckweed Family.

*Minute floating aquatics* with the shoot consisting of a green thalloid flat or plano-convex expansion, increasing copiously by gemmation. Flowers minute consisting of 1—2 naked stamens or a naked 1-celled ovary, both sometimes enclosed in a common minute membranous spathe and reaching the exterior by a lateral cleft in the frond. Ovary 1-celled with 1—7 ovules. Seed with or without albumen.

*Lemnaceæ* (p. 915).

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#### Sub-order II. PANDANALES.

*Woody plants or marsh herbs*. Leaves undivided, long and narrow, placed more or less with their flat sides opposed. Spathes usually deciduous, sometimes wanting. Perianth 0 or of hairs. Seed albuminous.

**134. The Screw Pine Family.**

*Shrubs* sometimes nearly stemless, or *trees*, often with stilt roots. *Leaves spirally arranged spinulosely toothed*. *Flowers* dicœcious, crowded on simple or branched spadices. *Perianth* 0. *Male* with numerous *stamens*, limits of an individual flower often not defined. *Ovary* of one to several carpels and cells. *Stigmas* distinct. *Ovules* solitary and suberect or many parietal. *Fruit* of 1—several-celled woody or fleshy *drupes*, the whole forming a large syncarp. *Seeds* minute.

*Pandanaceæ* (p. 918).

**135. The Reed-mace Family.**

*Marsh herbs*, often tall with *erect distichous linear leaves*. *Flowers* monoœcious, arranged like the aroids with the male portion of the spadix above the female or sometimes two or more cylindric female spikes below the male. *Perianth* 0 or of hairs. *Male fl.* with 1—5 *stamens*. *Fem.* with a minute stipitate carpel with 1-pendulous ovule. *Fruit* very minute with membranous pericarp.....*Typhaceæ* (p. 917).

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**Sub-order III. PALMALES.**

*Trees or shrubs* with distichous or spiral large flabellate or digitate or pinnately compound plicate leaves. *Flowers* monoœcious or dicecious. *Ovary* free or immersed in the spadix, apocarpous or syncarpous, 1—3-celled.

The *Cyclanthaceæ* are united here with the *Palmaceæ* for convenience. They only bear a superficial resemblance to one another, and in some respects the *Cyclanthaceæ* appear closer to the Aroids and in others to the *Pandanaceæ*.

**136. The Palm Family.**

*Woody plants* with a terminal unbranched crown of large rigid leaves or sometimes widely scandent with alternate leaves, or sometimes leaves distichous, plaited, palmate or pinnately divided. *Flowers* mostly small, never brightly coloured, usually brown or scarious, spadices often very compound. *Perianth* in 2 3-merous whorls. *Stamens* 3 or 6. *Ovary* superior of 3 1-celled carpels or syncarpous and 1—3-celled. *Ovules* 1—2 in each carpel, anatropous. *Embryo* small in a cavity near the surface of the albumen.....*Palmaceæ* (p. 920).

**137. The Cyclanth Family** (*Carludovica* only described).\*

*A small palm-like shrub*. *Flowers* of both sexes densely crowded on the same simple spadix. *Male perianth* toothed. *Female* sunk in the rhachis. *Ovary* 1-celled with 4 sessile stigmas. *Ovules* very many on 4 parietal placentæ.....*Cyclanthaceæ* (p. 919).

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\* N.B.—Herbaceous members occur in this family, which is not indigenous.

**Order III. GLUMIFLORÆ.**

(Grasses and Sedges.)

*Herbs with grass-like leaves* or, if woody, then with long slender mostly hollow "culms" which complete their height growth in one year. *Flowers much reduced*, each standing in the axil of one of a number of imbricating bracts (glumes) on the slender axis of a "spikelet," 1—2 sexual. *Perianth reduced* to scales or bristles or 0. *Stamens* in the normal 2 whorls of three (some Bamboos) or usually 3 or 2 only. *Ovary* of 3—1 united carpels, 1-celled, 1-ovuled. Fruit usually a nut, the seed fused with the pericarp, rarely free, albumen copious.

A highly evolved group probably derived from low down on the Monocotyledonous stock, and flowers much reduced.

Families: 138. *Cyperaceæ*; 139. *Gramineæ*.

**138. The Sedge Family.**

Grass-like herbs. *Stems usually 3-angled* or the leaves *tristichous* with closed, rarely open sheaths. *Ligule obscure* or 0. *Flowers* 1—2-sexual in the axils of the glumes *without a palea* (bracteole). *Perianth* of 6 scales or bristles or a number of hairs or 0. *Stamens* 3—1, *anthers basifixed*. *Ovary* 2—3-carpellary, *stigmas not feathery*. Embryo basal median.....*Cyperaceæ* (p. 930).

Exceptions:—

In the *Carices* the ovary is enclosed in a utricle through the top of which the stigmas project. From comparison with an allied genus (*Elyna*) it appears that the female flower is the remnant of a secondary spkt. in the axil of the bract; this secondary spikelet bears a convolute bract (utricle) in the axil of which is the naked female flower. The rest of the secondary shoot is abortive in *Carex*.

**139. The Grass Family.**

Herbs or woody (Bamboos). *Stems* if angled 2-edged, and leaves *distichous* with usually open sheaths and generally *distinct ligule*. Fls. 1—2-sexual, in the axils of the glumes and also *subtended by a palea* opposed to the glume, rarely palea 0. *Perianth* of 2, rarely 3, minute scales or "lodicules" or sometimes 0. *Stamens* 6—1, *anthers versatile*. *Ovary* probably of 1 carpel but with usually 2 feathery stigmas. Embryo basal lateral.....*Gramineæ* (p. 981).

**Order IV. ENANTIOBLASTEÆ.**

(Probably derived low down from the *Liliiflorous* stock.)

Herbs agreeing in the *ovule being straight* instead of anatropous as in most Monocotyledons, the *embryo lying at the opposite end* (or side, where the funicle is lateral) *to the hilum*. Frequently swamp plants with radical or alternate leaves with *sheathing base* and rarely *distinct petiole*. *Flowers hypogynous*, of typical monocotyledonous type of 5 3-merous whorls in a well-developed 2-sexual flower, or calyx and corolla sub-similar and very small and especially where flowers are in *capitate inflorescences*, calyx or corolla reduced to 2 members or to

hairs, or corolla 0. Inflorescence cymose in spathes, or often capitate without spathe, rarely paniced. Seeds sometimes laterally attached. *Albumen* copious *flowery*. *Embryo* minute.

Families: 140. *Commelinaceæ*; 141. *Xyridaceæ*; 142. *Eriocaulaceæ*.

Exceptions:—

The *Flagellariaceæ* are included here by most German authors and in the body of the Flora. But they show very many exceptions. Especially the ovules are anatropous with the radicle close to the hilum and the flowers remind one of the *Juncaceæ*, with which they are here placed. They, however, resemble the *Enantioblasteæ* in the laterally attached seeds and floury albumen.

#### 140. The Commelina Family.

Herbs with usually more or less *lanceolate* or *ovate parallel-nerved* leaves with a sheath. *Flowers* often cymose with the cymes enclosed in conduplicate spathes, but sometimes spathes absent and flowers paniced, *heterochlamydeous* and often *irregular*. Calyx 3-merous. *Corolla* larger, often blue, 3-merous, but 2 petals often larger or longer clawed than the third. Stamens normally 6 in two 3-merous whorls inserted at base of corolla, but often 2 or more reduced to staminodes, *filaments* often bearded. Ovary superior 3-celled or one cell abortive. Ovules 1 or more in each cell, axile, laterally attached.

*Commelinaceæ* (p. 1122).

#### 141. The Xyris Family.

Tufted herbs with radical linear or subulate and rush-like leaves and naked scapes sheathed at the base with a terminal 2-sexual head or spike of small sessile yellow flowers in the axils of imbricating bracts. *Fls.* heterochlamydeous somewhat irregular. Calyx with one sepal larger and caducous. *Petals* 3, clawed, marcescent. Stamens 3 fertile and 3 reduced or 0. Ovary 1- or incompletely 3-celled. *Ovules* many.

*Xyridaceæ* (p. 1120).

#### 142. The Pipe-wort Family.

Marsh or aquatic herbs with narrow, grass-like or rush-like leaves, radical (except when submerged) and very minute flowers in involucrate heads on naked scapes, usually monœcious. Perianth in two whorls sub-homoiochlamydeous, scarious. Sepals 2—3, free or connate, petals 2—3 or of hairs or 0, often on top of a stipes or slender corolla-tube. Stamens 6 or fewer. Ovary 3- rarely 2-celled, stigmas 3—2. *Ovules* solitary in the cells, pendulous. Capsule 3-lobed. Embryo outside the albumen.....*Eriocaulaceæ* (p. 1114).

### Order V. CALYGINÆ.

Herbs or suffruticose (*Flagellaria*) and sometimes scandent with narrow tubular or septate or flat simple leaves. *Flowers* regular homoiochlamydeous with the perianth mostly dry or scarious or occasionally green, rarely the inner whorl somewhat corolline in texture, in cymose clusters or panicles, 1—2-sexual. *Tepals* inferior in 2 3-merous whorls. *Stamens* 6 hypogynous with basifixed anthers. Ovary superior 3- rarely 1-celled, with styles or stigmas 3. *Ovules* 1—many axile in each cell,

or parietal on 3 placentæ in the 1-celled ovary, *anatropous*. Fruit drupaceous with 1—3 pyrenes or loculicidally 3-valved. Seeds erect (*Juncaceæ*) or laterally attached (*Flagellariaceæ*). Albumen copious, embryo next the hilum.

Families: 143. *Flagellariaceæ*; 144. *Juncaceæ*.

**143. The Flagellaria Family.**

*Stem leafy erect or scandent and sub-woody, climbing by the cirrhose leaf-tips. Leaves lanceolar, sheathing. Flowers in terminal panicles, homiochlamydeous, subscarious white or brown, regular, or tepals somewhat unequal. Ovary 3-celled. Ovules 1 in each cell, axile. Fruit fleshy or drupaceous. Seeds laterally attached. Embryo lenticular or sub-spherical. Albumen copious floury.....Flagellariaceæ (p. 1121).*

**144. The Rush Family.**

*Erect herbs with tufted stems and leaves on a perennial stock, rarely annual. Leaves mostly terete, slightly flattened or concave above. Flowers green or brown and sub-scarious or coriaceous, cymose, regular. Ovary 1—3-celled. Ovules many axile in the 3-celled ovary, rarely 3 only and basal in the 1-celled ovary, anatropous. Fruit capsular, 3-valved. Seeds not laterally attached, mostly elliptic with the testa often produced both ends.....Juncaceæ (p. 1131).*

**Order VI. LILIFLORÆ.**

(←—Probably derived from low down on the monocotyledonous stock, but leading to the most highly evolved orders.)

*Mostly herbs, stock very often bulbous, occasionally shrubs with a crown of sword-shaped leaves. Flowers regular or somewhat zygomorphic, but nearly always with 5 alternating 3-merous floral whorls (the inner whorl of stamens is suppressed in the *Iridaceæ* and some *Burmanniaceæ*). Perianth with both whorls usually petaloid, tepals free or connate. Ovary inferior or superior or half-inferior 3-celled with 2 rows of anatropous ovules axile in each cell. Albumen always present and usually fleshy or cartilaginous.*

Exceptions:—

Flowers very small and usually dioecious in *Dioscoreaceæ*.

Flowers heterochlamydeous in *Bromeliaceæ*, irregular in *Pontederiaceæ*, 2- or 4-merous in *Roxburghiaceæ* and few *Liliaceæ*.

Ovules 1—2 erect or ascending in each cell or pendulous in some *Hæmadoraceæ*, *Roxburghiaceæ*, *Dioscoreaceæ*, and a few genera of other families, q.v.

Albumen mealy in *Pontederiaceæ* and few *Bromeliaceæ*, on which account they are sometimes included in *Enantioblasteæ*.

Placentæ 3 parietal in some *Pontederiaceæ* and *Taccaceæ*. Seeds minute with rudimentary embryo and albumen of few cells only in *Burmanniaceæ*.

Families:—

A. (*Coronariæ*), ovary superior, free rarely shortly adnate at base:—

145. *Liliaceæ*; 146. *Roxburghiaceæ*; 147. *Pontederiaceæ*.

b. (*Epigynæ*), ovary inferior or half inferior:—

148. *Hæmadoraceæ*; 149. *Amaryllidaceæ*; 150. *Taccaceæ*; 151. *Bromeliaceæ* (ovary sometimes superior); 152. *Dioscoreaceæ*; 153. *Burmanniaceæ*; 154. *Iridaceæ*.

### 145. The Lily Family.

Herbs, rarely shrubs or trees with a secondary growth in thickness. Leaves various, rarely reduced to scales, usually parallel-nerved. Flowers mostly 2-sexual, regular, rarely umbelled. Perianth inferior, petaloid, tepals free or connate at base into a tube, in 2 3-merous whorls. Stamens 6 hypogynous or on perianth. Ovary free 3-celled with axile placentation. Ovules in each cell 2—many, anatropous. Fruit baccate or capsular. Seeds with copious albumen. Embryo straight or curved with radicle usually near the hilum.

*Liliaceæ* (p. 1133).

Exceptions:—

Ovules 1—2 in each cell, pendulous, straight in *Smilax*.

Ovules 1 erect in each cell or ascending from the lower angle in *Dracæna* and *Sansevieria*.

Flowers slightly irregular in *Gloriosa*.

### 146. The Roxburghia Family.

Herbs, twining in our species, with alt. opp. or whorled leaves. Flowers axillary or racemose, regular, 2—4-merous. Perianth half inferior, tepals in 2 2-merous whorls. Stamens 4 sub-hypogynous. Ovary free or half inferior 1-celled. Ovules 2 or more erect, anatropous. Capsule compressed, 2-seeded.....*Roxburghiaceæ* (p. 1149).

### 147. The Water Hyacinth Family.

Aquatic herbs with erect or floating leaves. Flowers spiked or racemed, irregular. Perianth unequally 6-partite. Stamens 1—6, one usually longer than the others. Ovary free 3-celled, or 1-celled with 3 parietal placentæ. Ovules 1 or more on each placenta. Fruit a loculicidal capsule. Seeds with horny or floury albumen.

*Pontederiaceæ* (p. 1150).

148. A small family separable from the *Liliaceæ* by the frequently zygomorphic flowers, the outer whorl of stamens sometimes absent, the three present standing opposite the inner tepals, sometimes stamens connate in a ring closing the mouth of the perianth, filaments very short. Ovary often inferior or half-inferior, 3-celled and containing in each cell few semi-anatropous ovules or (in *Peliosanthes*) with 1—2 ascending ovules. Stigma capitate. Fruit capsular or (*Peliosanthes*) seeds bursting through the thin pericarp while ripening. Embryo small in the fleshy albumen.....*Hæmodoraceæ* (p. 1149).

The genera with 1—2 sub-erect ovules and 6 stamens (including *Peliosanthes*) are sometimes included in the *Liliaceæ*. Thus limited there are no Indian species, *Sansevieria* sometimes included in this family being transferred to *Liliaceæ*.

**149. The Amaryllis and Agave Family.**

Herbs often bulbous, or shrubs with a stout caudex and a crown of large ensiform leaves. Leaves nearly always narrow, rarely ovate, parallel-nerved. Flowers as in *Liliaceæ* but more often umbelled with the umbel (sometimes reduced to a single flower) supported by one or more spathes, more often somewhat zygomorphic with declinate stamens, but especially differing in the inferior ovary. Frequently a corona present between or at the back of the stamens. Embryo small straight excentric, enclosed in albumen.....*Amaryllidaceæ* (p. 1151).

Exceptions:—

Leaves plicate in *Curculigo* and flowers sometimes 1-sexual.

**150.** A small family with the leaves, from a tuber, deeply partite, lobed or pinnatifid. Fls. umbellate and supported by a common spathaceous involucre. Perianth with a short broad tube, lobes 6. Stamens 6 cucullate with the anthers inside the cowl. Ovary 1-celled with 3 parietal placentæ: Ovules many, anatropous or almost amphitropous.....*Taccaceæ* (p. 1163).

**151. The Pine-apple Family.**

An American family mostly with clustered radical or sub-radical leaves spirally arranged and sheathing with an amplexicaul base. Inflorescence commonly from the centre of the leaf-rossette, spiciform capitate or paniced, and frequently with brilliantly coloured bracts, sometimes with a crown of leaves or bracts terminating the axis. Sepals 3 free or connate. Petals 3 free or united into a tube below. Stamens 6. Ovary inferior, half-inferior or superior, 3-celled. Ovules usually very many, anatropous. Fruit baccate, sometimes (as in the pine-apple) fruits combined into a syncarp.

*Bromeliaceæ* (p. 1164).

**152. The Yam Family.**

Twining from a tuberous rootstock or from a hard rhizome which frequently bears succulent tubers at the ends of long fleshy fibres. Leaves opposite or alternate, simple or digitately 3--5-foliolate, palmi-nerved and with scalariform or reticulate venation between the principal nerves. Fls. small, regular, dioecious. Tepals in two 3-merous whorls. Male with 3 or 6 stamens or 3 st. and 3 staminodes. Ovary inferior, 3-celled and 3-quetrous with 2 ovules in each cell. Frt. capsular, 3-winged (in our species). Seeds flat.....*Dioscoreaceæ* (p. 1165).

**153.** Herbs with linear radical leaves or leaves reduced to scales. Flowers regular, 2-sexual, spicate or racemed or solitary or on the branches of cymes. Perianth adnate to the ovary (hypanthium coloured) and produced above it into a persistent 6- rarely 3-lobed gamophyllous often angled tube with valvate lobes. Anthers 6 or 3, sessile on the perianth. Ovary inferior 3- or 1-celled. Ovules many small anatropous. Fruit capsular. Seeds minute. Albumen few-celled only. Embryo very minute.....*Burmanniaceæ* (p. 1175).



**154. The Iris Family.**

Herbs with usually tuberous rootstock and narrow often equitant leaves. Flowers 2-sexual, regular or somewhat zygomorphic. Perianth with two 3-merous whorls more or less connate at the base, tepals imbricating. Stamens 3, adnate to the outer whorl or epigynous, free or connate. Ovary 3-celled inferior. Style branches rarely simple, often petaloid. Ovules many 2-seriate axile. Fruit capsular. Seeds many.

*Iridaceæ* (p. 1175).

**Order VII. SCITAMINEÆ.**

Perennial, usually large, rhizomatous herbs, sometimes arboreous in form, very rarely stem woody. Leaves well developed with sheath petiole and blade and closely nerved. Flowers mostly very irregular, 2-sexual, usually spicate, heterochlamydeous. Calyx superior spathaceous or tubular or sepals imbricate. Corolla tubular below with 3 free or connate petals. Androecium mostly very irregular with only one perfect anther or one cell of an anther, the remainder of staminodes, two or more of which are usually petaloid, rarely (*Musaceæ*) with 5 perfect stamens and one staminode. Ovary inferior 3-celled with axile placentation, rarely with 3 parietal placentæ. Style slender; 2 very short stylodes usually present. Ovules many anatropous. Albumen floury. Embryo small.

Families: 155. *Musaceæ*; 156. *Zingiberaceæ*; 157. *Cannaceæ*; 158. *Marantaceæ*.

Exceptions:—

Flowers in *Musa* sometimes 1-sexual.

Ovules 1 only in each cell in *Marantaceæ*.

**155. The Banana Family.**

Large or gigantic herbs rarely woody (*Ravenala*) but often arboreous in form, the large stem usually composed of convolute leaf-sheaths, through the centre of which the inflorescence is thrust up until it emerges from the top as a stout spike covered with coloured bracts or spathes. Lowest spathes sometimes empty, next with 1- or 2-sexual flowers and terminal often remaining unopened. Flowers often zygomorphic with perianth in two whorls colourless or coloured, segments free or connate, sometimes unequal. Fertile stamens 5, very rarely 6, the posterior usually a staminode. Ovary 3-celled. Ovules 1—many in each cell.....*Musaceæ* (p. 1176).

**156. The Ginger Family.**

Perennial herbs, often very large, usually from a rhizome. Stem distinct or composed of convolute leaf-sheaths. Scape central or distinct from the leafy stem. Inflorescence spicate, capitate or paniced, rarely fls. solitary, often showy, irregular. Stamen only one perfect and anther 2-celled. The stamen is the dorsal one of the typical inner whorl of which the two ventral are staminodes combined into a petaloid lip. Outer whorl of androecium absent or two members present as

teeth, lobes or petaloid *staminodes*. Ovary 3- rarely 1-celled. Ovules many. Seeds often arilled.....*Zingiberaceæ* (p. 1178).

**157. The Indian-shot Family.**

As in *Zingiberaceæ* but *androecium* consisting of a single fertile anther-cell on the margin of a petaloid stamen. Opposed to the fertile stamen is a recurved petaloid staminode and in addition are 2—3 erect petaloid staminodes, all more or less adnate to the corolla tube. Style adnate at the base to the staminal tube, broad and flattened upwards with small terminal and oblique stigma. Ovules several in each cell in 2 series. Capsule 3-celled, papillose tubercled or echinate. Seeds globose. *Cannaceæ* (p. 1198).

**158. The Arrowroot Family.**

Closely resembling the last two families. Petiole above the sheath geniculate or swollen. Fls. paired in the bracts. One stamen only fertile with a single perfect anther-cell, the other half of the stamen being petaloid. The other two staminodes of the inner staminal whorl are the "cucullate staminode" which is furnished on one side with a cucullate appendage, and "the labellum" which is broader and often hardened. Of the outer whorl 1 or 2 staminodes are petaloid, or sometimes all 3 fail. Style stout curved, at first included in the cucullate staminode. Ovule 1 in each cell.....*Marantaceæ* (p. 1199).

**Order VIII. GYNANDRÆ.**

Terrestrial or epiphytic perennial herbs, often with pseudobulbs or fleshy stems, the joints of which form a sympodium. Leaves mostly fleshy or coriaceous, sometimes plicate. Flowers irregular, usually very zygomorphic. Perianth in two whorls, usually of similar texture. Calyx superior, 3-merous. Petals 3, one, the "lip," dissimilar from the other two. Stamens and style combined into a column. Anther-usually one only, rarely (*Cypripediæ*) two, sessile or sub-sessile on the column, opposed to the lip. Pollen cohering in each anther-cell into 1, 2 or 4 masses (*pollinia*) which are waxy or granular. Ovary inferior, 1- rarely 3-celled. Stigma one or two viscid areas on the top or front or on lateral processes of the column. Seeds most minute and numerous. Embryo not differentiated.

**159. The Orchid Family** .....*Orchidaceæ* (p. 1201)

## ABBREVIATIONS AND SIGNS.

The abbreviated names of botanists are not included. A fairly complete list of these will be found in Watt's *Dictionary of Economic Products*, I, xxvii, available in all Indian official libraries.

Synonymy has not usually been given except where the name differs from that used in—

- (a) *The Flora of British India* (F. B. I.).
- (b) Brandis's *Forest Flora* (Br. For. Fl.).
- (c) Brandis's *Indian Trees* (Ind. Trees).
- (d) Prain's *Bengal Plants* (Beng. Pl.).
- (e) *The Forest Flora of Chota Nagpur* (Fl. Ch. Nag. or F. C. N.).

The name given by Roxburgh in his *Flora Indica* (Fl. Ind. or Roxb.) has sometimes been added.

Reference has often been made to the Rev. A. Campbell's *Descriptive Catalogue of the Economic Products of Chutia Nagpur* (Desc. Cat.) and to his herbarium (Camp. Herb.), and sometimes to Wood's *Plants of Chutia Nagpur* (Wood) and Thomas Anderson's paper on "The Flora of Behar and the Mountain Parasnath" (Anderson), published in the *Journ. Asiatic Society of Bengal*, 1863. H. B. C. or Hort. Bot. Cal. is the Herbarium at Sibpur, Calcutta. C. & N. refers to the systematic list of the plants of Barkuda Island in the Chilka Lake by Dr. H. G. Carter and Mr. V. Narayanswami of the Botanical Survey of India published in the *Memoirs of the Asiatic Society of Bengal*, 1922. Other botanical works and herbaria quoted in the text have been referred to in full or the abbreviations are sufficiently obvious.

Of works not exactly botanical reference has often been made to *Indian Plants and Drugs* (I. P. & D.) by Nadkarni, and to *The Materia Medica of the Hindus* (Mat. Med.) by U. C. Dutt, or the names of these authors have been cited.

The following indicate the languages to which a vernacular name is supposed to belong:

Beng.=Bengali, H.=Hindi, K.=Kol, *i.e.* including both Mundari (M. or Mund.) and Ho (where these are not given separately), Kharw.=Kharwari, S.=Santali, Sans.=Sanskrit, Or.=Oriah, Ur.=Uran, Th.=Tharu.

### DESCRIPTIVE ABBREVIATIONS AND ABBREVIATED PLACE NAMES.

alb.	.	albumen, endosperm.
alt.	.	alternate.
B. & O.	.	Bihar and Orissa.
C.P.	.	Central Provinces.
c.s.	.	cold season.
cold.	.	coloured.
cor.	.	corolla.

C.T.	Central Tract.
cult.	cultivated.
ell.	elliptic.
exc.	excepting or excluding.
f.	fide.
fem.	female.
fl. or fls.	flowers.
fr. or frt.	fruits.
ft.	feet.
gl. or gls.	glumes.
h.s.	hot season.
hyp.	hypanthium.
inc.	including.
inf. or inflor.	inflorescence.
L. or l.	leaves.
lanc.	lanceolate.
lfts.	leaflets.
m.s.	moderate or medium sized.
m. fls.	male flowers.
N.T.	Northern Tract.
opp.	opposite.
oblancc.	oblanccolate.
Par.	Parasnath.
ped.	peduncle or pedicel.
ped. spkt.	pedicelled spikelet.
per.	perianth.
pet.	petals.
peti.	petiole.
r.s.	rainy season.
sec. n.	secondary nerves: when followed by a number of this number refers to the number of secondary nerves <i>each side</i> of the midrib; the words 'each side' are usually omitted.
sep.	sepals.
S.P.	Santal Parganas.
spkt.	spikelet.
S.T.	Southern Tract.
st.	stamens.
syn.	synonym.
tep.	tepals.
var.	variety.
vern.	vernacular.

SIGNS.

1 added after a locality, but without the name of collector or of herbarium, signifies that the author has himself seen the plant in the locality named (or in the case of Kalahandi, obtained a specimen through a collector sent to that State by himself).

! The same sign following *the name of a person* in italics signifies that the author has seen a specimen of the species concerned collected by, or in the herbarium of, the person named.

*Italics.* The name of a locality followed by *the name of a person* in italics but without the sign ! signifies that the locality is given on the authority of the person named, but that the author has either not seen it or is uncertain of the identification.

and ". Feet and inches respectively.

∞ numerous or indefinite.

+. The plus sign when used for parts of a flower, *e.g.* petals 3+3, indicates separate whorls. In the example, two whorls of 3 petals in each whorl.

Type. Page and family *numbers* in the Introduction in deep type refer to the numbers in the body of the work.

## GLOSSARY OF BOTANICAL TERMS USED IN THE FLORA.

**ABRUPTLY ACUMINATE**, passing suddenly into a tapering point at the apex.

**ACCRESCENT**, continuing to grow.

**ACHENE**, a dry 1-seeded carpel of an apocarpous fruit, e.g. the pips of a strawberry.

**ACHLAMYDEOUS**, without covering. A term applied to a flower devoid of any perianth.

**ACICULAR**, needle-like, long, slender and rigid.

**ACROPETAL**, with the youngest organs nearest to the apex.

**ACROSCOPIC SIDE**, that side of a lateral organ towards the apex of the parent axis. *Cp.* Basiscopic.

**ACULEATE**, prickly, usually applied to somewhat curved prickles like those of a rose, and which are not morphologically branches.

**ACUMINATE**, ending in a tapering apex.

**ACYCLIC**, not arranged in whorls. A term applied to the parts of a flower when these are arranged spirally on the axis.

**-ADELPHOUS**, combined in groups; e.g. monadelphous, combined in one group.

**ADHERENT**, when the members of a flower become united in the course of growth to the members in a different whorl and of a different character, e.g. when the stamens become united to the corolla. *Cp.* Coherent.

**ADHESION**, the state of being adherent.

**ADNATE**, *see* Adherent.

**ADNATE ANTHERS**, *see* Anthers.

**ADVENTITIOUS**, not arising in the regular order from the growing apices, but subsequently and irregularly.

**ÆSTIVATION**, the arrangement of the parts of the floral envelopes in bud.

**ALBUMEN**, a general name for the nutritive tissue stored up in a seed outside the embryo, whether endosperm or perisperm.

**ALBUMINOUS**, containing albumen.

**ALTERNATE**, the relative position of lateral members on an axis when neither opposite nor whorled.

**AMPHITROPOUS**, said of an ovule which is curved round so that one end approximates to the other.

**ANATROPOUS**. An anatropous ovule is an ovule inverted on the funicle or stalk in such a way that though the nucellus remains straight the micropyle is directed towards the point of origin of the funicle which is adherent to the side of the ovule. *Vide* also Ovule.

**ANDRŒCIUM**, a collective word for all the stamens (and staminodes) in a flower.

**ANNULUS**, a row or group of specially thickened cells on the sporangia of many ferns, usually arranged in a ring interrupted at one point and by its elastic straightening rupturing the sporangium.

**ANTERIOR**, the side remote from the parent axis. The antithesis to Posterior. Unless twisting of the pedicel has taken place the anterior sepal or sepals of a flower in an inflorescence will be the lower sepal or sepals, the upper one or ones will be called posterior and the side ones lateral.

**ANTHER**, that part of the stamen which contains the pollen. In Angiosperms it usually consists of 4 cells, loculi or pollen-sacs (microsporangia), one pair on each side of the anther constituting the "anther-lobes." The cells or loculi often coalesce so that only 2 or even one cell is present in the ripe anther. When the loculi lie their whole length on the relatively broad connective, which then appears as a continuation of the filament, the anther is called *adnate*. When the filament appears to end at the base of the anther, the latter is called *innate*. If the anther swings freely on the top of the filament, it is called *versatile*.

**ANTHERIDIUM**, the organ in Cryptogams which produces the spermatozoids or male gametes.

**APETALOUS**, without petals or corolla.

**APOCARPOUS**, *see* Ovary.

**ARCHEGONIUM**, the organ which contains the ovum or oosphere. It typically consists of a narrow upper portion or neck leading to a basal dilated portion containing the oosphere. The spermatozoids reach the oosphere through a central canal in the neck and after fertilization the oosphere develops as the oospore.

**ARCHESPORIUM**, the cell or group of cells which give rise to the spores.

**AREOLA**, a space marked off from the rest or from the adjacent areolæ by some line, nerve or coloration.

**ARIL**, an envelope which grows up from the base of the seed and more or less completely covers it. It is usually fleshy, *e.g.* the flesh on the Litchi seed, the red covering on the Kujri (*Celastrus paniculatus*) seed.

**ARISTATE**, awned, or "when the point is fine like a hair," *Bth.* *See* Awn.

**ASCENDING**, becoming erect from a prostrate or sub-prostrate base.

**ASEXUAL GENERATION**, the spore producing generation, such as the fern, in contra-distinction to the fern prothallium. Syn. sporophyte.

**ASPEROUS**, rough with small papillæ.

**ATROPHY**, the partial or complete suppression of a member.

**AURICLE**, an ear-like appendage.

**AWN**, a rigid very fine or almost hair-like terminal appendage, *e.g.* the appendage on the ears of barley or the terminal twisted appendages of the Spear-grass.

**AXIL**, the upper angle formed by an axis and a lateral member, such as the angle formed by a leaf-stalk with the stem from which it springs.

**AXILE**, situated round an axis. Axile ovules are those situated on the column passing vertically through the centre of an ovary, which

column may be either a free axis, or formed by the meeting of the internal walls of the ovary.

**AXILLARY**, situated in an axil.

**AXIS**. Any member which bears lateral subsidiary members may be called the axis of such subsidiary members.

**BACCATE**, berry-like.

**BALSAM**, a resin dissolved in an ethereal oil.

**BARREN**, *see* Fertile.

**BARK**, all the tissues alive or dead situated outside the cambium ring.

**BASAL-NERVED**, with several equally, or sub-equally, strong main or primary nerves starting from the base. Syn. palminerved, *c.p.* Penninerved. *See also* Nervation.

**BASIFIXED**, fixed to the stalk at the base. *Cp.* Peltate, Dorsi-fixed, etc.

**BASISCOPIG SIDE**, the side of a lateral organ towards the base of the parent axis. *Cp.* Acroscopic.

**BAST**, a system of tissues distinct from the xylem or wood, and in Dicotyledons nearly always lying outside it, and separated from it by the cambium. The tissues of most economic importance in the bast are the *fibres* which yield such materials as jute, hemp, and other textiles.

**BEAKED**, provided with a firm excurrent solid or narrowly tubular prolongation which is often sharply marked off from the body of the organ. (The term is not applied to leaves.)

**BERRY**, typically a fleshy indehiscent fruit with many seeds. Sometimes, however, the seeds are few. The covering or pericarp consists of a thin skin or *epicarp*, a fleshy portion or *mesocarp*, and sometimes a firmer hard inner portion or *endocarp*. Where, however, the endocarp becomes stony or hard the fruit becomes a *drupe*. Examples of a berry are the Jamun (*Eugenia*), Mehrli (*Flacourtia*), Brinjal (*Solanum*). The term is sometimes extended to include fruits which are not typical berries but which resemble a berry in most characters.

**BIFID**, 2-fid, divided into 2 parts about half-way down.

**BINATE**, 2-nate, 2 arising together from the same point.

**BI-PINNATE**, pinnate with the pinnae, or some of them, again pinnate.

**BI-PINNATIFID**, pinnatifid with the segments again pinnatifid.

**BI-SEXUAL**, 2-sexual, containing both fertile stamens and carpels with ovules.

**BLADE**, the expanded part of a leaf, bract, etc., as distinct from the stalk.

**BOSTRYX** or **BOSTRYCHOID CYME**, *see* Helicoid cyme.

**BRACT**, a reduced leaf. Bracts are usual on an inflorescence and often bear a flower in their axils.

**BRACTEOLE**, small bracts occurring on the axis of a next higher order than that on which the bract is situated. If bracts and bracteoles appear to arise from the same axis, the bracteoles will usually be in a different position; thus in Dicotyledons if the bract is ventral the two bracteoles if present are usually lateral.

**BUCCINA**, a trumpet, horn. Hence bucciniform.



**BULLATE**, raised between the nerves.

**CADUCOUS**, quickly falling off.

**CALYCINE**, resembling a calyx in texture rather than petals.

**CALYCVLUS**, (1) a calyx-like assemblage of minute leaves subsidiary to the true calyx and outside of it, or (2) a calyx-like organ, *e.g.* in some Loranthaceæ of which the morphology is doubtful, and may be a part of the torus.

**CALYPTRATE**, falling off as a cap without expanding, *e.g.* the corolla of many vines. Cap-like.

**CALYX**, the outer floral envelopes where there are two and differentiated into calyx and corolla. The term is also used where the inner floral envelope or corolla is considered as suppressed. *See* Flower, Perianth.

**CALYX-TUBE**, the tube or cup formed by the cohesion of the leaves of the calyx. Also loosely applied to an annular zone of the torus, which grows up and bears the calyx or sepals and frequently other members, such as petals, etc., on its edge. *See* Hypanthium. Where, *e.g.* in many Combretaceæ, etc., the hypanthium in an epigynous flower is produced into a tube beyond the ovary, this tubular portion alone is here referred to as a calyx-tube, the term hypanthium being exclusively used for the lower portion.

**CAMPYLOTROPOUS**, *see* Ovule.

**CANESCENT**, *see* Hoary.

**CAPITATE**, (1) clustered together into a head or ball. (2) Knob-like.

**CAPITELLATE**, in the form of a very small knob.

**CAPITULUM**, a head of flowers.

**CAPSULE**, a form of fruit which becomes dry when ripe and opens by two or more valves.

**CARPEL**, the modified leaves which bear the ovules. The carpels occupy the centre of the flower when present (*e.g.* in female or hermaphrodite flowers) and together form the ovary (*q.v.*).

**CARPOPHORE**, the axis of a ripe ovary from which the ripe carpels subsequently separate or are sometimes pendant.

**CARUNCLE**, a peculiar growth at the apical or micropylar end of the seed.

**CATKIN**, a peculiar form of inflorescence consisting of an elongated axis clothed with bracts in the axils of which are 1- rarely 2-sexual flowers usually without, rarely with very inconspicuous, perianth. The whole inflorescence is deciduous together.

**CAUDATE**, furnished with a long slender tail-like tip.

**CHARTACEOUS**, paper-like in texture.

**-CHOTOMOUS**, divided several times into 2 (2-chotomous) or 3 (3-chotomous) forks.

**CIRCINATE**, (1) rolled up longitudinally with a growing tip inside. (2) Coiled.

**CLADODE**, a leaf-like branch of only one internode, *e.g.* the so-called "leaves" of Asparagus.

**CLAVATE**, club-shaped.

**CLAW**, the narrow or stalk-like base found in some petals.

**COCCUS**, one of the lobes of a fruit, each of which is usually derived

from a single carpel of the ovary, and when ripe, becomes more or less detached from the other cocci. Cocci may be dehiscent or indehiscent.

-COCCOUS, adjective of the above used in composition, *e.g.* 5-coccous means composed of 5 cocci.

COLUMELLA, a term applied to the persistent axis of a fruit from which the rest of the fruit falls away in some cases when ripe.

COMMISSURE, the plane of division between two carpels in Umbelliferous fruits.

COMPLICATE, folded together lengthwise upon itself.

COMPOUND, composed of two or more similar parts; thus a compound leaf is composed of two or more separate leaflets, a compound inflorescence of smaller inflorescences.

CONNATE, united one to another. The term is used of similar parts only, such as sepal to sepal or petal to petal, etc., *e.g.* the petals of the Cotton plant; but the union of dissimilar parts, as, *e.g.*, petal to sepal, would be termed "adnate."

CONNIVENT, weakly cohering.

CONTORTED, a form of aestivation in which each member in a whorl has one margin overlapped by the preceding member, while the other margin overlaps the succeeding member. Sometimes called *overlapping* or *twisted*. The term "twisted" is here reserved for an actual twist which sometimes occurs in addition to overlapping.

CONVOLUTE, rolled up from one or both margins.

CORDATE, shaped like the conventional heart (as on playing-cards), or with the base heart-shaped.

COROLLA, one of the envelopes of the flower and a collective name for the petals. The corolla if present is usually situated within the calyx, but rarely the calyx is absent. It may usually be distinguished from the calyx not only by its position but by its peculiar texture and colour, *e.g.* the red petals of a rose, hence *corolline* or *petaloid*.

CORONA, a ligular outgrowth from the corolla or petals on the inside which sometimes appears like a second corolla, or a ligular outgrowth from the back of the stamens which may be interrupted between the stamens or continuous into a tube, *e.g.* in *Pancreatium*.

CORIACEOUS, firm and dry, or very tough leathery.

CRUSTACEOUS, firm and brittle, or very hard.

CORYMB, a form of inflorescence in which the several branches or flower-stalks arising at different levels reach more or less the same level at the top.

COSTA, COSTULE, *see* Nervation.

COTYLEDON, a leaf present on the embryonic plant while yet in the seed. The cotyledon (in Monocotyledons) or cotyledons (in Dicotyledons and Gymnosperms) in some species never expand but are absorbed by the germinating plant, (hypogeal germination); in other species they appear above ground as the first green leaves of the plant (epigeal germination).

CRYPTOGAM, a plant which does not form flowers and seeds in the ordinary sense of those words, though the aggregate of small sporophylls in Lycopods, etc., may be termed a *flower*.

**CUSP**, a short hard point or tip; sometimes also used in the sense of a short pointed tip from an otherwise obtuse leaf.

**CUSPIDATE**, (1) furnished with a cusp; (2) sometimes used as a short expression for abruptly acuminate. Bentham says "some botanists make a slight difference between acuminate and cuspidate, the acumen being more distinct from the rest of the leaf in the latter case than in the former." I think it better to use "cuspidate" only for a short sudden or hardened acumen.

**CYCLIC**, with the parts arranged in whorls, not spirally.

**CYME**, a system of branching in which the main axis ceases to grow or terminates in a flower; the secondary or lateral axes from beneath the apex continue to grow beyond the parent axis and may be likewise superseded by branches or axes of a higher order. *Cp.* Raceme.

**DECANDROUS**, 10-androus, with ten stamens.

**DECIDUOUS**, falling off. *Cp.* Caducous.

**DECLINATE**, inclined to the lower side, and often ascending at the tip.

**DECOMPOUND**, repeatedly branched.

**DECUMBENT**, having the lower parts prostrate.

**DECURRENT**, prolonged downwards from the base.

**DECUSSATE**, in planes at right angles to one another.

**DEFINITE**, not varying in number, not numerous.

**DEFLEXED**, bent downwards.

**DEHISCE**, to open by the separation of the walls or valves.

**DEHISCENT**, dehiscing when ripe.

**DENTATE**, with teeth projecting more or less perpendicularly from the margin.

**DENTICULATE**, with little teeth, or points along the margin.

**DIADELPHOUS**, 2-adelphous, in two bundles. A term applied to stamens which are grouped into two lots; one lot may, however, contain only one stamen.

**DICHASIMUM**, a cymose method of branching in which each axis ends in a flower (or other short unbranched axis) from beneath which a pair of opposite lateral branches arise. *Syn.* Dichasial cyme.

**DICILAMYDEOUS** = heterochlamydeous, or with two whorls of tepals.

**DICHOTOMOUS**, a method of branching in which each axis bifurcates at the tip.

**DICOCCOUS**, 2-coccous, consisting of two cocci.

**DIDYMOUS**, consisting of two equal or similar connected halves or lobes. In the case of anthers, the term is especially applied to those with two rounded lobes without separating connective.

**DIDYNAMOUS**, in two unequal pairs.

**DIFFUSE**, loosely or widely spreading.

**DIGITATE**, spreading like the fingers of the hand. In the case of digitate leaves, each leaflet is properly provided with a short stalk or petiole; if this is absent the leaf is palmately-compound or palmately-partite (*q.v.*).

**DIMEROUS**, 2-merous, with parts in pairs.

**DIMIDIATE**, half wanting or rudimentary, or appearing to be so.

**DIMORPHIC**, occurring in two different forms. *Syn.* Dimorphous.

**DIOECIOUS**, where the sexes occur on different individuals, the male

flower on distinct plants from the female, as, *e. g.*, usually in the Papaya (*Carica*).

**DIPLOSTEMONOUS**, with the stamens in two whorls, those of the outer whorl opposite to the sepals, those of the inner whorl alternate with them.

**Disc**, a swelling or swellings, sometimes glandular, of the torus inside the calyx and under or outside the pistil.

**DISCIFORM**, disc-like in the popular sense of the word "disc." Also in the *Compositæ*, a flower head without ray flowers, *cp.* Radiate.

**DISTICHOUS**, disposed alternately in two opposite rows, or "regularly arranged one above another in two opposite rows, one on each side of the stem."

**DISSECTED** or **DIVIDED**, when the incisions between the segments just reach the midrib or petiole, but the parts or segments so divided off do not separate from the axis without tearing. *Cp.* -sect.

**DIVARICATE**, spreading in opposite directions from a common base.

**DORSAL**, situated at the back of; in some senses the same as *posterior*. The dorsal part of a carpel is the part *remote* from the axis of the ovary or axis of the flower produced. *Cp.* Ventral.

**DORSIFIXED**, fixed by the back of, in contrast to the state of being attached by the end or margin, etc.

**DRUPACEOUS**, more or less resembling a drupe.

**DRUPE**, a form of fruit consisting of a more or less succulent pericarp which encloses a single or many-celled stone, *e.g.* a plum. The stone in a drupe is the inner portion, or *endocarp*, of the fruit, and is to be distinguished from a hard seed *testa*. The stone may contain one or more seeds.

**DRUPEL**, each of the small drupes which may be formed from an apocarpous ovary, or the drupe-like lobes of a deeply divided fruit derived from a lobed but syncarpous ovary.

**EBRACTEATE**, without bracts.

**ECHINATE**, with long spreading spines.

**ECOLOGY**, *see* Ecology.

**EDAPHIC**, depending upon the nature and condition of the soil.

**EFFUSE**, a term applied to an inflorescence with loose widely-spreading branches.

**EMARGINATE**, having a deep dent at the apex. If the dent is broader and shallower it becomes *retuse*.

**EMBRYO**, the new plant from the time of its inception in the fertilized ovule and until the germination of the seed.

**ENDOSPERM**, the tissue formed within the embryo-sac or macrospore subsequent to fertilization (in the case of Angiosperms) and destined to feed the embryo. In Gymnosperms the prothallium (though a secondary endosperm may be also developed). *Cp.* Perisperm.

**ENTIRE**, with the margin or edges not toothed or cut but even and continuous.

**EPICALYX**, a whorl of bracts just beneath the calyx and in some respects resembling it; in other cases stipular appendages of the sepals which also resemble a secondary exterior calyx.

**EPICARP**, the outermost layer of the fruit.

**EPICEAL**, when the cotyledons are raised above the ground free from the seed in germination and become leaf-like.

**EPIGYNOUS**, an epigynous flower is one in which the torus or receptacle grows up at the circumference (which now becomes a hypanthium), carrying with it the calyx, corolla and stamens and completely enclosing the ovary. An epigynous calyx, stamens, etc., refers to this superior position with regard to the ovary or pistil. *Cp.* Perigynous, Hypogynous.

**EPIPETALOUS**, situated on the corolla or petals. The position of epipetalous stamens may be either due to the growth of a common zone of the torus carrying with it both petals and stamens, or to the growing up together of both corolla and stamens (*i.e.* adhesion of corolla and stamens).

**EPIPHYTE**, a plant which grows upon another plant without, however, drawing its nutriment from the living parts of such other plant. *Cp.* Parasite.

**EPISEPALOUS**, (1) situated on the sepals. (2) Situated opposite to the sepals.

**EQUITANT**, in vertical rows with the bases of the outer sheathing the bases of the inner leaves, *e.g.* in many of the Iris Family.

**ERECTO-PATENT**, between erect and spreading.

**EROSE**, appearing torn or frayed at the edges.

**EUSPORANGIATE**, where the sporangia proceed from a group of epidermal cells and the archesporium is the hypodermal terminal cell of the axile row of cells of the rudimentary sporangium.

**EVANESCENT**, quickly disappearing.

**EXALBUMINOUS**, without albumen.

**EXCURRENT**, running out beyond the margin.

**EXTRA-AXILLARY**, situated away from the axil of the leaf to which it is nearest.

**EXTORSE**, applied to anthers which open towards the circumference of the flower and not towards the pistil. Opposed to *Introrse*.

**FALCATE**, somewhat curved.

**FALSE SEPTUM OR DISSEPIMENT**, an inner wall of an ovary which is not formed from the incurved edges of the carpels and is usually of late development.

**FASCICLED**, closely aggregated.

**FASTIGIATE**, with the branches all upright.

**FEMALE**, a female flower is one which bears an ovary containing ovules capable of fertilization and becoming seed, and does not bear stamens. A flower which only bears an imperfect or functionless ovary (pistillode) is not considered a female flower. A *female plant* is one which only bears female flowers.

**FERTILE**. A fertile flower is synonymous with a perfect female flower. A *fertile stamen* is one that develops functional pollen, in contradistinction to a staminode. A fertile frond in a fern is one that bears sporangia. Opposed to barren.

**-FID**, used in composition, divided about half-way down. *Cp.* -partite, -lobed, -sect. "If the leaves are cut into *lobes*, they are said to be

pinnatifid, palmatifid, pedatifid, etc.," *Bentham's British and Colonial Floras*.

FILAMENT, the stalk of an anther, *i.e.* the lower part of a stamen, which may, however, be absent, in which case the anther is sessile.

FILIFORM, very slender, hair-like.

FIMBRIATE, clothed with narrow or filiform appendages.

FLABELLATE, fan-shaped.

FLESHY, thick and of somewhat firmer texture than succulent.

FLOWER, a collection of sporophylls or spore-bearing leaves (stamens or pistil) together with the usually more or less modified portion of the axis (torus, receptacle) on which they are inserted, and together with the specialized leaves (perianth, calyx, corolla), if any, which surround or envelope these organs.

A typical 2-sexual flower in Angiosperms consists of (a) two circles (whorls) of perianth leaves, the outer of which is green and herbaceous (calyx), the inner (corolla) white or coloured and of different texture (petaloid), (b) one or more whorls of male sporophylls (stamens), (c) one or more female sporophylls or carpels which bear the ovules. All or some of the above parts may be arranged spirally in some flowers, and any or all may be absent with the exception of a single stamen or a single carpel and the torus.

-FOLIOLATE, in composition refers to the leaflets in a compound leaf, *e.g.* 3-foliolate means with 3 leaflets.

FREE, not united with other members.

FREE CENTRAL PLACENTATION, where the ovules are situated on the axis of a unilocular ovary, which may be produced above the base of the ovary or not.

FROND, a term usually applied to the leaf of a fern.

FRUCTIFICATION, a fruit or aggregation of fruit, including such parts of the axis, bracts, etc., which are accrescent in fruit.

FRUIT, the ovary (in the case of an apocarpous ovary *all* the carpels) and its contents after the fertilization of the ovules, including in the case of inferior ovaries the accrescent hypanthium or investing part of the floral axis, *e.g.* apple. In Cryptogams, the collection of sporangia.

(*Note.*—Some botanists term each carpel of an apocarpous fruit a fruit.)

FRUTESCENT, becoming shrubby.

FRUTICOSE, shrubby.

FUGACIOUS, rapidly dying or falling off.

FUNICLE, the stalk by which the ovule is attached to the placenta of the ovary.

FURCATE, forked.

GAMO-, in composition means united or in one piece, *i. e.* not divided to the base into separate members, *e. g.* gamophyllous, with the perianth leaves united at least below, etc. The term is used even where perhaps the lower or tubular portion is an annular zone of the floral axis of the same texture as the leaves, petals, etc., concerned.

GEMINATE, in pairs.

GIBBOUS, swollen on one side; humped.

GLABRATE, nearly glabrous.

GLABROUS, without any hairs.

GLABRESCENT, with deciduous hairs, becoming glabrous.

GLAUCOUS, of a blue-green colour.

GLUME, the bracts and bracteoles on the spikelets of the grasses and sedges.

GONOPHORE, an internode of the floral axis between the corolla and stamens, and hence bearing both the stamens and the pistil. *Cp.* Gynophore.

-GONAL, -CONOUS, in composition signifies -angled, *e. g.* 3-gonous. When acutely angled I have usually used the term "-quetrous."

GREGARIOUS, occurring associated in large quantities, *e. g.* the Sal tree.

GYNCECEUM or GYNECIUM, the carpel, ovary or assemblage of carpels in a flower, together with their appendages (style, stigma).

GYNANDROUS, with the stamens adnate to the pistil.

GYNANDROPHORE, same as *gonophore*.

GYNOBASIC, arising from the base of the carpel or ovary.

GYNOPHORE, an internode of the floral axis between the stamens and the pistil, so that the pistil is considerably separated from the stamens. *Cp.* Gonophore.

HAIRY, clothed with somewhat long, not very dense hairs. *Cp.* *pubescent, villous*, etc.

HAPLOCHLAMYDEOUS, with only one whorl of perianth leaves.

HAPLOSTEMONOUS, with only one whorl of stamens.

HASTATE, shaped like an arrow-head in which the barbs, basal lobes or auricles spread more or less at right angles to the rest of the blade.

HELICOID (CYME), a form of sympodial cymose branching in which the newer axis always arises to the same side of the parent axis, so that the sympodium becomes more or less spiral, *e. g.* each half of a pedate leaf. *Syn.* Bostrychoid.

HEMICYCLIC, with some of the floral members whorled or cyclic and others spiral, *e. g.* with the calyx and corolla in whorls and the stamens and carpels spirally arranged as in *Clematidææ*.

HEMIPARASITE, partially parasitic. Hemiparasites have green leaves and thus form starch, etc., for themselves. Holoparasites are completely parasitic.

HERMAPHRODITE (flower), a flower in which both stamens and ovary are present and functional.

HETEROCHLAMYDEOUS, with the perianth distinctly differentiated into a calyx and a corolla.

HETEROGAMOUS, a term usually restricted to the flower-heads of the *Compositæ* and the spikelets of grasses where the flowers are of two kinds differing in sex in the same head or spikelet, *i. e.* some male, female, hermaph. or neuter flowers, or any two or three of these, are included in the same head.

HETEROSPOROUS, bearing spores of different kinds. *See* Spore.

HILUM, the scar on a seed indicating the point of separation from the funicle or stalk.

HIRSUTE, with a thick covering of somewhat firm, moderately long and spreading hairs. *Cp.* Hairy, Pubescent, Villous, etc.

**HISPID**, with short scattered very stiff hairs or bristles; sometimes the base of the hair only is stiff. A hispid surface feels harsh to the hand.

**HOARY** or **CANESCENT**, when the hairs are so short as not to be distinguished by the naked eye and yet give a general whitish or grey hue to the surface.

**HOMOGAMOUS**, a term usually restricted to the flower-heads of the *Compositæ* and the spikelets of grasses where the flowers are all similar to one another in sex in the same head or spikelet, *i.e.* either all male, all female, or all hermaph.

**HOMIOCHLAMYDEOUS**, where the different whorls or members of the perianth or floral envelopes are all similar in texture, *i.e.* not distinctly differentiated into calyx and corolla. *Cp.* Haplochlamydeous, Heterochlamydeous.

**HOMOLOGOUS**, of similar morphological significance.

**HYGROPHYTE**, a plant requiring a constant supply of moisture all the year round.

**HYPANTHIUM**, a more or less tubular or flask-shaped zone of the floral axis which grows up above the level of the ovary and bears on its margin or at different levels the floral envelopes and androecium. It is sometimes constricted above the ovary and prolonged into a "beak" above it. It is either green or coloured, specially in fruit. The ovary may lie free within it or be closely invested by (adnate to) it, in which case it may be referred to as the ovary-wall. *See also* Calyx-tube.

**HYPOGEAL**, germination in which the cotyledons remain in the seed.

**HYPOGYNOUS**, situated on the torus at the same level as, or below the level of the base of the ovary. *Cp.* Perigynous, Epigynous.

**IMBRICATE**, a mode of æstivation in which one member of the whorl is outside all the others (*i.e.* its margins are free) and one inside all the others (*i.e.* both margins are overlapped); the others usually overlap by one margin only. Also used for leaves, etc., where they overlap one another like the tiles of a house.

**INCISED**, deeply cut.

**INCURVED**, with the ends curved inwards or towards the axis.

**INDEFINITE**, of varying number and usually numerous.

**INDEHISCENT**, not opening by valves or pores. The liberation of the seeds of an indehiscent fruit takes place through the consumption of the fruit by animals, or through the rotting or irregular rupturing of the walls of the pericarp.

**INDUMENTUM**, the clothing of hairs, scales, etc.

**INDUPLICATE**, rolled inwards on both sides.

**INFERIOR**, an inferior calyx, stamens, etc., implies insertion at a level below, or near, the base of the ovary; an inferior ovary implies that the sepals, stamens, etc., are inserted on the torus at a level above or near the top of the ovary. *Cp.* Epigynous.

**INFLORESCENCE**, an axis or assemblage of axes especially devoted to the bearing of flowers and including the flowers and their bracts and bracteoles.



**INFRUTESCENCE**, an assemblage of fruits including in many cases the more or less modified axes which bear them.

**INFUNDIBULAR**, funnel-shaped, having the lower part tubular and gradually widening upwards, as in a chemical funnel.

**INNATE**, said of stamens in which there is a distinct transition from, or articulation between, the anther and the filament, in contradistinction to one in which the connective appears merely as a continuation of the filament. *Cp.* Adnate. In some cases, however, *e.g.* *Dimorphocalyx*, the whole anther may be innate but its cells adnate to a thick connective.

**INTEGUMENT**, one of the coats or envelopes of the nucellus of the ovule. There may be one or two integuments which grow up from the base of the ovule completely investing the nucellus with the exception of a minute channel at the tip termed the *micropyle*, through which in most plants the pollen-tube finds its way to the embryo-sac.

**INTERNODE**, the space between two leaves or metamorphosed leaves.

**INTERPETIOLAR**, said of stipules situated between the bases of opposite leaves, and which are frequently more or less connate, so that each pair, made up of one from each leaf, may resemble single stipules.

**INTRAPETIOLAR**, said of stipules when each pair of a single leaf unite together within the axil of the leaf.

**INTRORSE**, said of anthers which open towards the pistil. *Cp.* Extrorse.

**INVOLUCRE**, an assemblage or whorl of bracts or leaves situated close beneath a flower or inflorescence.

**IRREGULAR**, unsymmetrical, *i.e.* not being capable of division into two similar halves or only by a single plane passing through the axis (zygomorphic). Sometimes also used for flowers in which some of the members in the same whorl differ from others.

**ISOMEROUS**, with the number of members in each whorl the same.

**ISOSPOROUS**, *see* Spore.

**ISOSTEMONOUS**, with the stamens equal in number to the normal number of the sepals, petals or (in haplochlamydeous flowers) tepals.

**-JUGATE**, in composition in.....pairs, *e.g.* multijugate=in many pairs.

**KEEL**, the anterior petal in the *Papilionaceæ*; a ridge shaped like the keel of a boat as in the adjective "keeled".

**LACINIATE**, irregularly cut into very narrow lobes.

**LANCEOLATE**, shaped like a lance-head. A lanceolate leaf may or may not taper as much at the base as at the other end, but if it is much wider near the base the leaf will become ovate-lanceolate. It is usually at least three times as long as broad.

**LATERAL**, situated to the right and left of the median plane. *See* Anterior.

**LATEX**, milky juice. Laticiferous, possessing latex.

**LEAF**, leaves in the broad morphological sense are lateral exogenous outgrowths of an axis originating below the growing apex in acropetal succession from the undifferentiated tissue of the growing point, and differing in form from the axis which produces them.

In its typical form a leaf consists of a flat expanded green blade,

or in a compound leaf several blades (*leaflets*), a stalk or *petiole*, and two lateral appendages at or near the base of the petiole (*stipules*). Any of these parts may be absent or the leaf variously metamorphosed into foliar tendrils, bracts, scales, petals, etc.

The growth and life of a leaf is usually strictly limited, it never bears flowers, but it often bears sporangia (as in ferns, carpels, stamens). It often bears a bud or shoot in its axil except in the case of many metamorphosed leaves. In descriptions of shape, etc., the word *leaf* merely denotes the blade of the ordinary foliage leaves.

**LEAFLET**, one of the blades of a compound leaf (see above). A leaflet may usually be distinguished from a simple leaf from its position (one very frequently terminating the foliar axis), and from bearing no bud in its axil.

**LEGUMINOUS**, resembling the peas and beans, especially in the nature of the fruit.

**LENTICEL**, cortical pores. Usually lens-shaped or elongate small dots or excrescences on the bark; they are filled with loose tissue, the intercellular spaces of which serve as a passage for oxygen into the inner tissues.

**LEPIDOTE**, covered with small flat scales.

**LEPTOSPORANGIATE**. The sporangia are formed from a single epidermal cell, and have a peculiarly shaped, usually tetrahedral archesporium.

**LIGULE**, a membranous or petaloid outgrowth from the surface of an organ. In grasses and many other monocotyledons the membranous appendage at the mouth of the sheath.

**LIGULATE**, strap-shaped.

**LIMB**, the expanded part of a corolla, petal, etc., in contra-distinction to the tube or claw.

**LINEAR**, at least four or five times as long as broad.

**LOBED**, cut less than half-way down into (unless otherwise specified) more or less rounded segments. Lobed or cleft, "so that the incisions do not reach the midrib or petiole," *Bentham*. Bentham evidently uses the word "lobes" and "fid" in a more extended sense than is usually done. He says that bifid, trifid, multifid, mean two-lobed, three-lobed, etc.

**-LOCELLATE**, used in composition to indicate the number of locelli or cells in an anther, especially before the fusion which often takes place on dehiscence.

**-LOCULAR**, used in composition to indicate the number, etc., of cells or compartments in an ovary or fruit, or in a ripe anther just before dehiscence.

**LOCULICIDAL**, a mode of dehiscence in which rupture takes place through the middle of the outer wall of each cell or loculus. *Cp.* septicial.

**LOCULUS**, a compartment of an ovary, anther, fruit, etc.

**LODICULE**, small scales, usually much swollen at the time of flowering, occurring in the flowers of many grasses, and by some supposed to represent the inner whorl of a rudimentary perianth. They appear to have the function of forcing apart the glumes.

**LYRATE**, with a very large terminal lobe compared with the smaller and narrower lateral lobes in a pinnatifid leaf.

**MACROSPORANGIUM**, a sporangium which contains one or more macrospores. In the Gymnosperms and Angiosperms the macrosporangium is represented by the nucellus of the ovule.

**MACROSPORE**, a relatively large asexually produced female spore, *s.e.* a spore producing a prothallium which bears archegonia but not antheridia, represented in the Angiosperms and Gymnosperms by the embryo-sac.

**MALE FLOWER**, a flower which bears fertile stamens but not fertile carpels. An abortive pistil may be present in a male flower or not.

**MARCESCENT**, remaining attached after flowering, usually in a withered or altered state.

**MARGINATE**, with a margin of a different character from the rest of the member.

**MEDIAN**, lying in the plane drawn through the centre of the member and the longitudinal centre of the axis bearing the member.

**MEGASPORE**. Syn. Macrospore.

**MERICARP**, one-half of a schizocarpous fruit.

**-MEROUS**, in composition, indicates the number of members in each whorl, *e.g.* 5-merous.

**MICROSPORANGIUM**, a sporangium which contains microspores. In the Gymnosperms and Angiosperms each loculus of an anther is a microsporangium.

**MICROSPORE**, relatively small asexually produced spores, which give rise to a prothallus bearing antheridia. In the Gymnosperms and Angiosperms the pollen-grains are the microspores.

**MICROPYLE**, the canal through the integuments of an ovule at the apex of the nucellus.

**MIXED FOREST**, forest composed of a large number of different species rather than of one or two gregarious species.

**MONOCARPIC**, dying after one flowering season, *e.g.* some Palms. If, after flowering, the whole or part of a plant lives and produces flowers in another season it is caulocarpic.

**MONADELPHOUS**, more or less united into one bundle by the filaments.

**MONOCHLAMYDEOUS**, a flower with only one kind of floral envelope not differentiated into calyx and corolla (although possibly in two whorls, as in some *Lauraceæ*). Syn. homoiochlamydeous.

**MONOECIOUS**, bearing both male and female flowers on the same individual, *e.g.* many *Cucurbitaceæ*.

**MUCRONATE**, tipped with a very short hard, usually blunt point. If the point is longer or acute it becomes cuspidate or awned.

**MURICATE**, covered with scattered short firm thick or conical spines.

**MUTICOUS**, without appendages.

**-NATE**, used in composition, arising from the same point or whorled, *e.g.* binate in pairs, ternate in threes.

**NERVATION**, the arrangement of the fibro-vascular bundles in the leaves. The method of describing the nervation differs somewhat in the Flowering Plants and Ferns.

I. *Flowering Plants*.—The nerves or ribs which spring directly from the petiole (or stem in sessile leaves) are termed *primary nerves*. The centre one, or if there is only one, is the *mid-rib*. If there are several primary nerves spreading from the base the leaf is *palm-nerved* or *palmately nerved*; 3-nerved, 5-nerved, etc., refer to the number of primary nerves. If all the primary nerves are parallel or nearly so the leaf is *parallel-nerved*. The larger nerves which spring laterally from the primary nerves are the *secondary nerves*, and those that arise from these the *tertiary nerves*, which may, as well as the nervation of a higher order, be also called the *nervules*. If the nervules are very numerous and anastomose with one another the nervation is *reticulate*, but this expression is sometimes also used merely as the antithesis of *parallel-nerved*.

II. *Ferns*.—The continuation of the stipes or stalk of the frond into the blade is called the *rhachis* or *primary rachis* in a compound or deeply divided frond, *rhachis* or *mid-rib* or *costa* in a less divided or simple frond. The branches from the primary rhachis in a bi-many-pinnate or deeply 2—many-pinnatifid frond are the *secondary rachides*, and the branches from these again the *tertiary rachides*, according to the state of division of the frond. The mid-rib of a final lobe or segment is a *costule*. The nerves that spring from the costæ of a simple frond or the costule of a segment are the *veins*, and those of a higher order the *venules* or *veinlets*.

**NODE**, the plane of insertion of a leaf on the axis.

**NUT**, a hard dry, 1-seeded indehiscent fruit.

**NUTLET**, the dry 1-seeded lobes of some fruits, each of which becomes detached like a separate fruit, *e.g.* in *Labiatae* and *Boragaceae*. See also *Coccus*.

**OB-**, in composition means inversely. Thus an ovate leaf has the wider part towards the base, an *obovate* leaf is inversely ovate and has the wider part towards the apex.

**OBDIPOSTEMONOUS**, *diplostemonous* in which the members of the outer whorl of stamens are opposite to the petals, and those of the inner whorl opposite to the sepals.

**OBLIQUE**, when referring to shape means with one half more largely developed than the other.

**OBLONG**, longer than broad and with the sides more or less parallel.

**OBSOLETE**, not developed.

**OBTUSE**, blunt but scarcely rounded.

**OCHREATE** or **OCHREATE**, said of stipules which are united into a tube round the stem.

**ECOLOGY**, the science of the relations of an organism to its environment.

**OOSPHERE**, a naked nucleated mass of protoplasm, which after coalescence with the nucleus of the spermatozoid becomes the *oospore* and embryo of the succeeding generation.

**OOSPHERE**, see *Oosphere*.

**OPPOSITE**, on different sides of the axis with the bases on the same level.

**ORTHOTROPOUS**, an *orthotropous* ovule is straight with the micro-

pyle opposite to the chalaza of base from which arise the integuments.  
Cp. Anatropous. *Vide also* Ovule.

OVAL, broadly elliptical.

OVARY, the part of a flower which contains the ovules, and consisting of one or more carpels which cohere by their edges to form one or more closed cells or chambers, the *cells* of the ovary. An ovary is *apocarpous* if the carpels composing it are free from one another, in which case each carpel forms a separate chamber by the incurving and meeting of its edges (*see* Suture). An ovary is *syncarpous* if the carpels composing it are united to one another. A syncarpous ovary is 1-celled where the component carpels only cohere by their edges or where the coherent edges are incurved without reaching the axis; it is 2- or more-celled where the coherent edges of the carpels are sufficiently incurved to meet one another in the axis of the ovary, so as to form walls, or *septa*. Septa sometimes arise also by vertical walls between the axis of the ovary and the mid-ribs of the carpels, or in a 2-carpellary ovary by a wall joining the sutures. These are sometimes called *false septa*.

OVATE, egg-shaped with the broader end towards the base scarcely twice as long as broad.

OVATE-LANCEOLATE, OVATE-OBLONG, etc., between ovate and lanceolate, between ovate and oblong, etc.

OVULE, usually small or minute bodies attached to the carpellary leaves (carpels) in most Gymnosperms, and usually to the carpellary leaves, but sometimes on the base or on the free axis of the ovary in the Angiosperms, always in the Angiosperms inside the closed ovary. The ovule consists of a central portion (macrosporangium, nucellus) and nearly always of one or two integuments which envelop the nucellus by growing up from its base. It is attached by a stalk, *funicle*, to the placenta or is more rarely sessile. If the ovule and nucellus are straight with the micropyle opposite to the base (chalaza) the ovule is *orthotropous*; if it is inverted so that the funicle is adnate to the side (forming the *raphe*) and the micropyle is directed towards the placenta it is *anatropous*; in this case the nucellus remains straight between the chalaza and the micropyle, but if the whole ovule including the nucellus is itself curved the ovule is *campylotropous*. In this case the embryo also becomes curved. On fertilization and consequent development of the embryo the ovule becomes the *seed*.

PALE OR PALEA (adj. paleaceous), a chaffy scale. Specifically the upper of the two bracts which subtend a flower in the *Gramineæ*. The palea of the *Gramineæ* is most frequently 2-nerved and may possibly represent two connate tepals of the outer perianth whorl.

PALMATE, with the segments radiating like the spread fingers of the hand. A palmate leaf may have the segments cut to the base, in which case it becomes compound, but if the leaflets are petioluled it is called *digitate*.

PALMATIFID, palmate with the sinuses reaching about half-way down.

PALMATIPARTITE, palmate with the sinuses reaching beyond the middle.

PALMATISECT, much cut in a palmate manner.

**PALMINERVED**, with the primary nerves radiating from the apex of the petiole.

**PANDURIFORM**, fiddle-shaped, with the base and end broader than above the base.

**PANICLE**, a repeatedly branched inflorescence.

**PAPILIONACEOUS**, shaped somewhat like the flowers of a pea or bean. A typical papilionaceous flower has a corolla with a large posterior petal (*standard*), two lateral petals (*alæ*, *wings*) and two anterior petals more or less combined into a *keel*.

**PAPILLÆ**, small multicellular outgrowths from the epidermis.

**PAPPUS**, the scaly, hairy or feathery modified calyx of the fruit of some plants, especially of the *Compositæ*.

**PARALLEL-NERVED**, with numerous nerves from the base running more or less parallel and close to one another, as *e.g.* in the leaves of Bamboos, etc.

**PARASITIC**, drawing sustenance from the living tissues of other plants.

*Cp.* Epiphytic, saprophytic.

**PARI-PINNATE**, pinnate with the leaflets in pairs and no terminal leaflet.

**-PARTITE**, in composition means cleft considerably beyond the middle.

*Cp.* -fid, -lobed.

**PECTINATE**, with narrow segments spreading like the teeth of a comb.

**PEDATE**, a form of branching in which the segments of each half of the leaf form a helicoid cyme.

**PEDICEL**, a small stalk. Especially the stalk of a single flower of an inflorescence to distinguish it from the peduncle.

**PEDUNCLE**, the stalk of an inflorescence, or of a single flower when the inflorescence is 1-flowered, or the common stalk of two or more pedicelled flowers.

**PELLUCID**, translucent.

**PELTATE**, (1) shield-shaped, round, like the indusium of some ferns; (2) of leaves, attached to the petiole in the centre of the blade, or at least not by the margin.

**PENNINERVED**, with one mid-rib and secondary nerves branching from it. *Cp.* Nervation, Basal-nerved.

**PENTADELPHOUS**, applied to stamens aggregated into 5 groups.

**PENTAMEROUS**, with 5 members in each whorl.

**PERIANTH**, a general term for the floral envelopes including both calyx and corolla, but more especially when there is no differentiation into calyx and corolla.

**PERICARP**, the whole wall of the fruit including the epicarp, mesocarp and endocarp.

**PERIGYNOUS**, a term applied to the flower or to the sepals, petals, or stamens when these are raised on a zone (hypanthium) of the torus above the level of the bases of the ovary when the ovary is free in the tube so formed or only adnate by means of the intercalated disc.

*Cp.* Hypogynous, Epigynous.

**PERISPERM**, nutritive tissue of the nucellus *outside* the embryo-sac, which remains in the seed until absorbed by the *germinating* embryo. Most dicotyledonous seeds contain endosperm but not perisperm.

- PERSISTENT, not falling off.
- PERULATE, wrapped in scales, as many winter buds.
- PETAL, one of the divisions of the corolla.
- PETALOID, of a more or less delicate texture and white or coloured.  
*See* Corolla. *Cp.* Sepaloid.
- PETIOLE, the stalk of a leaf.
- PETIOLULE, the stalk of a leaflet in a compound leaf.
- PHYLLOCLADE, a branch compressed so as to resemble a leaf and performing the functions of a leaf. *Cp.* Cladode.
- PHYLOGENY (adj. phylogenetic), (1) ancestry from forms or groups which differ specifically, or generically, or in more important characters, from the existing species or group. (2) Opposed to *ontogeny*, or the origin and development of the individual.
- PILLOSE, covered with rather long, not matted nor very silky hairs. "Thinly sprinkled with rather long hairs," *Bth.*
- PINNA, the branches of a bi-pinnate leaf. *See* Pinnate.
- PINNATE, a compound leaf with two or more leaflets springing from each side of the axis or *rachis*. If the leaflets are odd so that the rachis terminates in a leaflet, the leaf is imparipinnate; if the leaflets are even with no terminal leaflet, the leaf is paripinnate. If the rachis of the leaf bears one or more pairs of secondary rachides which latter bear the leaflets, the leaf is *bi-pinnate*. If the secondary rachides bear again rachides the leaf is *tripinnate*, and so on.
- PINNATELY, in a pinnate manner, *i.e.* with the branches springing from either side of the central axis. *Cp.* palmate (adv. palmately).
- PINNATIFID, deeply lobed to about half-way down or more with the lobes pinnately arranged.
- PINNATISECT, pinnatifid down to the mid-rib. *Cp.* Dissected.
- PINNULE, the ultimate free divisions or leaflets of the frond in ferns.
- PISTIL, a collective word for the ovary, style and stigma.
- PISTILLODE, a rudimentary pistil.
- PLACENTA, the surface to which are attached the ovules.
- PLACENTATION, position of the placenta.
- PPLICATE, plaited.
- PLUMOSE, feathered.
- PNEUMATOPHORE, organs for admitting oxygen to the roots in some swamp plants.
- POD, typically a dry fruit derived from a mono-carpellary ovary, elongated in shape and dehiscing along one or both sutures, such for instance as a pea-pod. In a more extended sense any fruit of the Leguminous order or other fruit resembling a typical Leguminous fruit.
- POLLEN, the male spores which are developed in the pollen-sacs or loculi of anthers.
- POLYADELPHOUS, in many bundles.
- POLYGAMOUS, bearing male, female and hermaphrodite flowers on the same plant.
- POSTERIOR, *see* under Anterior.
- POSTICOUS, hinder, at the back, posterior.
- PRICKLE, a pointed spine-like process originating from the epidermal, or epidermal and subjacent, tissue only. *Cp.* Thorn.

PRIMARY NERVES, *see* Nervation.

PROCUMBENT, when the branches spread along the ground the whole or greater portion of their length. *Cp.* Ascending.

PROSTRATE, when they lie *close* to the ground.

-PLINERVED, when several primary nerves diverge from close to the base but the lateral ones diverge from the mid-rib a *little above* the base.

PROTANDROUS, the anthers ripening before the pistil is ready for fertilization. Syn. Proterandrous.

PROTHALLIUM, prothallus, the plant produced direct from a spore. *q.v.*

PSEUDOCARP, a fruit or cluster of fruits together with the accrescent axis, peduncle or other parts not usually considered to belong to the fruit proper, *e.g.* a pine-apple.

PUBERULOUS, slightly pubescent. Syn. Puberulent.

PUBESCENT, covered with close short fine hair. Pubescence is a denser shorter state of hairiness than hairy.

PUNCTATE, marked with small dots or points.

PUNGENT, with a pin-like point capable of penetrating the flesh.

PUTAMEN, the hard endocarp, especially a many-celled endocarp, of fruits.

PYRENE. When a putamen consists of or breaks up on ripening into several parts each enclosing a seed, each such part is called a pyrene. *Cp.* Coccus.

-QUETROUS, in composition = -cornered or -angled. In this Flora 3-quetrous signifies more sharply 3-angled than 3-gonous.

QUINATE, with 5 segments or leaflets.

RACEME, an inflorescence in which the main axis continues to grow and the lowest flowers are the oldest and open first.

RACEMOSE, a form of branching in which the main axis continues to grow and remain stronger than the lateral axes, which successively spring from it, with the youngest nearest the apex. *Cp.* Cyme.

RACHIS or RHACHIS, (1) that part of a pinnate leaf which bears the leaflets; in a bi-pinnate leaf the primary rachis bears the pinnæ, the secondary rachides the leaflets. (2) The axis of an inflorescence.

RACHILLA or RHACHILLA, the axis of the spikelet of grasses or sedges.

RADIATE, bearing ray flowers of a different form to the inner flowers of an umbel or capitulum.

RADICAL, direct from the root.

RADICLE, the embryonic root.

RAPHE, the ridge or course of the funicle along the side of some ovules, the funicle being adnate in anatropous ovules. *q.v.*

RAPHIDES, acicular crystals sometimes found embedded in tissues, and in some cases visible as small raised lines on the surface.

RAY FLORETS or RAY FLOWERS, the more or less zygomorphous flowers found at the circumference of many umbels, flower-heads, etc.

RECEPTACLE, the portion of the axis on which is situated the florets in a capitate inflorescence, or on which is situated the parts of the flower in a flower.



**REGULAR**, with all the members symmetrically disposed around the geometric centre of the flower, and with either all the members in a single whorl equal and similar, or if dissimilar then regularly alternating.

**RENIFORM**, kidney-shaped.

**REPAND**, with a wavy margin, the sinuses being more shallow than in *sinate*.

**REPLUM**, a partition of the ovary which is not a part of the carpels. A septum joining the sutures of the two carpels in *Cruciferae* and some other families, from which the carpels or valves finally separate.

**RETINACULUM**, an upcurved acute subsequently hardened process from the placenta (possibly a modification of the funicle) on which the ovules and seeds are borne in most *Acanthaceae*.

**RETORSE**, directed backwards.

**RETUSE**, with the apex depressed so that there is a sinus at the tip, which is less deep than emarginate; "very obtuse or truncate, and slightly indented," *Bentham*.

**RHACIS, RHACILLA**, see *Rachis, Rachilla*.

**RHIZOME**, an elongated underground stem with usually horizontal growth.

**ROOTSTOCK**, see *Stock*.

**ROTATE**, a corolla with a very short tube and a horizontally spreading limb, or tube 0.

**ROTUND**, roundish; not angular.

**RUGOSE**, with numerous minute elevations and depressions.

**RUMINATE**, with the testa of the seed projecting as points and plates into the albumen.

**RUNCINATE**, incised with the lobes directed backwards.

**SACCATE**, bulged into a small sac or cavity.

**SAGITTATE**, arrow-shaped with the basal lobes directed backwards.  
*Cp. Hastate.*

**SALVER-SHAPED**, with a long tube and horizontally spreading limb.

**SAMARA**, a fruit with the pericarp compressed and expanded into a wing, or each part of a schizocarpous fruit in which the pericarp is thus modified.

**SAPROPHYTE**, a plant which feeds upon decayed organic matter.

**SARMENTOSE**, with long arching slender branches which are often subscandent.

**SCABRID**, covered with small hard hairs or points so as to feel rough to the touch.

**SCABROUS**, very scabrid.

**SCAPE**, a peduncle which rises direct from the root.

**SCARIOUS**, dry and membranous.

**SCHIZOCARP**, a fruit which splits up into two or more distinct portions (mericarps, cocci, etc.) each with its own wall.

**SCLERENCHYMATOUS**, applied to tissue, consisting usually of more or less isodiametric cells, in which the cell walls are very greatly thickened and hardened.

**SCORPIOID**, with the (apparently) lateral axes forming a double row on one side of the usually curved (apparent) main axis or sympodium.

Hole's definition differs. He says the lateral branch develops alternately on opposite sides.

-SECT, in composition means deeply cut, especially cut nearly to the axis. *See* Dissected.

SECUND, all inclined in one direction.

SEED, the ovule after fertilization and development of the embryo. The seed consists of the more or less modified integuments of the ovule which become the *testa* or seed coat (*see also* Aril, Arillus), sometimes also a part of the tissue of the nucellus, which becomes filled with food material (perisperm), frequently a tissue which has become developed inside the embryo-sac (endosperm), and finally the more or less completely developed and differentiated embryo. *See also* Introduction (*Spermophyta*), p. 90.

SEPAL, one of the divisions of the calyx, texture usually herbaceous.

SEPALOID, green and resembling a sepal in texture rather than a petal. *Cp.* Petaloid.

SEPTICIDAL, a mode of opening of a fruit by means of a split through the median plane of the interior walls or dissepiments, so that the fruit becomes more or less separated into its component carpels, but these are not closed as in cocci, and the seeds escape either by dissolution of the inner part of the septum or by the ventral suture, with separation of the carpels, which usually begins by an opening at the top of the fruit. *Cp.* Loculicidal.

SEPTIFRAGAL, a mode of dehiscence in which a central column bearing the septa or part of the septa remains while the exterior walls of the fruit and often part of the septa separate from it. *E.g.* in *Elatinaceæ* the valves separate from the whole axis and septa. *Cp.* Loculicidal, Septicidal.

SEPTUM, an interior wall.

SERRATE, toothed like a saw with the teeth inclined forwards.

SERRULATE, serrate but with the teeth very minute.

SESSILE, without a stalk.

SETA, a long stiff hair. Setaceous, needle-like; very slender and tapering, and of no appreciable width; more slender than in linear. "Very slender like bristles or hairs," *Bth.*

SETOSE, beset with setæ.

SEXUAL GENERATION, *see* Spore.

SILKY, sericeous, covered with very fine adpressed silky hairs.

SIMPLE, not composed of a number of similar parts, opposed to compound. A leaf is *simple* even if segmented provided that the divisions are not separated by portions of the axis destitute of blade.

SINUATE, somewhat deeply waved. *Cp.* Repand.

SORUS, a group of sporangia, sometimes covered by an indusium.

SPATHE, a large bract which sheaths an inflorescence or part of an inflorescence, at least, in its young state.

SPATHACEOUS, resembling a spathe, sheathing and not divided up into distinct sepals, petals, etc.

SPICATE, spiked, with the flowers in a spike. *q.v.*

SPICIFORM, resembling a spike in appearance.

**SPIKE**, a form of racemose inflorescence in which the flowers are sessile on the axis.

**SPADIX**, a spike with an enlarged fleshy axis and usually enclosed when young in a *spathe*.

**SPIKELET**, the ultimate parts of the inflorescence of grasses (rarely an inflorescence consists of only one spikelet) and *Cyperaceæ* are called spikelets. A spikelet in the grasses consists of an axis (rachilla) with usually three or more distichously arranged bracts (glumes), of which the lowest two (one or more) are usually empty and the others contain an opposing bracteole (pale) and a male or female or 2-sexual naked flower. *See also* Glume, Pale, Lodicule.

**SPORANGIOPHORE**, the part of a stem or branch bearing sporangia.

**SPORANGIUM**, a special sac in the inside of which are produced the spores.

**SPORE**, a single cell with usually a rounded firm wall, capable of germination and producing another individual. This individual is not always of the same form as that which produced the spore, and in the Vascular Cryptogams is known as the *prothallium*. The prothallium bears sexual organs, female (archegonia) or male (antheridia), and is hence known as the *gametophyte* or sexual generation. Inside the archegonium is produced after fertilization an *oospore*, which finally gives rise to the embryo of a new spore-bearing generation. Spores may be either all similar (*isosporous*) or dissimilar (*heterosporous*). In the former case the prothallia are usually 2-sexual; in the latter case the smaller spores (microspores) produce antheridia-bearing prothallia only; the larger spores (macrospores) produce archegonia-bearing prothallia only. *See also* Introduction, pp. 86—90.

**SPOROCARP**, small round bodies with firm walls, which contain several sporangia. They are found more especially in the *Hydropteridæ*, and are probably very much metamorphosed leaf segments.

**SPOROPHYLL**, a leaf or metamorphosed leaf which bears the sporangia either on its surface or in its axil. A number of symmetrically arranged sporophylls on a special receptacle, such as stamens and carpels in an Angiosperm, forms a flower in the most general sense of the word.

**SPOROPHORE**, the asexual or spore-producing generation, opposed to the Gametophyte or sexual generation. *See* Spore.

**SQUARROSE**, with numerous close-set spreading leaves, bracts, or tips or processes of leaves, bracts, etc.

**STAMEN**, a modified leaf or sporophyll in the flowering plants which bears the microsporangia or pollen-sacs. A typical stamen consists of a stalk (filament) and the specially modified blade (anther) which bears the pollen-sacs. *See also* Anther.

**STAMENODES**, imperfect or reduced or rudimentary stamens which do not bear fertile pollen.

**STELLATE**, spreading in a star-shaped manner.

**STIGMA**, the part of a carpel especially adapted by means of papillæ, viscosity, etc., to receive the pollen-grains. The stigmas of the several carpels forming an ovary may be separate or united, stalked or sessile.

**STIPES**, a stalk, especially the stalk of a fern leaf.

**STIPELLA**, the stipule of a leaflet.

STIPITATE, stalked.

STIPULE (adj. stipular). Stipules are a pair of processes (often absent), one of which springs from either side of the leaf-base (*i.e.* where the stalk of a leaf or the base of a sessile leaf leaves the stem). They are either membranous or foliaceous in texture, usually small but sometimes exceeding the leaf-blade (which they often protect) in bud.

STOCK, it includes a small portion of the summits of the previous year's roots as well as of the base of the previous year's stems. The under-sides will emit new roots. These perennial stocks only differ from the permanent base of an undershrub in the shortness of the perennial part of the stems and in the texture usually less woody. Where the stock is entirely underground it is called the *rootstock*.

STOLON, a slender stem usually furnished at first with scale-leaves only, springing from the root or base of the stem and extending some distance under or on the ground, ultimately rooting and giving rise to a new plant.

STROPHOLE, a thickening about the hilum or base of a seed, perhaps of the nature of an incomplete aril.

STYLE, a slender outgrowth or appendage of a carpel and bearing the stigma. The style may be absent. In an ovary of more than one carpel the separate styles may be distinct or more or less connate into one; in the latter cases the stigmata may be distinct or fused.

SUBULATE, awl-shaped, *i.e.* slender and tapering to a point.

SUCKERS, young plants formed at the end of creeping, underground rootstocks. (2) Plants formed from adventitious root-buds.

SUCCULENT, soft and juicy. *Cp.* Fleshy.

SUFFRUTESCENT, somewhat shrubby.

SULCATE, grooved.

SUPERIOR, situated above another member. A superior ovary has its base above the insertion of the calyx; a superior calyx is inserted at a level above the top of the ovary.

SUTURE, a seam, the line marking the connate edges of a carpel (ventral suture) and sometimes also the line marking the mid-rib of the carpel (dorsal suture).

SYMPodium, an apparent main axis made up of the superposed lower parts of successive lateral axes.

SYNANGIUM, a number of sporangia growing together so as to appear as loculi of a single aggregate.

SYNCARPOUS, *see* Ovary.

SYNANDROUS, with the stamens united throughout into a column.

SYNGENESIOUS, with the anthers cohering.

TENDRIL, a filiform sensitive organ which winds round supports to enable weak stems to reach the light. Tendrils are of various morphological origin in different groups. Some may be modified branches, others leaves, another the end of a leaf rachis, etc.

TEPAL, a division of a perianth; a word applicable to either a sepal or a petal. "An anagram of *petal*," Jackson.

TERETE, cylindrical.

TERNARY, with 3 members in a whorl.

**TERNATE**, in groups of 3. A leaf with 3 leaflets is sometimes said to be ternate, but in this case it is really the *leaflets* which are ternate and the leaf is 3-foliolate.

**TESTA**, the outer covering of a seed.

**TETRADYNAMOUS**, with 4 long and 2 short stamens.

**THORN**, a modified shoot or branch in the form of a hard spine.

**THORN WOODLAND**, forests composed principally of thorny species.

**THYRSE**, a close panicle more or less spindle-shaped.

**TOMENTOSE**, with exceedingly close matted short pubescence.

**TORULOSE**, alternately swollen and constricted.

**TORUS**, the portion of the floral axis from which spring the perianth, stamens, carpels or any portion of the flower. The torus may therefore be convex, cylindrical, concave, etc. Same as receptacle in some senses.

**TRICHOTOMOUS**, with the axis successively dividing into three branches.

**TRICOCOUS**, ultimately splitting into 3 cocci.

**TRI-PINNATE**, with the primary axis of the leaf pinnate with one or more pairs of the pinnæ again pinnate and with one or more pairs of the secondary pinnæ pinnate.

**TRIPLE-NERVED**, 3-nerved, with 3 nerves from base; with 3 primary nerves.

**TRIQUETROUS**, with 3 sharp corners.

**TROPOPHILOUS**. Plants adapted for a physiologically wet climate at one season of the year and a dry climate at another season are termed tropophilous.

**TRUNCATE**, as though cut off at the end.

**TUBER**, a short, thick, more or less succulent rootstock or rhizome, *e.g.* potato; or the swollen end of a root which is attached at the upper end to a rootstock or rhizome as in *Curcuma*, etc.

**TURBINATE**, top-shaped.

**TURCID**, tense as though with pressure from within; swollen.

**UMBEL**, an inflorescence in which the branches all radiate from the top of the peduncle. If these branches each terminate in a flower the umbel is *simple*; if they are again umbellately branched, the umbel is *compound*.

**UNILOCULAR**, applied to an ovary not divided up by partitions into separate compartments.

**URCEOLATE**, flask-shaped and broadest below the middle.

**VALVATE**, said of sepals, etc., when they are only connate in bud by their edges, which do not overlap.

**VENTRAL**, the lower side. This is the popular usage, but it is the side towards the axis of the inflorescence in the case of flowers, and towards the axis of the flower or ovary in the case of carpels, towards the ventral suture of the carpel in the case of ovules. (*N.B.*—I may sometimes have inadvertently used it in the popular sense. The term "axial-side" would be less ambiguous.) *Cp.* Anterior, Posterior.

**VENTRICOSE**, suddenly bulged.

**VENULOSE**, with numerous vein-like raised lines; closely finely veined.

**VERNATION**, the method in which leaves are arranged or folded in bud.

**VERRUCOSE**, covered with wart-like small bosses.

VERSATILE, said of an anther which is attached above its base to the attenuated tip of the filament on which it swings.

VERTICILLATE, whorled.

VILLOSE, villous, covered with long fine soft hairs.

VIRGATE, with slender erect rod-like stems or branches.

VISCID, with a sticky secretion.

XEROPHILOUS, adapted by structure to conditions of drought.

XEROPHYTES, plants which inhabit localities where they are subject to conditions of physiological drought.

ZYCOMORPHIC, symmetrical right and left of the median plane only, as in many lipped flowers. Sometimes equivalent to *irregular*.

**TABLE OF CORRESPONDING ENGLISH AND METRIC LENGTHS.**

APPROXIMATE EQUIVALENTS OF FRACTIONS AND DECIMALS OF AN INCH, LINES AND MILLIMETRES.

Inches.	Lines.	Mm.	Inches.	Lines.	Mm.
$\frac{1}{16}$		.79	$\frac{1}{16}$		15.1
$\frac{1}{8}$		.8	$\frac{1}{8}$		15.2
$\frac{1}{4}$		1	$\frac{1}{4}$		15.9
$\frac{3}{16}$	$\frac{1}{2}$	1.06	$\frac{3}{16}$		16
$\frac{1}{2}$		1.3	$\frac{1}{2}$		16.7
$\frac{5}{16}$		1.6	$\frac{5}{16}$	8	16.9
$\frac{3}{8}$		1.7	$\frac{3}{8}$		17
$\frac{7}{16}$		2	$\frac{7}{16}$		17.5
$\frac{1}{2}$	1	2.1	$\frac{1}{2}$		17.78
$\frac{9}{16}$		2.4	$\frac{9}{16}$		18
$\frac{5}{8}$		2.5	$\frac{5}{8}$		18.2
$\frac{11}{16}$		2.8	$\frac{11}{16}$		19
$\frac{3}{4}$		3	$\frac{3}{4}$	9	19.05
$\frac{13}{16}$		3.2	$\frac{13}{16}$		19.8
$\frac{7}{8}$	$1\frac{1}{2}$	3.5	$\frac{7}{8}$		20
$\frac{15}{16}$		4	$\frac{15}{16}$		20.3
1		4.1	1		20.6
$\frac{17}{16}$	2	4.2	$\frac{17}{16}$	10	21
$\frac{9}{8}$		4.8	$\frac{9}{8}$		21.4
$\frac{19}{16}$		5	$\frac{19}{16}$		22
$\frac{5}{4}$		5.1	$\frac{5}{4}$		22.2
$\frac{21}{16}$	$2\frac{1}{2}$	5.5	$\frac{21}{16}$		22.8
$\frac{13}{8}$		6	$\frac{13}{8}$	11	23
$\frac{23}{16}$		6.3	$\frac{23}{16}$		23.1
$\frac{3}{2}$	3	7	$\frac{3}{2}$		23.8
$\frac{25}{16}$		7.1	$\frac{25}{16}$		24
$\frac{27}{16}$		7.6	$\frac{27}{16}$		24.6
$\frac{7}{4}$		7.9	$\frac{7}{4}$	12	25
$\frac{31}{16}$		8	1		25.3995
$\frac{11}{8}$		8.5	$\frac{11}{8}$		30
$\frac{13}{8}$	4	8.7	$\frac{13}{8}$		40
$\frac{35}{16}$		9	$\frac{35}{16}$		50
$\frac{7}{4}$		9.5	2		50.79
$\frac{39}{16}$		10	$\frac{39}{16}$		60
$\frac{5}{4}$		10.1	$\frac{5}{4}$		70
$\frac{41}{16}$		10.3	$\frac{41}{16}$		76.2
$\frac{43}{16}$	5	10.6	$\frac{43}{16}$		80
$\frac{11}{4}$		11	$\frac{11}{4}$		90
$\frac{47}{16}$		11.1	$\frac{47}{16}$		100
$\frac{11}{4}$		11.9	$\frac{11}{4}$	4	101.6
$\frac{49}{16}$		12	$\frac{49}{16}$		127.0
$\frac{5}{4}$	6	12.7	$\frac{5}{4}$	5	152.4
$\frac{51}{16}$		13	$\frac{51}{16}$	6	177.8
$\frac{13}{4}$		13.5	$\frac{13}{4}$	7	203.2
$\frac{55}{16}$		14	$\frac{55}{16}$	8	228.6
$\frac{7}{4}$	7	14.3	$\frac{7}{4}$	9	254.0
$\frac{58}{16}$		15	$\frac{58}{16}$	10	279.4
$\frac{589}{16}$			$\frac{589}{16}$	11	304.8
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