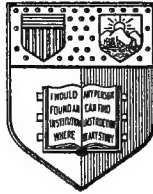


OUR NATIVE FERNS.

UNDERWOOD.



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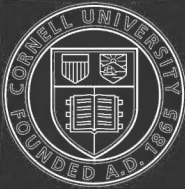
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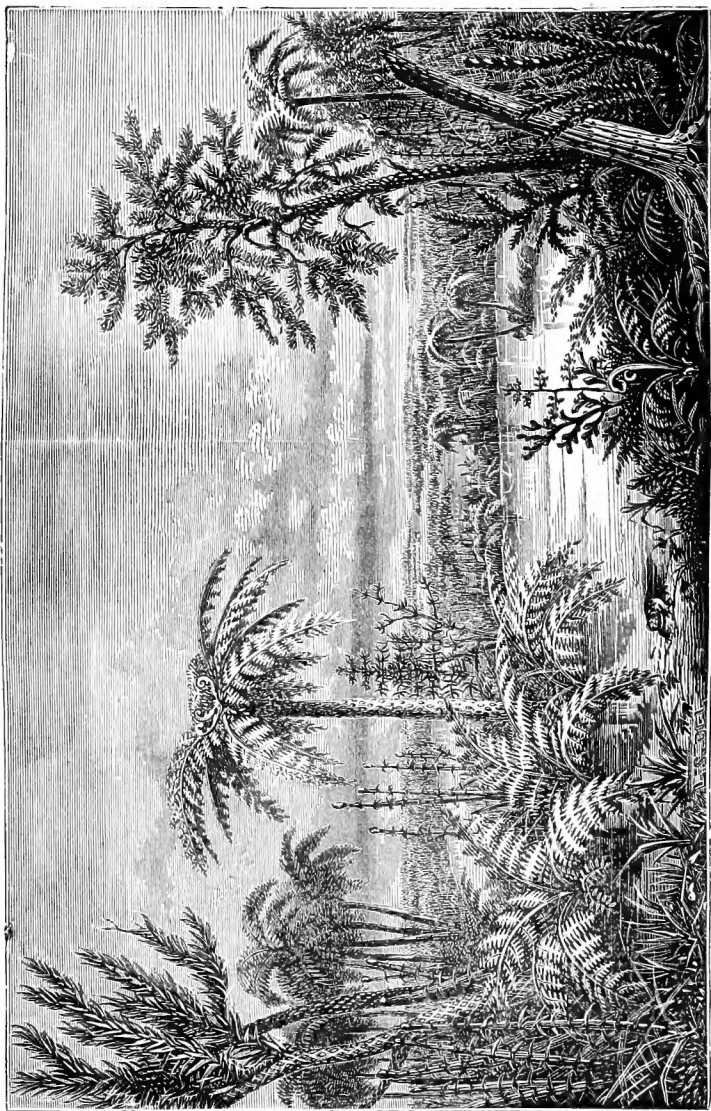
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CARBONIFEROUS PTERIDOPHYTA.—(After Dana.)

OUR
NATIVE FERNS

AND

HOW TO STUDY THEM

WITH

Synoptical Descriptions of the North American Species

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PROFESSOR OF GEOLOGY AND BOTANY IN THE ILLINOIS WESLEYAN UNIVERSITY

He prayeth best who loveth best
All things, both great and small;
For the dear God who loveth us,
He made and loveth all.

COLERIDGE

ILLUSTRATED

BLOOMINGTON, ILL.

1881
W.

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Dedication.

TO

MY SISTER

WHOSE WILLING ASSISTANCE AND LOVING
SELF-SACRIFICE HAVE BEEN STEPPING-STONES
OVER DIFFICULT PLACES,
THESE PAGES ARE AFFECTIONATELY
INSCRIBED.



PREFACE.

DURING the past decade a department of botanical study that previously had attracted the attention of specialists only, has rapidly come into prominence among all classes of people. The interest in Ferns has become so great that in spite of peculiar difficulties in the way of study, many have acquired marked proficiency in the subject, and large private collections have been accumulated.

When the writer commenced the study of this interesting botanical order six years ago, as a means of recreation, during the later years of a collegiate course of study, the subject was found to be beset with embarrassments which others have probably met in their own experience. Among the many the following may be noted :

1. The subject of cryptogamic botany is assigned a very subordinate position in our best school and college text-books and is often entirely omitted. The more recent text-writers are recognizing this deficiency and beginning to supply the need here indicated.

2. The great majority of teachers do not supplement the text-books by instruction in this important branch of botanical science. Not having been instructed themselves, and finding discouraging elements in the way of self-study, they are necessarily unqualified to instruct others.

3. The descriptions of many of our native ferns are scattered through various scientific journals and rare books, usually inaccessible to those who need them most.

4. As in all specialties, works treating exclusively on ferns either structurally or systematically, are rare and expensive. Previous to 1877 no work on the subject of ferns had been published in America, and to this date no manual available to students has been issued that classifies all our native species or outlines their morphology and mode of life.

The design in issuing this little volume is to furnish to those desiring a better understanding of ferns the means of gaining a knowledge of their structure and life, and of readily determining the species growing spontaneously in North America north of the Mexican boundary. If the work succeeds in rendering assistance to any already interested in the subject, or in stimulating any to commence a systematic and scientific study of this most attractive botanical order, the writer will feel abundantly repaid.

In the preparation of chapters IV. and V., Sachs' *Lehrbuch* has been frequently consulted. The descriptions of our native ferns have been collected from various sources. Hooker's *Synopsis Filicum* and the papers by Prof. Eaton in Gray's Manual, Chapman's Flora, and "The Ferns of the Southwest" have furnished much of the material. In *Botrychium* the valuable papers by George E. Davenport have furnished many additions, especially respecting the method of vernation. In addition, the original descriptions of various authors and the large private collection of the writer have been freely consulted, with the hope of making the work in every way a satisfactory manual for identifying species.

The grouping of species is in part my own, but in a few cases that of other authors has been adopted. The "Artificial Synopsis of Genera" has cost much labor, and though in some respects is still unsatisfactory, it may be found useful for distinguishing genera. Synonyms are given only where recent changes in nomenclature have been made.

No attempt has been made to popularize the language of the work at the expense of scientific accuracy, the writer fully believing that if this subject or any other department of the natural

sciences is ever studied with any satisfaction to the learner, it must be accomplished by severe and unflinching mental effort. It is hoped, however, that the language is sufficiently clear to be readily appreciated by those who are really interested in the subject. That all technical terms may be understood, a copious glossary has been prepared in connection with the index.

The illustrations are largely from drawings by the writer. A few have been copied from other authors, as is in each case acknowledged. The valuable frontispiece was secured through the kindness of Dr. James D. Dana, from his "Manual of Geology."

The writer would here take occasion to express his gratitude to very many botanical correspondents and friends for material aid in the preparation of this work, either in the loan of books or specimens, or in valuable notes, suggestions and corrections. Were it not invidious to specify, a few might be mentioned to whom he feels under special obligations,

L. M. U.

Bloomington, Ill., January, 1881.

◀ERRATA▶

- Page 29. After Fig 3, for *Trichomjanes* read *Trichomanes*.
- Page 49. For *Group* II.—MUSCINEÆ, read *Group* III.—MUS-
CINEÆ.
- Page 51. Last line, omit the asterisk.
- Page 83. For *W. angustifolia*, Sm. read *W. angustifolia*, Sm.

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ABBREVIATIONS.

Gr.	Greek.
Lat.	Latin.
Var.	Variety.
°	Feet.
\"	Inches.
\"	Lines.

- LIST OF AUTHORS. -

- AIT. . . . WILLIAM AITON, Scotland, 1731-93.
 ANGS. . . . ——— ANGSTRÖM, Germany (?)
 BAKER, . . . JOHN GILBERT BAKER, England.
 BERNH. . . . JOHANN JAKÖB BERNHARDI, Germany, 1774-1840.
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 1780-1846.
 A. BR. . . . AL. BRAUN, Germany.
 R. BR. . . . ROBERT BROWN, Scotland; 1773-1858.
 BRONG. . . . ADOLPHE BRONGIART, France, 1801-76.
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 EHRH. . . . FREDERICK EHRHART, Switzerland, 1745-95.
 ENGELM. . . . GEORGE ENGELMANN, Saint Louis, Mo.
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 GRAY. . . . ASA GRAY, Cambridge, Mass., b. 1810.
 H. & A. . . . SIR W. J. HOOKER and G. A. WALKER-ARNOTT,
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 KUHLEWEIN, . . . ——— KUHLEWEIN, Germany.
 L. . . . CARL VON LINNE (LINNÆUS), Sweden, 1707-78.
 LAM. . . . JEAN BAPTISTE DE MONET DE LAMARCK, France,
 1744-1829.
 L'HER. . . . CHARLES LOUIS L'HERITIER DE BRUTELLE, France,
 1746-1800.
 LINK. . . . HEINRICH FRIEDRICH LINK, Germany, 1767-1851.
 LINN. F. . . . CARL LINNÆUS, Sweden, 1741-83.
 MART. & GALE. MARTENS and GALEOTTI.
 METT. . . . DR. G. METTENNIUS, Germany.
 MICHX. . . . ANDRE MICHAUX, France, 1746-1802.
 NUTT. . . . THOMAS NUTTALL, England, America, 1786-1859.
 PLUMIER, . . . CHARLES PLUMIER, France, 1646-1704.
 PRESL, . . . JANS SWATOPLUK PRESL, Bohemia, 1791-1849.
 PURSH, . . . FREDERICK PURSH, Germany, America, 1774-1820.
 RICH. . . . LOUIS CLAUDE MARIE RICHARD, France, 1754-1821.
 ROTH, . . . JOHANN RUDOLPH ROTH, Germany, 1815-58.
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 SM. . . . SIR JAMES E. SMITH, England, 1759-1828.
 J. SM. . . . JOHN SMITH, England.
 SPRENG. . . . KURT SPRENGEL, Germany, 1766-1833.
 SWZ. . . . OLAF SWARTZ, Sweden, 1760-1818.
 THUNB. . . . CARL PETER THUNBERG, Sweden, 1743-1828.
 TORR. . . . JOHN TORREY, America, 1796-1873.
 WALT. . . . THOMAS WALTER, England, America, 1740-1800.
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◀INTRODUCTION▶

In the entire vegetable world there are probably no forms of growth that attract more general notice than the Ferns. Delicate in foliage, they are sought for cultivation in conservatories and Wardian-cases, and when dried and pressed add to the culture of many a domestic circle by serving as household decorations. They furnish to botanists a broad and inviting field for investigation, and he who examines their more minute structure with the microscope will find deeper and still more mysterious relations than those revealed to the unaided eye. Ferns thus appeal to the scientific element of man's nature as well as to the æsthetic, and while they highly gratify the taste, they furnish food for the intellect in a like degree.

In olden time the obscure fructification of the common brake led to many superstitious ideas among the common people and the older poets have woven these popular notions into our literature. Butler tells in *Hudibras* of bugbears so often created by mankind :

“That spring like fern, that infant weed,
Equivocally without seed,
And have no possible foundation
But merely in th' imagination.”

Shakespeare only reflects a prevalent belief of his time when he says :

“We have the receipt of fern seed; we walk invisible.”

Others allude to the falling of the seed on the anniversary night of the birth of the ‘loved disciple.’ The old simplers with their lively imagination were impressed by the fancied resemblances of some parts of fern growth to various organs of the human body, and introduced them into their system of specifics. Traces of their influence still remain in the names of some of our common ferns as spleenwort and maidenhair.

To form a correct understanding of ferns we must study the ferns themselves as well as the text-book, as it is only by direct contact with nature that we gain definite and satisfactory informa-

tion. The text-book is only useful in giving directions how to investigate. To understand thoroughly an animal we must study its habits in its native haunts. To know its structure and position in the animal kingdom we must carefully dissect a large number of specimens and study the development of the individual from its beginning. In like manner, to understand fully a fern we must search where nature has planted it, watch it as it uncoils from the bud, matures, produces its fruit, and finally returns to the earth; examine it with needles and lenses and discover its minute structure and its life-history. These pages which aim to give an outline of the forms of fern growth, the methods of fruiting, the germination or growth from the spore, and finally the more minute structure of the entire plant, can only be thoroughly understood by taking the ferns in hand and studying them in connection with the text. For the first three chapters and the determination of species a strong pocket lens and a few needles mounted in handles for dissection will furnish the necessary outfit. Chapters IV. and V. will require a compound microscope with its appliances for successful investigation.

Let no one imagine that the task will be an easy one. Patient application and careful observation are essential to success, yet he who becomes once interested in the work will find a subject that deepens in interest with every step and even becomes enchanting as he seeks to determine the mysterious processes of fern development and the marvels of fern structure.

OUR NATIVE FERNS.

CHAPTER I.

HAUNTS, HABITS, AND DISTRIBUTION OF FERNS.

Our outward life requires them not,—
Then wherefore had they birth?
To minister delight to man,
To beautify the earth.

—MARY HOWITT.

1. General Characters.—Our native ferns comprise plants varying in height from less than an inch to six or seven feet, or even more. Some are stout and fleshy, others are delicate and even filmy; but most are herbaceous, resembling ordinary flowering plants in the texture of their foliage. While most would be recognized as ferns by even a novice, a few differ so widely from the ordinary typical forms that to an unskilled observer they would scarcely be considered as bearing any resemblance to ferns whatever. The fronds of one of our Florida species resemble narrow blades of grass, and the fertile spikes of another from New Jersey might be mistaken for a diminutive species of sedge. A third from Alabama would, perhaps, be called a moss by the inexperienced, while a fourth, frequently found in New England, has a climbing stem and broad, palmated leaves.

When we add to these peculiar forms of our own country those of foreign lands, and include the immense tree-ferns of tropical regions, we find our early conception of a fern inadequate to cover this diversity of forms. Without attempting an accurate definition of a fern, let it be regarded for present purposes as a flowerless plant, producing spores instead of seeds, possessing more or less woody tissue, and having its leaves coiled in the bud from apex to base. After the necessary study of the structure of some of our common ferns, we will be able to comprehend the more technical definition found later in the work.

2. **Mode of Growth.**—Ferns vary greatly in their method of growth, yet each species has a plan which, within certain limits, is fixed and definite. Some, like the common brake, have their fronds rising from more or less distant portions of the creeping rootstock. Others are tufted, many fronds rising irregularly in a cluster, while still others grow in crowns or circles, the later fronds continually rising within the older ones. In the grape-ferns (*Botrychium*) the rootstocks usually produce a single frond each season, the bud for the succeeding year growing within the base of the common stalk.

3. In many there is a tendency to dimorphism, the fertile or fruit-bearing fronds differing to a greater or less extent from the sterile ones. In a few species, like the sensitive-fern and the ostrich-fern (*Onoclea*), this is carried so far that the sterile and fertile fronds bear no resemblance to each other, and in one instance have been mistaken for different species and so described.

4. **Variation.**—The same species will often present wide differences in the size of the fronds. This depends to some extent on the character of the soil and the ordinary climatic conditions. For example, the lady-fern (*Asplenium filix-fœmina*), which in ordinary locations grows from two to four feet high, in mountainous regions is sometimes reduced to from three to six inches, when it forms the *var. exile*. In like manner the marginal shield-fern (*Aspidium marginale*) usually two or three feet high, is reduced to five inches when growing on rocky cliffs, and yet regularly produces fruit.*

5. In some cases there is a tendency to variation in size that cannot be referred to soil or climatic influences. The common grape-fern (*Botrychium Virginianum*) will be found in some localities to vary from six inches to two feet in height, all well fruited and matured, and with the extreme sizes growing within a pace of each other in the same soil and with the same environment. The other species of the same genus present similar variations, and judging from size and external appearance alone, a regular gradation of forms might be arranged from the most diminutive undivided forms of *B. simplex* to the largest of *B. Virginianum*.

6. Another tendency to variation is noticed in the forking of fronds either at the summit or at the ends of the branches. The hart's-tongue (*Scolopendrium*) is frequently forked at the summit,

* Compare Bulletin Torrey Botanical Club, October, 1878.

the walking-leaf (*Camptosorus*) less commonly, while the same tendency is noticed in various compound forms, as *Asplenium angustifolium*, *Cheilanthes vestita*, *Pellaea atropurpurea* and others. Some of the species of *Botrychium* show the same tendency, especially in their fertile segments.*

7. Time of Fruiting.—The time of maturing fruit is different among different species, and also varies with geographical location and proximity to tropical climates. In the Northern States some species produce their fruit as early as May, and others as late as September, but the greater number are best studied in July and August. In semi-tropical climates, like Southern California and the Gulf States, the time of fruiting is often earlier, sometimes occurring in February or March. Some fronds are killed by the early frosts, while others like the Christmas-fern, are ever-green and may be gathered in midwinter.

8. Local Distribution.—Ferns are largely dependent for successful growth on the amount of warmth, moisture and shade to which they are subjected, and we would naturally expect to find them reaching a maximum in size and abundance in warm swamps or shady marshes. While this is in general true, we nevertheless find many species thriving only in rocky places, thrusting their roots into the crevices of the rocks with little earth for their nourishment, and many times exposed to the scorching rays of the sun. Of necessity, such species are of comparatively small size, and likely to be protected in some way against the heat of the sun and the lack of moisture in times of drought. Others still are found in wet, rocky ravines, often where moistened by the spray of cascades or waterfalls, and, consequently, have no such provision against the heat of an extended summer. Certain others thrive in open fields that are comparatively dry and unshaded. One species of Southern Florida is aquatic, having the sterile fronds floating in shallow water. A few species are epiphytic, or grow on other plants, some being found on tree-trunks to the height of 150 or 200 feet!

So, while moisture, warmth and shade in abundance are the climatic conditions essential to promote luxuriant fern growth, it can and does continue when any or all these conditions are reduced to a minimum.

9. Ferns may then be sought in any of the following situations, and it will be seen that each situation has its characteristic species.

* See also Bulletin Torrey Botanical Club, August, 1880.

- A. Wet swamps or marshes with or without abundant shade.
- B. Rich woods, more or less moist.
- C. Uncultivated open places and dry hillsides.
- D. Moist, rocky ravines or rocky places not subject to summer drought.
- E. Exposed rocky cliffs.
- F. Standing water.
- G. Growing on other plants. (Epiphytic.)

10. In the first location mentioned above, we may find the chain-ferns (*Woodwardia*), many of the spleenworts (*Asplenium*), a few of the shield-ferns (*Aspidium*), the flowering-ferns (*Osmunda*), as well as the genera, *Acrostichum*, *Onoclea*, etc. These include some of our largest and coarsest ferns.

11. In the second we find a few spleenworts, most of the shield-ferns, the beech-ferns (*Phegopteris*), most of the grape-ferns (*Botrychium*), the maidenhair (*Adiantum*), the *Dicksonia*, and some others. In this situation we find the finest development of foliage and the greatest artistic finish among all the ferns.

12. In uncultivated places, and on rocky hillsides, we often find the common bracken or brake (*Pteris aquilina*), and the lady-fern (*Asplenium filix-fœmina*), though these are by no means confined to these locations, the latter growing quite frequently in moist woods, and even in cold, wet swamps. Many other ferns are found occasionally in openings of the forest or recent clearings, where they maintain a sickly existence, sometimes for a series of years. In such locations, ferns often become contracted, and abnormal in growth, and lose their bright green color by exposure to the open sunshine.

13. In moist ravines and on rocky banks, the bladder-ferns (*Cystopteris*) may be found, with the peculiar walking-leaf (*Camp-tosorus*), the rare hart's-tongue (*Scolopendrium*),* and many of the smaller spleenworts. The long pendent fronds of *Cystopteris bulbifera*, add greatly to the beauty of our natural ravines, and often serve to conceal the uncouth rocks, or at least draw the attention to that which is more delicate and artistic. On dripping rocks, or where the sides of ravines are kept continually moist by

* This rare fern seems to show a decided preference for limestone rocks, and thus far has been found only above the geological formation known as the Corniferous limestone. I believe a thorough search for this fern along the outcrops of this formation in Central New York and elsewhere, would show a wider distribution than is at present attributed to this species.

the spray of waterfalls, such delicate pellucid ferns as the filmy-fern (*Trichomanes*) and *Pellaea gracilis* may be sought. There seems to be a direct connection between the environment and the texture of the fern. The last two mentioned grow in very damp situations, and are pellucid and almost membranous. *Cystopteris*, in somewhat drier situations is thinly herbaceous, while *Asplenium Trichomanes* and *Camptosorus*, requiring less moisture, are more firm, and form the transition to the next group which contains ferns often leathery in texture.

14. On dry cliffs we may look for the various species of *Woodsia*, the cloak-ferns (*Notholaena*), the lip-ferns (*Cheilanthes*), and the cliff-brakes (*Pellaea*). All these are peculiarly fitted to survive long periods of drought, and in some cases are specially provided with structural appendages for this purpose.

15. Only one of our native species is strictly aquatic, the anomalous *Ceratopteris thalictroides* found in Southern Florida, though *Acrostichum aureum* is often found with its rhizoma rising from the water of salt marshes.

16. Among the epiphytic ferns are several species of *Folypodium*, especially *P. incanum*, *P. Scouleri*, and *P. aureum*, the last always being associated with the cabbage-palmetto (*Sabal Palmetto*). *Vittaria* and *Nephrolepis* are also of this class and are frequently pendent from the same plant, though occasionally found on other tree-trunks. *Ophioglossum palmatum*, another peculiar tropical fern-like plant, belongs to the same list.

17. These principles of climatic distribution are more or less modified by the geographical range of species, which must be considered in this connection.

18. **Geographical Distribution.**—Ferns are found in all parts of the world. The number of described species is not certainly known, and the uncertainty is largely increased for the reason that our best systematists do not agree as to what constitutes a species. One of the best authorities describes 2646 species, though several recognized American species are not mentioned, and this is probably true of those of other countries.*

From what has been said respecting the climatic conditions of fern growth, we would naturally expect to find them most abundant in countries where warmth and moisture predominate. These conditions seem most completely met on tropical islands or in

* *Synopsis Filicum*, or, A Synopsis of All Known Ferns. By Sir W. J. Hooker and J. G. Baker. Second Edition, London, 1874.

tropical continental areas with insular climates. The little island of Mauritius having an area of 676 square miles, or less than one-third the area of Delaware, has 235 native species, while Java, little larger than New York, has 460. Brazil furnishes 387, and the Isthmus of Panama 117. Comparing these with colder climates, we find 67 in all Europe, and only 26 within the borders of the arctic zone.

"Our Native Ferns," as described later in this volume, including the botanical orders, *FILICES* and *OPHIOGLOSSACEÆ*, comprise 147 species, 15 varieties, and 6 sub-varieties. Some authors recognize more varieties, and others even recognize more species.

19. **Divisions of our Fern Flora.**—It has been found convenient to divide the surface of the earth into faunas and floras, limited by the natural distribution of the various species of animals and plants. These limits are by no means sharply defined, for wherever the limit is made some species will pass beyond it; yet the majority found on one side are different from the majority of those on the other. North America (excluding Mexico), forms the Nearctic realm or fauna (*Regnum Nearcticum*), and the same boundaries may be used in the limitation of our fern flora, although some species from tropical regions invade our southern borders.

Mr. J. H. Redfield has given us a distribution of our native species into six geographical divisions or subdivisions of the Nearctic realm, from which the following section is copied.*

20. "I. **COSMOPOLITAN:** widely distributed over the globe in both temperate and tropical regions.

II. **BOREAL:** inhabiting (with a few exceptions) the northern portion of the United States, extending through Canada and British America, some species even reaching Labrador, Greenland and Alaska, and nearly all represented also in the northern portions of the Old World.

III. **APPALACHIAN:** extending throughout the mountain and hilly region of the states east of the Mississippi, often to the coast, and northward into Canada, and in a few instances also inhabiting the Old World.

IV. **PACIFIC:** extending along the western border of the continent at points from Alaska to California, in a few cases appearing also in the Rocky Mountain region.

* Bulletin Torrey Botanical Club, January, 1875.

V. NEW MEXICAN: inhabiting the central mountain regions of New Mexico and Colorado, many of the species extending thence into Mexico, and some even to South America, and a few of them also occurring in California.

VI. TROPICAL: inhabiting the border of the Gulf of Mexico, most of the species extending into the West Indies and Tropical America."

21. The distribution of our species can be seen from the following table:

<i>Regions.</i>	<i>Species.</i>	<i>Varieties.</i>	<i>Sub-Varieties.</i>	<i>Species peculiar to Nearctic Realm.</i>
I. COSMOPOLITAN,...	2	.....	.....	.....
II. BOREAL,.....	25	3	.....	2
III. APPALACHIAN,....	36	3	4	17
IV. PACIFIC,.....	26	6	2	18
V. NEW MEXICAN,...	28	.....	.....	11
VI. TROPICAL,.....	30	3	.....	3
Total,.....	147	15	6	51

For the distribution of individual ferns, and for the list of species peculiar to America, the reader is referred to the description of the species later in this work. Future discoveries will be likely to modify to some extent the limits there given. It will be noticed that those parts of our realm separated farthest from other countries contain the greatest number of peculiar species.

22. **Local Lists.**—The number of species found in a single locality is usually limited, yet in certain locations there is a marked diversity. As an instance, in one of the *habitats* of the rare hart's-tongue,* the writer has collected twenty species illustrating nine genera within the radius of a stone's throw. Such localities, however, are comparatively rare and must include wide diversity of soil and shade within very narrow limits.

The following table will indicate something of the local distribution of species. Carefully prepared lists from all parts of the

* "Green Pond," near Jamesville, Onondaga County, N. Y.

country would be a valuable addition to our knowledge of geographical distribution :

LOCALITY.	AUTHORITY.	DATE AND PLACE OF PUBLICATION.	NO. OF SPECIES.	NO. OF VARIETIES.
New York.	Torrey Bot. Club.	Bulletin, Oct., 1878.	50	4
Illinois.	H. N. Patterson.	<i>In litt.</i> , May, 1880.	37	1
Kentucky.	John Williamson.	"Ferns of Kentucky."	40	1
Michigan.	Elmore Palmer.	"Cat. of Plants of Mich." 1877.	29	
Arkansas.	F. L. Harvey.	<i>In litt.</i> , Dec., 1880.	37	3
Vicinity of Syracuse, N. Y.	Writer.	Botanical Index, July, 1878.	35	9
Onondaga Co., N. Y.	Mrs. M. O. Rust.	"Filices Onondagenses," 1879.	39	9*
Vicinity of Richmond, Ind.	Mrs. M. P. Haines.	Botanical Index, April, 1878.	15	2
San Diego, Cal.	D. Cleveland.	Check list.	23	
Vicinity of Worcester, Mass.	Miss Adelle Estabrooke.	<i>In litt.</i> , Feb., 1880.	26	2
Jefferson Co., Ind.	John F. Baird.	"Cat. Plants of Jefferson Co., 1878.	24	2
La Salle Co., Ill.	H. L. Boltwood.	<i>In litt.</i> , June, 1880.	20	
Essex Co. Mass.	John Robinson.	Bulletin Essex Institute, March, 1875.	32	4*

23. **Geological Distribution.**—It is well known that the plants and animals now existing on the earth are not the same in kind as those of former ages. Geologists have carefully studied the stony heart of nature, and have drawn therefrom the story of the development of land and sea, and the successive populations that from time to time have held possession of our globe. Plants furnishing the natural food for animals must have preceded animal life, yet, in the earliest geological ages, the remains of animals are far more numerous. The abundance of the deposits of graphite and iron-ore in the earliest or Archæan rocks indicates the existence of extensive plant growth, but the remains are so transformed as to make it impossible to determine the character of this primeval vegetation.

In the succeeding Silurian age, the fossil remains indicate the existence of algæ or sea weeds in abundance, and a single small

* Only the species and varieties recognized in this work are enumerated.

species of ground pine attests the existence of some of the higher *Cryptogamia*; no ferns, however, have been found in America older than the Devonian. Over fifty species of Devonian ferns have been described from the American rocks chiefly, by Dr. J. W. Dawson of Montreal.

It is in the coal measures, however, that ferns and other *Cryptogamia* are found in the greatest abundance and profusion. Their delicate foliage is impressed on the various rock strata above the beds of coal, and so perfectly are they preserved that not only the methods of fructification but even the microscopic spores have been detected! In the coal measures of the United States and Canada (counting from the base of the Catskill), three hundred and eighty-one species of ferns have been described, chiefly by Prof. Léo Lesquereux. The most abundant American genera are *Neuropteris* 45 species, *Pecopteris* 50 species, *Sphenopteris* 31 species, *Pseudopecopteris* 25 species, and *Rhacophyllum* 24 species.

The frontispiece gives an ideal representation of the vegetation of the Carboniferous age. The luxuriant tree-ferns, the *Lepidodendrids*, ancient representatives of the diminutive club mosses or ground pines, the *Calamites*, allies of the modern scouring-rushes, and other forms no less wonderful are seen in their profusion.

In the later geological ages, Mesozoic and Tertiary, ferns are found preserved in the rocks, with the leaves of many trees and shrubs of existing genera. The indications are, that ferns formed a far smaller part of the vegetation of these later ages than in the preceding Carboniferous, and even approximated to that of the present. Six Cretaceous and twenty-four Tertiary species have been catalogued,* including species in the existing genera *Lygodium*, *Pteris*, *Woodwardia*, *Aspidium*, *Gymnogramme*, etc., as well as some related to genera abundant in earlier formations. No living species is found fossil, unless Dr. Newberry's variety of *Oncoclea sensibilis* becomes established.† In the course of geological history, however, we can trace a gradual approximation to the modern types from the generalized forms of Devonian and Carboniferous times.

* Tenth Report, Hayden Geological Survey of the Territories, Washington, 1878.

† Prof. Lesquereux writes me: "Though analogous by the nervation, I doubt the identity on account of the coriaceous character of that fossil fern, which I have not seen in any variety of *O. sensibilis* now living."

CHAPTER II.

MORPHOLOGY OF THE GROWING FERN.

Pour bien savoir une chose, il faut en savoir les details.

—LA ROCHEFOUCAULD.

24. Every one familiar with the forest and its products must have seen the young ferns unrolling from the bud in spring and early summer. It will be noticed that the fronds are coiled from the apex to the base, and form crosiers, so called from their resemblance to the head of a bishop's staff. This method of veneration is called *circinate*, and is rarely found except among ferns. In the grape-ferns and adder-tongues, the veneration is straight or merely inclined, thus approximating that of ordinary flowering plants.

25. *Rhizoma*.—Ferns usually spring from an underground stem called the *rhizoma* or rootstock. This may be simple or branched, smooth or scaly, horizontal, oblique, or even vertical. In some ferns it is fine and hairlike, while in others it is very large and stout. In some cases the rhizoma creeps at the surface of the ground and even rises above it, as in the variety of *Aspidium conterminum* recently discovered in Florida. In the tree ferns of warmer climates it often forms a trunk fifty feet high bearing the fronds at the summit when it takes the name of *caudex*.

26. *Fronde*.—The aerial portion consists essentially of a leaf-stalk and blade; the former is technically called the *stipe*, and the latter the *frond*. Though these are usually distinct from each other in appearance, the stipe is sometimes wanting, and in others no distinction can be made between them. Both stipe and frond, or either one, may be glabrous (smooth), pubescent (softly hairy), hairy, woolly or scaly. When the scales are small and somewhat appressed, the surface is said to be squamous. In a few of our native ferns the under surface is covered with a white or yellow powder bearing some resemblance to flour or corn-starch. For this reason a surface of this character is called *farinaceous*. Such is the California gold-fern or "golden back" (*Gymnogramme triangularis*), and several of the cloak-ferns (*Notholaena*), and such are the various gold and silver ferns of conservatories, including some of the richest and most beautiful in the world.

27. The frond may be *simple* when it consists of a single undivided leaf, or *compound* when it is divided into segments. The

exquisite delicacy and the extent to which this dividing is carried in some ferns gives to them their chief æsthetic value.

The continuation of the stipe through a simple frond is called the *midvein*; through a compound frond is called the *rachis*, and is further distinguished as *primary* when the frond is much compounded. A frond is *entire* when the margin forms an unbroken line; when so cut as to form lobes extending half way or more to the midvein it is called *pinnatifid*; when these incisions extend fully to the midvein the frond is said to be *simply pinnate* and the divisions are called *pinnæ*. When the pinnæ are cut into lobes the frond is *bipinnatifid* and the lobes are called *segments*, and when these extend to the secondary midveins it is *bipinnate* and the divisions are called *pinnules*. The secondary midvein then becomes a *secondary rachis*. In like manner we may have ferns that are *tripinnatifid* and *tripinnate*, *quadripinnatifid* and *quadripinnate*. The last lobes are designated *ultimate segments* and the last complete divisions *ultimate pinnules*. All these various forms from entire to quadripinnate are abundantly represented among our native ferns.

28. In some pinnate fronds, as in the oak-fern (*Phegopteris Dryopteris*), the lower pair of pinnæ is greatly enlarged and more compound than those above, so that the stipe appears to form three branches bearing similar and nearly equal portions. Fronds of this character are usually triangular or pentagonal in outline and this method of branching is called *ternate*. It will be readily seen that this is merely a modified form of the ordinary pinnate frond. Throughout the domain of nature there is infinite variety of form and structure and at the same time, unity in plan and conformity to a few generalized types of structure.

29. *Venation*.—The method of veining admits of great variation, often serving to distinguish species and more especially the sections of the various genera. In some ferns, like most shield-ferns (*Aspidium*), the veins are *free*, that is arising from either side of the midvein they do not unite with any other vein. In some of these the vein is simple, (not branched), in others variously forked. In many the veins repeatedly anastomose or unite together forming a series of network or *areolæ*. This may be somewhat irregular as in *Onoclea*, or forming a single row of areolæ next to the midvein and thence free to the margin as in *Woodwardia Virginica*, or forming many uniform areolæ by the parallel transverse veinlets connecting the distinct and parallel primary veins as in *Polypodium Phyllitidis*.

CHAPTER III.

FRUCTIFICATION IN FERNS.

“But on St. John's mysterious night,
Sacred to many a wizard spell,
The hour when first to human sight
Confest, the mystic fern-seed fell.”



Fig. 1. Enlarged section through a sorus of *Polypodium falcatum*, Kellogg, showing the stalked sporangia. (Original.)

30. Spores and Sporangia.

—In the flowering plants (PHANEROGAMIA) there is a true sexual reproduction, the ovules in the female organs (pistils) being fertilized by the pollen produced by the stamens, thus giving rise to the embryo of the new plant.

The CRYPTOGAMIA on the contrary produce no flowers. Instead of seeds developed from fertilized ovules, minute spores are produced asexually from which new ferns are developed by a peculiar process of germination very unlike that of flowering plants. These spores are collected in little sacs known as *sporangia* or capsules. The sporangia in the true ferns (POLYPODIACEÆ) are collected in little clusters on the back of the frond or are variously arranged in lines along the veins or around the margins. (Fig. 1).



Fig. 2. Sporangium of *Polypodium vulgare*, L. discharging its spores. Much enlarged. (Original.)

These clusters of sporangia are called *sori*, and may be naked, as in *Polypodium*, or provided with a special covering known as the *indusium* or involucre, as in *Aspidium* (Fig. 10). The various forms of the sori and indusia serve as the basis for classification into genera and tribes, while each sub-order has its peculiar form of sporangia.

31. In the POLYPODIACEÆ the sporangia are more or less completely surrounded with a jointed vertical ring and at maturity burst open transversely and discharge their copious spores (Fig. 2). The clusters of sporangia may be marginal.

intramarginal or dorsal, according as they have their position at the margin or more or less remote from it. They may be roundish, oblong or linear in shape, or arranged in variously forking

lines, or may even be spread in a stratum over the entire under surface of the frond. They may be indusiate or non-indusiate according as they are covered or naked; and the indusia may be inferior (attached below the sorus), as in *Woodsia* (Fig. 12), or superior as in *Aspidium* (Fig. 11), or of various intermediate methods of attachment.



FIG. 3.



FIG. 4.



FIG. 5.

Fig. 3.—Enlarged sessile sporangium of *Trichomjanes radicans*, Swz. (Original.)

Fig. 4.—Sporangium of *Schizaea pusilla*, Pursh, showing the apical ring. Much enlarged. (Original.)

Fig. 5.—Sporangium of *Osmunda regalis*, L., showing the rudimentary ring. Enlarged. (Original.)

32. In the other sub-orders of FILICES the sporangia are variously arranged. In the HYMENOPHYLLACEÆ or filmy ferns the flattened sporangia are sessile along a filiform receptacle and are surrounded with a complete transverse ring. At maturity they open vertically, (Fig. 3). In the SCHIZÆACEÆ the sporangia are ovate, surrounded at the apex by a complete ring, and open by a longitudinal slit. (Fig. 4). In the OSMUNDACEÆ or flowering ferns the sporangia are larger, globose and naked, with the mere trace of a transverse ring, and open longitudinally. (Fig. 5).

33. In Order OPHIOGLOSSACEÆ the sporangia are not reticulated, possess no trace of a ring, open by a transverse slit, and are variously spiked and paniced. (Fig. 6).

The various methods of fructification can be best understood by describing the peculiarities of the various genera in regular succession and noting the variations occurring in the sections or sub-genera. By this means we will arrive at a better understanding of the principles of fern classification as discussed in a future chapter. As the subject of venation is closely connected with that of fructification, it will be treated in the same connection.

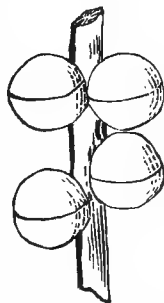


Fig. 6: Enlarged sporangia of *Botrychium ternatum*, Swz. (Original.)

34. *Acrostichum*.—In this genus the sporangia are spread in a stratum over the under surface of the upper pinnæ in our solitary species, but in some exotics they cover portions of the upper surface as well. There is no indusium.

35. *Polypodium*.—(Fig. 1). This genus contains the largest number of existing ferns, and though all the species agree in the roundish naked sori, the venation is widely different in the various sections which are chiefly formed on the character of the veins. Four of the five sections are represented in our nine species.

In *EUPOLYPODIUM* the veins are free, yet are occasionally known to unite,* thus indicating a tendency to vary toward the next section. The sori are generally found at the end of a free veinlet.

In *GONIOPHLEBIUM* the veins unite near the margin forming large areolæ, each containing a single free veinlet which bears the sorus at its end. A tendency to variation is seen in *P. incanum* in which the veins are free, as well as in *P. Californicum* in which they are often partly free.

In *PHLEBODIUM* the veins form ample areolæ in a row next the midvein and frequently in one or more secondary rows, each bearing a single sorus at the junction of two or more veinlets. A large number however bear the sori at the end of a single veinlet. From the fertile areolæ to the margin the veins anastomose more copiously.

In *CAMPYLONEURON* the areolæ each usually bearing two sori, are found between the parallel primary veins which extend from the midrib to the margin.

36. *Gymnogramme*.—In this genus the sori follow the course of the veins and consequently vary with the venation, being simple, forked, pinnated or anastomose with each other. The sori are non-indusiate.

37. *Notholæna*.—In the cloak-ferns the sori are marginal and provided with no indusia. This genus is linked very closely to *Gymnogramme* on one hand and to some species of *Cheilanthes* on the other. From the latter it is scarcely separable and the two are likely to be confounded by beginners.

38. *Vittaria*.—This peculiar genus occupies a somewhat intermediate position between the indusiate and non-indusiate genera, and while usually associated with the latter has considerable claim to be ranked with the former. The fronds are narrow and grass-like, bearing the sporangia in an intramarginal groove, often more

* Catalogue of the Davenport Herbarium, p. 8.

or less covered by the inrolled edge of the frond. The venation is very obscure.

39. *Adiantum*.—The maidenhairs have a peculiarly smooth foliage and usually possess no midvein. The veins are usually flabellate, and after forking once or more times bear the sori at their extremities. The margin of the frond is reflexed thus forming an indusium which bears the sporangia on its under surface.

40. *Pteris*.—(Fig. 7). In this genus, which includes the common brake, the otherwise free veins are united by a filiform receptacle which bears the sporangia. This continuous marginal line of fructification is covered by a membranous indusium formed of the margin of the frond.

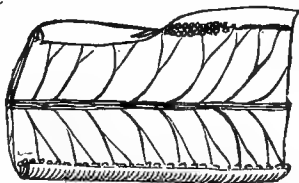


Fig. 7. *Pteris longifolia*, L. Enlarged segment of pinna showing the vein-like receptacle under the marginal indusium. (Original.)

41. *Cheilanthes*.—The lip-ferns found within our limits are unequally divided among four sections, all agreeing in bearing the sori at or near the ends of the veins covered by an indusium formed of the margin of the frond.

In *ADIANTOPSIS* the indusia are distinct and confined to a single veinlet. Our species varies from the typical species of this section and has even been assigned to a separate genus.

In *EUCHEILANTHES* the indusia are more or less confluent but not continuous, usually extending over the apices of several veinlets.

In *PHYSAPTERIS* the ultimate segments are bead-like, and the indusium is continuous all round the margin.

ALEURITOPTERIS has the fronds farinose below, and includes a single species somewhat doubtfully assigned to our limits.

42. *Cryptogramme* has dimorphous fronds, the margins of the fertile being closely rolled toward the midvein thus covering the confluent sori. At maturity these open flat in order to discharge the spores.

43. *Pellæa* has representatives of three sections within our limits all agreeing in possessing intramarginal sori which finally become confluent and form a marginal line covered by an indusium formed of the margin of the frond.

CHEILOPLECTON includes herbaceous species with visible veins and broad indusia.

ALLOSORUS includes coriaceous species having wide indusia, while PLATYLOMA includes species similar in texture but with extremely narrow indusia and broad segments.

44. *Ceratopteris* is an anomalous genus having a few sori arranged on two or three veins parallel to the midvein and covered by the broadly reflexed margin of the frond.

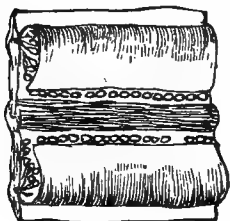


Fig. 8. *Lomaria spicant*, Desv. Enlarged section of the contracted fertile pinna showing intramarginal indusium. (Original.)

45. *Lomaria* (Fig. 8) stands intermediate between those genera in which there is an indusium formed of the revolute margin of the frond and those in which the indusium is remote from the margin. Our single species has dimorphous fronds, free veins and the fructification in a broad band next the midvein, covered by a continuous and distinctly intramarginal indusium. This genus closely resembles the next in general habit and is sometimes united with it.

46. *Blechnum*.—In this genus the sori are linear and near the midvein, and are covered by a membranous indusium which is fixed at its outer margin, bursting at its inner margin when the sporangia are mature. A single representative is found within our limits.

47. *Woodwardia*.—Three species of chain-ferns occur within our limits, and each represents a distinct section based on the methods of venation. All have oblong or linear sori more or less sunken in the frond, covered by special lid-like indusia bursting at their inner margins, and arranged in chain-like rows near the midvein thus giving the popular name to the genus.

EUWOODWARDIA has uniform fronds and veins forming at least one series of areolæ between the sori and the margin.

ANCHISTEA has also uniform fronds but with free veins from the sori to the margin, while LORINSERIA has dimorphous fronds and the veins everywhere uniting to form areolæ, as in the sensitive-fern (*Onoclea sensibilis*).

48. *Asplenium*.—The numerous species of spleenworts are closely related to each other in their methods of fructification but differ widely in the form, texture and cutting of their fronds. The sori are placed on the upper side of an oblique vein (sometimes crossing it in *ATHYRIUM*) and covered by an indusium of the same shape attached by its edge to the fruiting vein and opening toward

the midvein. In some species part of the indusia are double. The veins are free in all our species. In *EUASPLENIUM* the sori are straight or slightly curved; in *ATHYRIUM* they are often curved, even horseshoe shaped and frequently cross to the outer side of the fruiting vein.

49. *Scolopendrium* (Fig. 9), bears the linear sori in pairs, one from the upper side of a veinlet and its mate from the lower side of the next. The indusia are attached by their edges to the veins, and folding toward each other appear like a double indusium covering a single sorus. The veins extend nearly at right-angles to the midvein, are free and usually forked.

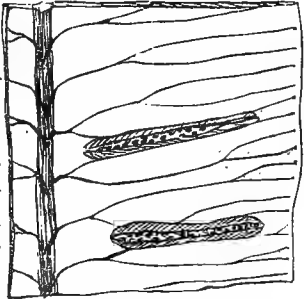


Fig. 9. *Scolopendrium vulgare*, Sm. Section of frond showing venation and fructification. (Original.)

50. *Camptosorus*: The walking-leaf has oblong or linear indusiate sori, which are irregularly scattered and borne partly on veins parallel to the midvein, and partly on those that are oblique. Those near the midvein are single, those toward the margin are often approximate in pairs and often form crooked lines. The veins are everywhere copiously reticulated.

51. *Phegopteris*.—In this genus the sori are round and naked as in *Polypodium* with which this genus is sometimes united. The sporangia spring from the back of the veins instead of the apex as in the latter genus and the veins are free.

52. *Aspidium* is largely represented in our limits by two well marked sections which are sometimes regarded as distinct genera, and a third section with characters less distinct containing a single species. In all the sori are roundish and borne on the back of the veins or rarely at their apex. In *NEPHRODIUM* the indusium is cordato-reniform or orbicular with a narrow sinus. This at first covers the sorus and is attached by its margin, but later busts away at the margin but remains attached at the sinus. In some species in this section the indusium becomes shriveled before the fruit matures and in this condition might be mistaken for a non-indusiate species (Fig. 10).

In *POLYSTICHUM* the indusium is orbicular and peltate being fixed by the centre; the veins are free as in *NEPHRODIUM* (Fig. 11).

IN *CYRTOMIUM* the indusium is the same as in *POLYSTICHUM*, but the veins tend to unite near the margin.

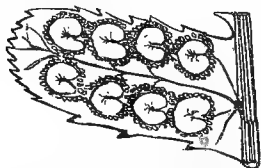


Fig. 10. *Aspidium (Nephrodium) rigidum*, Swz., var. *argutum*; D. C. E. Enlarged segment showing indusia. (Original.)

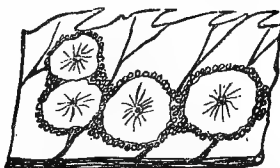


Fig. 11. *Aspidium (Polystichum) munifolium*, Kf. Enlarged section showing indusia. (Original.)

53. *Nephrolepis* has roundish sori borne at the apex of a free vein, near the margin of the frond. The indusia are usually reniform fixed by the sinus or base and open toward the margins of the pinnæ.

54. *Cystopteris*.—The bladder-ferns take their popular name from the delicate, hood-like indusium which is attached by its broad base on the inner side of the roundish sorus and partly under it. Later this is thrown back and withers away. The veins are free and the fronds have the aspect of species of *Aspidium*, but are usually more delicate in texture.

55. *Onoclea*.—This genus contains two quite dissimilar species which, until recently, have been separated into two genera by American botanists. Both have dimorphous fronds, the margins of the contracted fertile frond being strongly revolute and concealing the fruit. *O. Struthiopteris* has necklace-shaped pinnæ, crowded confluent sori, and free and simple veins. *O. sensibilis* has paniced berry-shaped pinnules and copiously anastomosing veins.



Fig. 12. *Woodsia obtusa*, Torr. Enlarged section of pinnule showing venation and inferior indusia. (Original.)

56. *Woodsia* (Fig. 12) has roundish sori borne on the back of the veins with the indusia attached beneath the sporangia and flat and open or early bursting at the top into irregular lacinæ or lobes. In *EUWOODSIA* the indusia are flat and open from an early stage with their cleft and ciliate margins concealed under the sori. In *HYPOPELTIS* the indusium is more conspicuous and encloses the sporangium at first but soon bursts at the top forming several jagged lobes.

57. *Dicksonia*.—In this genus the small globular sorus is borne in an elevated, globular receptacle and enclosed in an inferior, membranous, cup-shaped indusium. The veins are always free.

58. *Trichomanes* (Fig. 13) has sessile sporangia borne on a filiform receptacle at the summit of a vein. The indusia are tubular or funnel-shaped with an expanded and often somewhat two-lipped mouth.

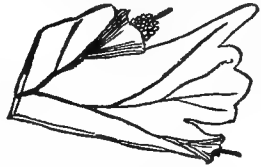


Fig. 13. *Trichomanes radicans*, Swz. Enlarged section showing method of fructification. (Original.)

59. *Lygodium*.—In our species of climbing-fern the fructification is borne on contracted, forked pinnules occupying the upper portion of the frond. The ovoid sporangia are solitary or occasionally in pairs and are borne in the axils of the large, imbricated, scale-like indusia which are fixed by their bases to short, oblique veinlets.

60. *Anemia*.—In this genus the two lowest branches of the frond bear panicles of fruit at the end of very long stalks. The ovate sporangia are sessile in two rows along the branchlets of the panicle without special covering of any kind. In the section represented by our species the veins are free.

61. *Schizæa*.—In this genus the large ovoid sporangia are sessile in double rows along the single vein of the narrow fertile divisions. In our species the pairs of fertile pinnæ form a distichous spike. (Fig. 14).

62. *Osmunda* has the large globose sporangia, short-stalked and borne on the contracted fertile portions of the frond. In the cinnamon-fern (*O. cinnamomea*) the fertile fronds are entirely distinct from the sterile, yet manifesting a tendency to variation in the *var. frondosa*. In the interrupted flowering-fern (*O. Claytoniana*), the fructification is confined to a few of the middle pinnæ of the frond. In the royal flowering-fern (*O. regalis*) the fructification is borne at the apex of the fronds.



Fig. 14. *Schizæa pusilla*, Pursh. Entire plant natural size. (Original.)

63. *Ophioglossum*.—In the adder-tongues the sporangia are large and cohere in two ranks along the margins of a single spike, opening by a trans-

verse slit to discharge their copious sulphur-yellow spores. The veins of the sterile portion of the plant copiously anastomose.

64. *Botrychium*.—In the grape-ferns the sporangia are globular and arranged in double rows along the narrow segments, more or less in panicles. The veins are free in all the species, yet in the smaller, fleshy ones this may not be readily perceived.

65. *Spores*.—The spores of ferns constitute the fruit proper. A spore consists of two distinct closed sacs and the cell contents, all of which differ from each other in chemical composition. The outer layer (*exospore*) consists chiefly of cellulose; the inner layer (*endospore*) contains some albuminous matter in addition, while the cell contents consist chiefly of a thin, colorless, jelly-like substance known as protoplasm, with grains of chlorophyll (the green coloring matter of plants), starch and oil. The exospore may be smooth or roughened by points, granules, warts, or prickles. The shape varies with different species yet all are rounded, and most are oblong or at least longer than broad. All are microscopic and many are of such a shape that they do not appear uniform, owing to the various directions from which we view them. (Fig. 15-22).



Fig. 15-22. Spores, highly magnified. *Cryptogramme acrostichoides*, R. Br., *Lygodium palmatum*, Swz., *Cystopteris fragilis*, Bernh., *Schizaea pusilla*, Pursh.

Acrostichum aureum, L., *Polypodium Californicum*, Kf., *Gymnogramme triangularis*, Kf., *Notholaena candida*, Hook. (Original.)

66. The number of spores produced by a single fern is incredible. Lindley calculated that a single frond of *Scolopendrium* produced about 80 sori, with an average of 4500 sporangia in each sorus, and each sporangium containing 50 spores, making a total of 18,000,000 spores. The copious green spores of *Osmunda cinnamomea* or the pale yellow, powdery spores of a well developed specimen of *Botrychium Virginianum* must far exceed this computation.

CHAPTER IV.

GERMINATION OF FERN SPORES.

Alle Glieder bilden sich aus nach ew'gen Gesetzen,
Und die seltenste Form bewahrt im Geheimniss das Urbild.

—GOETHE.

67. The germination of the fern spores usually takes place a considerable time after they are discharged from the sporangia, but in *Osmunda* which develops its fruit early in the season they commence their growth only a few days after dissemination.

68. **The Sexual Generation (Oophore).**— In germination the exospore splits along the side and the protruding endospore, sometimes with its divisions already formed by septa or partitions, forms, not a fern, but a thalloid structure resembling a lichen or marchantia, called the *prothallium*. Different ferns vary in the method of forming this prothallium, some producing it immediately at the spore and others after the formation of a thread-like

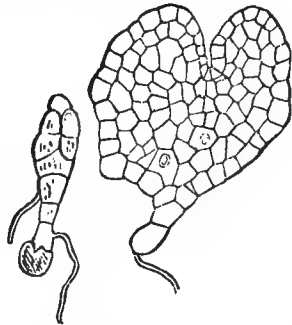


Fig. 23-4. Prothallium of *Pteris serrulata*, Linn. f., showing two stages of growth. (After Moore).

growth known as the pro-embryo. The prothallium is entirely composed of cellular tissue, and in the true ferns (POLYPODIACEÆ) is broadly cordate or reniform in shape, and bears large numbers of root-hairs from the under part of its posterior portion, (Fig. 23-4.) The prothallium seldom exceeds one-tenth of an inch in length. On the under surface of the prothallium two sorts of organs are produced analogous to the stamens and pistils of the PHANEROGAMIA, respectively known as *antheridia* and *archegonia*. The position of these organs on the prothallium varies in different sub-orders.

69. **Antheridia.**—These are small masses of tissue developed in the same manner as the root-hairs, consisting of a single layer of cells forming the wall and containing a number of spirally coiled threads usually with a number of cilia on their anterior coils. At maturity the antheridium swells by the absorption of

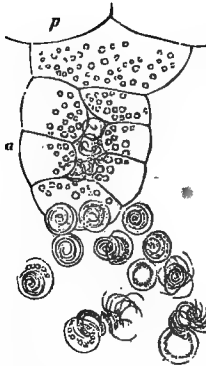


Fig. 25. Antheridium of *Adiantum Capillus-Veneris*, L., showing the escaping antherozoids. (After Sachs.)

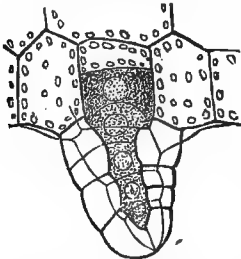


Fig. 26. Young archegonium of *Pteris serrulata*, Linn. f., showing oosphere, neck and canal-cell (After Sachs.)

water and finally bursts its wall, discharging these coiled filaments which possess the power of locomotion, and for this reason are called *antherozoids*. These antherozoids often drag with them a little vesicle which seems to play no part in the process of reproduction. (Fig. 25).

70. **Archegonia.**—The archegonium (sometimes called pistillidium), is also a rounded mass of tissue usually less prominent than the antheridia, consisting of an external layer of cells and a large central cell which soon divides into two. The lower portion, at first the larger, develops into a roundish cell, which is analogous to the ovule of flowering plants and is called the *oosphere*. The upper portion of the central cell develops between those composing the neck of the archegonium into a canal filled with a sort of mucilage; this finally swells up, forces the cells of the neck apart, and is expelled to aid in attracting and retaining the antherozoids at the neck of the archegonium. The oosphere is thus left exposed. (Fig. 26).

71. **Fertilization.**—The antherozoids, analogous to the pollen of flowers, when discharged from the antheridium, swim in the moisture always present on the under surface of the prothallium, swarm in large numbers around the neck of the archegonium and are retained by the mucilage. Some finally force their way into the canal of the neck, a few reaching the oosphere and disappearing within its substance. There is thus a true sexual generation among ferns, and the formerly appropriate term, *Cryptogamia* (hidden marriage) loses its application under the untiring scrutiny of the microscopist. After fertilization the neck of the archegonium closes and the fertilized oosphere, now called the *oospore*, increases in size and finally develops into a true fern.

72. The Asexual Generation (Sporophore.)—After the oosphere has been fertilized it commences its growth by the ordinary processes of cell multiplication and for a time remains within the walls of the archegonium, which continue to grow, until finally the interior growth breaks through the walls, differentiated into its first root and leaf. The young fern draws its nourishment from the prothallium for a time but soon develops root-hairs which, extending into the soil, maintain thereby an existence independent of the prothallium. The latter growth having accomplished its work withers away. (Fig. 27.) The first parts of the root, stem, and frond are very small and comparatively simple in structure, but those formed later are successively larger, and not only bear a closer resemblance to the mature form of the species, but also develop increased complexity of structure. "The fern continues to gain strength, not by subsequent increase of size of the embryonic structures, but by each successive part attaining a more considerable size and development than the preceding ones, until at length a kind of stationary condition is arrived at in which the newly formed organs are nearly similar to the preceding ones."

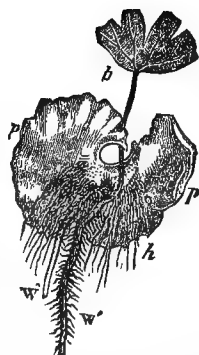


Fig. 27. *Adiantum Capillus-Veneris*, L. Prothallium and young fern seen from below: pp, prothallium; b, first leaf; h, root-hairs of prothallium; w, w', first and second roots. (After Sachs).

73. The complete life history of a fern illustrates a principle common among the lower forms of animal life known as "alternation of generations." Instead of the direct production of a mature sexual plant, as among the higher forms of vegetation, there is the production of a sexual growth resembling a lower form of vegetation, which in turn is followed by the growth of a mature plant producing its fruit without the assistance of sexual organs.

74. Recapitulation.—To review the life history of a fern we find the following processes:

A. Production of the spores asexually by the mature plant. (FRUCTIFICATION.)

B. Growth of the prothallium from the spore with or without the development of a pro-embryo. (SEXUAL GENERATION. OOPHORE).

C. Production of sexual organs, archegonia (female) and antheridia (male), on the under surface of the prothallium.

D. Fecundation of the oosphere developed in the archeogonium by the antherozoids developed in the antheridium. (FERTILIZATION).

E. Growth of the mature fern in successive stages from the oospore. (ASEXUAL GENERATION*. SPOROPHORE).

75. *Ophioglossaceæ*.—In this order the prothallia are destitute of chlorophyll, develop under ground and are monœcious, as in the *FILICES*. In *Botrychium lunaria* the prothallium is an ovoid mass of cellular tissue, light brown without and yellowish white within. It produces a number of antheridia and archegonia on the upper surface as well as the lower, differing somewhat from the true ferns in the method of their development.

* The term "generation" in the above sense, although in common use by the best botanical writers is decidedly unfortunate and misleading. A generation is properly the production of offspring resembling the parent, or the offspring thus produced, which the prothallium is not and the mature fern is not. The generation proper must then be considered as including the entire life history of a fern of which the prothallium and mature fern are successive phases. The terms "sexual" and "asexual" as used in this connection are likewise misleading as they might apply as well to the origin as to the producing power of the so-called "generation." The prothallium is asexual in origin but develops sexual organs; the mature fern on the other hand produces no sexual organs, but is itself the product of bisexuality. I suggest the terms *Thalloid phase* and *Pteridoid phase* for sexual and asexual generation. The same criticism applies with equal force to the use of the expression "alternation of generations" by zoologists.

CHAPTER V.

FERN STRUCTURE.

Be it ours to meditate,

* * * *

And to the beautiful order of thy works

Learn to conform the order of our lives.

—BRYANT.

76. Tissues.—The life history of every plant commences in a single cell, and all the complications of vegetable growth depend on two simple processes, viz: the enlargement of individual cells to their full size, and their multiplication by division. The lowest forms of vegetable life consist of a single cell, either globular or elongated. Those of a somewhat higher grade consist of a single row of cells, or at most a single layer; while still higher forms of growth consist of masses of cells variously grouped together and specialized by differentiation from the typical form and character. These specialized cells give rise to the various forms of vegetable tissue. The earliest tendency to differentiation is seen in the arrangement of the outer row of cells to form a boundary wall. In higher forms of growth the interior cells tend to form one or more series of string-like rows surrounded by the normal cellular tissue. We thus reach the basis of the classification of vegetable tissues into three groups: (a) *Epidermal tissue*. (b) *Fundamental tissue*. (c) *Fascicular or Vascular tissue*. (Fig. 28). The first and second are common to both ferns and mosses. The last is first seen in the ferns, where it is a character so constant that it serves as the basis for separating the so-called "vascular" CRYPTOGAMIA from other flowerless plants. These three forms of tissue may be seen by examining a thin cross section of the stipe of a living fern with the microscope.

77. Roots.—Roots are constantly produced as the rhizoma advances, and consist for the most part of little fibrils which are naked for a short distance from the apex in order that they may freely absorb the moisture from the earth. The epidermis is also thin and usually consists of a single layer of small cells. It differs from that of the rest of the plant in having no stomata (81). As the apex continues to grow, the epidermis of the part behind becomes harder and frequently develops hairs or more frequently irregular scales.

78. **Stipe.**—The stipe is made up of the three forms of tissue, (Fig. 28), and usually contains several bundles of vascular tissue. In the dried stipe these can be easily examined, by scraping off the external covering of the stem. These bundles of fibres give stability to the fern and are continued through the rachises and veins thus forming the framework for the softer portions of the frond. The stipes are sometimes smooth and polished, sometimes hairy or beset with stalked glands, and sometimes densely clothed, especially near the base, with chaffy scales.

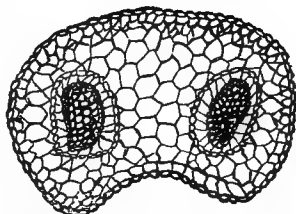


FIG. 28. Cross section of stipe of *Cystopteris fragilis*, Bernh., showing two bundles of vascular tissue. (Original.)

79. **Frond.**—In the HYMENOPHYLLACEÆ, the frond consists of a single layer of cells. This condition is also found in the leaves developed along the axis of growth among the mosses to which this sub-order is related in some of its forms. In all other ferns there are several layers of cells variously compacted together and forming all the varieties of texture, membranous, herbaceous, coriaceous and fleshy. The epidermis is usually easily separable from the underlying tissue, when its peculiar markings can be studied.

From the epidermis a great variety of appendages are developed which are all modifications of hairs and are all included under the term *trichomes*, however different in appearance or distinct in function. These are not confined to the frond but develop here their greatest variation. They are frequently found on the roots, the rhizoma, and the stipe, under the form of root-hairs or scales of various forms. Scales are especially abundant in certain forms of *Aspidium*, as well as in *Scolopendrium* and other genera.

80. **Trichomes.**—On the fronds the trichomes may be developed as simple unarticulated or articulated hairs, consisting of one or two cells at most. They may appear as stalked glands like those that arise from the stipe of *Cheilanthes Cooperæ* or the margin of the indusium of *Aspidium spinulosum*, var. *intermedium*; or they may be developed into scales of intricate cellular structure like those on the under surface of certain forms of *Cheilanthes*, particularly *C. Fendleri* and *C. Clevelandii*. Among the FILICES the sporangia are specialized trichomes developed in clusters (*sori*) along the veins, or spread over the entire surface of the frond, or even arranged in spikes or panicles. The epidermis also

develops an excrescence known as the indusium, which consists of a single layer of cells, and is variously arranged as indicated in Chapter III. In some cases a false indusium is provided which is not a growth from the epidermis and may consist of several layers of cells.

In the OPHIOGLOSSACEÆ the sporangia are not developed from the epidermal cells, but arise from a transformation of the interior tissue of the leaf. This with other characters as clearly defined serves to separate these anomalous plants from the order FILICES to which they were formerly appended.

81. **Stomata.**—If the epidermis covering the under surface of a fern be examined under a high magnifying power, peculiar structures will be seen in the form of semi-elliptical or crescent shaped cells connected at their apices and separated between. These are the stomata or breathing pores, and are merely openings to the air chambers of the plant. The two elliptical cells form the mouth of the passage and expand when moist, allowing the atmospheric gases and watery vapor to escape or enter, but close the entrance by contraction in time of drought. The stomata are not confined to the fronds but are found to a greater or less extent on all aerial portions of ferns and higher plants as well as on subterranean stems. In many of our species of *Cheilanthes* and *Notholaena* there is an additional provision against drought in the copious tomentum or chaff which is borne on the under surface of the fronds.

82. **Buds and Bulblets.**—In a few species of conservatory ferns adventitious buds are produced on the surfaces of the fronds. These soon develop into young ferns and it is not uncommon to see a large number in various stages of growth rising from a single frond. This peculiarity is common among several species of *Asplenium*, especially *A. furcatum*, Thunb., and will sometimes be found to occur among some of our native species. Bulblets are found in the axils of the upper pinnæ of *Cystopteris bulbifera* which often fall to the ground and develop into new plants after a manner analogous to the development of the axillary buds of the tiger lily.

83. **Vernation.**—As has been before stated, ferns are rolled in the bud from the apex downward (*circinate*), distinguishing them from the higher forms of vegetation. Among the OPHIOGLOSSACEÆ, however, the vernation is either straight, inclined at the apex of one or both segments, or else the fertile segments are folded on the main stalk, making the vernation wholly inclined.

Until recently there has been much difficulty in distinguishing the smaller species of *Botrychium*, and some forms seem to connect the smaller ones with the reduced forms of *B. ternatum* and *B. Virginianum*.

The publication of a series of distinguishing characters with illustrations by a specialist in this genus,* has added much to our positive knowledge of these intimately related species, and has made their identification a matter of comparatively easy investigation. The buds may be found enclosed in the base of the common stalk (except in *B. Virginianum* where they are placed in an upright cavity at one side) and may be examined with a strong lens. The three divisions are summed up as follows :

I. Vernation wholly straight. *B. simplex*, Hitch. (Fig. 29.)

II. Vernation partly inclined in one or both portions. *B. lunaria*, Swz., (Fig. 30), *B. boreale*, Milde., *B. matricariæfolium*, A. Br., (Fig. 31), and *B. ternatum*, Swz. (Fig. 32).

III. Vernation wholly inclined, in the fertile frond recurved. *B. lanceolatum*, Angs., (Fig. 33), and *B. Virginianum*, Swz."

The special characters of each species will be found under the descriptions of the *Botrychia* later in this work. The cuts will be valuable for reference, and will enable even beginners to identify the species of this complicated genus with comparatively little difficulty.

* Vernation in *Botrychia*, by Geo. E. Davenport. Bulletin Torrey Botanical Club, Jan., 1878, from which the cuts in this work are copied. See also Bulletin, Nov., 1880.

CHAPTER VI.

CLASSIFICATION AND NOMENCLATURE OF FERNS.

The education of a naturalist now consists chiefly in learning how to compare.

—AGASSIZ.

84. **Nomenclature.**—Before the time of Linnæus, the method of naming plants and animals was a subject of much embarrassment to science and gave rise to endless confusion. This great author, justly called the “Father of Botany,” introduced a new system of nomenclature that gave a new impetus to the study of nature. His system has since been in constant use and has made possible the greater accuracy and definiteness in the scientific descriptions of subsequent naturalists. He also introduced a system of classification which, though artificial and since abandoned, paved the way to the more natural system since adopted. He arranged the various plants and animals known to him in a few groups according to some particular plan of structure, divided these into still smaller groups and so on to the lowest divisions, genera and species. To these divisions special names were assigned, thus giving to each organism a double name, the first *generic* which may be likened to our family name, the other *specific* corresponding to our baptismal name. Thus the common marginal shield-fern bears the appellation *Aspidium marginale* given it by the Swedish botanist, Olaf Swartz. The first it bears in common with all the shield-ferns which have a like method of fructification. The latter is peculiar to this particular species which bears its sori near the margin of the segments.

85. **Generic Names.**—These may be derived from some characteristic of growth or structure, in honor of some botanist or distinguished patron of science, or occasionally from some mythological or symbolical character. The derivations of the generic names of our native ferns are given in the glossary at the close of this volume.

86. **Specific Names.**—These are usually adjective elements either Latin or Latinized and must agree in gender with the generic name according to the rules of Latin syntax. Errors in agreement have frequently been made by botanists who were not versed in the classics, and it is unfortunate that errors of this character as well as gross errors in the orthography of generic names have

found their way into accepted text-books of botany.* Specific names frequently indicate something regarding habit or mode of growth or may indicate the locality in which the organism was first discovered. A few take their name from their discoverer, in which case the name is Latinized and takes a genitive ending. The derivation of the specific names of our native species will be found in the glossary.

87. The advantage of this binary nomenclature is at once evident when we consider the immense number of ferns alone, to say nothing of the remainder of the vegetable world and the hosts of the animal creation. By this means organisms of complex structure can be definitely characterized with comparatively few words and the scientific name once established remains the same among scientists of all nations and languages.

88. There are, however, liabilities to error and confusion in the Linnæan system of nomenclature, as various authors have often assigned the same name to several species. For example, the name *Cheilanthes vestita* was given by Brackenridge to Eaton's *C. gracillima*. Hooker assigned the same name (in part) to Nuttall's *C. lanuginosa*, while Swartz assigned the same to the fern described in this volume under the name of *C. vestita*. It becomes necessary, therefore, in referring to a species to indicate the author of the specific name usually, if written, by an abbreviation.

89. **Synonymy.**—It may also be remarked in this connection that different authors have described the same fern under widely different generic and specific names. For example, the delicate *Woodsia Ilvensis* of Brown was described as *Acrostichum Ilvense* by Linnæus, *Polypodium Ilvense* by Swartz, *Nephrodium rufidulum* by Michaux, *Aspidium rufidulum* by Willdénow and *Woodsia rufidula* by Beck. Many other species have been as variously classified. From the confusion of the past we are rapidly emerging and our nomenclature is coming to be established on a permanent and scientific basis.

90. **Species.**—Goethe tells us that nature knows only individuals, and that species exist only in the school-books. From this extreme there has been every grade of opinion respecting species to the direct opposite which regards species as invariable, actual existences, types originally ordained and summoned to existence by the Creator. Linnæus, for example, defined species in these words: "*Species tot sunt diversæ, quot diversas formas ab*

**Cistopteris* for *Cystopteris* is an example.

initio, creavit infinitum ens."* Various definitions have been given to species, but none accord with the actual practice of systematists who seem inclined to make a species what they choose, and, indeed, the existence of various connecting forms between many species distinct under normal conditions, makes the practical definition of the term almost an impossibility. We may, however, for practical purposes, regard as a species an assemblage of individuals not differing essentially from each other, and capable of producing like individuals by the ordinary processes of reproduction. A recent writer defines species as "the present aspect of a line of organic development, destined to become something else in the future, as it was something else in the past."† This would seem to be in accordance with the now widely accepted biological doctrine respecting the origin of species.

Species among ferns are founded chiefly on differences in the cutting of the fronds and their method of venation.

91. **Varieties.** Many forms differing only slightly from the ordinary specific types, and yet capable of transmitting their variations from generation to generation, are regarded as varieties. There is a tendency on the part of a few authors to multiply varieties indefinitely, and of a single species as many as sixty-five varieties have been described. Among the best systematists, however, there is a growing tendency to restrict the number. In the present volume a distinction is made between those varieties that are more decided and constant in their characters, and those that are more directly connected with the typical forms. The former are printed in the same full-face type as the species, the latter in small capitals. It would seem that the latter class might as well be dropped from our lists, and possibly some forms now regarded as true varieties will be found to be based on characters that are not constant.

92. **Genera.** The genera of ferns are founded mostly on the arrangement of the sporangia on the veins, as well as the character, shape, and position of the indusia.

93. **Tribes.** Genera are collected into tribes, according as they agree in the position and arrangement of the sporangia in clusters or sori, or resemble each other in mode or habit of growth.

* There are as many different species as the Infinite Being created in the beginning.

† Dr. A. Winchell in Preadamites, p. 232.

94. **Sub-Orders.** Tribes are grouped into sub-orders, according as they agree in the characters of the sporangium, its shape, method of discharging its spores, and the existence, character, or absence of a ring.

95. **Orders.** Ferns are often classed in a single order, but in accordance with the latest researches of the best structural botanists, they are separated into three distinct orders, *FILICES*, *MARATTIACEÆ* and *OPHIOGLOSSACEÆ*, which are distinguished principally by the mode in which the sporangia are developed, and also by other minor characteristics. Two of the orders are well represented in our flora. The *MARATTIACEÆ* are mostly confined to tropical regions.

96. **Classification.** The true idea of classification is the grouping together of objects according to essential and fundamental resemblances. Every system is more or less artificial, yet there is a continual approach toward the true natural system, which is the ultimatum of scientific classification. That the various systems of classification as applied to ferns, as well as their position in the vegetable kingdom, may be better understood, the following outlines from a few of the leading botanists is appended.

97. **Position of Ferns in the Vegetable Kingdom.** The *CRYPTOGAMIA* or flowerless plants formed class XXIV. of the Linnæan system of classification and contained the following orders : *

- I. *FILICES*. (Ferns.)
- II. *EQUISETACEA*. (Scouring Rushes.)
- III. *LYCOPODINEÆ*. (Club Mosses.)
- IV. *MUSCI*. (True Mosses.)
- V. *HEPATICÆ*. (Liverworts.)
- VI. *ALGÆ*. (Sea Weeds.)
- VII. *LICHENES*. (Lichens.)
- VIII. *FUNGI*. (Mushrooms.)

98. Lindley, in his "Vegetable Kingdom," divides the asexual or flowerless plants into two classes, *THALLOGENS* and *ACROGENS*, the latter containing eleven families, among which are *FILICES* and *OPHIOGLOSSACEÆ*.

* Linnæus recognized only four orders : Nos. II., III., V. and VII. have been added by later botanists.

99. Dr. Asa Gray, in the fifth edition of his "Botanical Text Book," restricted ACROGENS so as to include only such flowerless plants as contain woody tissue and vessels, while the mosses and liverworts are placed in a separate class, ANOPHYTES. This distinction, however, has been modified in the last edition by dividing the class ACROGENS into *Cellular* and *Vascular*.

100. Sachs, in his admirable "Text Book of Botany," classifies the vegetable kingdom as follows :

Group I—THALLOPHYTES	{	Class I. ALGÆ.
		(Confervæ Seaweeds.)
Group II—CHARACEÆ	{	Class II. FUNGI.
		(Mildew, Mushrooms, Lichens.)
Group II—MUSCINEÆ	{	Class III. CHARACEÆ. (Chara.)
		Class IV. HEPATICÆ.
Group IV { VASCULAR CRYPTOGAMIA	{	(Liverworts.)
		Class V. MUSCI. (Mosses.)
		Class VI. FILICES. (Ferns.)
		Class VII. EQUISETACEÆ.
		(Horsetails.)
		Class VIII. OPHIOGLOSSACEÆ.
		(Adder-tongues.)
		Class IX. RHIZOCARPEÆ.
		(Hydropterides.)
		Class X. LYCOPODIACEÆ.
(Club Mosses.)		
Group V—PHANEROGAMIA	{	Class XI. GYMNOSPERMÆ.
		(Confers, Cycads.)
		Class XII. MONOCOTYLEDONÆ.
(Lilies, Grasses, etc.)		
Class XIII. DICOTYLEDONÆ.		
(Roses, etc.)		

The above classification will serve to show the relative position of ferns in the vegetable world, yet the arrangement of classes under the Vascular Cryptogams seems hardly satisfactory and the nomenclature is at least unfortunate.*

101. The following classification of the Vascular Cryptogams or PTERIDOPHYTA, may be taken as representing the latest generalizations :

*The ending, *aceæ*, has long been reserved for botanical orders, and for the sake of uniformity all groups of plants receiving ordinal rank, should receive this termination. *Selaginelleæ* may thus be more properly written *Selaginellaceæ*. In a recent text book the old original name *Lycopodiaceæ* is changed to *Lycopodiææ* without obvious reason. Were the term *Filices* not so long established it could with profit be changed so as to conform with the terminations of the other PTERIDOPHYTA. A uniform terminology is a desideratum in botanical science.

102. **Classification of Order Filices.** The subdivisions of the order FILICES have been various, and the following are given for comparison with that followed by the leading American systematists. As the *Synopsis Filicum*, from which the second is taken, is largely used in this country, the American genera are distributed under their respective tribes.

103. **Mettenius' Arrangement.**

- Sub-Order I. HYMENOPHYLLACEÆ. Ring complete, oblique or transverse.
- Sub-Order II. GLEICHENIACEÆ. Ring complete, transverse.
- Sub-Order III. SCHIZÆACEÆ. Ring complete, apical.
- Sub-Order IV. OSMUNDACEÆ. Ring rudimentary or none.
- Sub-Order V. MARATTIACEÆ.*
- Sub-Order VI. CYATHEACEÆ. Ring complete, oblique.
- Sub-Order VII. POLYPODIACEÆ. Ring complete, vertical; including the five tribes: *Acrosticheæ*, *Polypodieæ*, *Asplenieæ*, *Aspidieæ* and *Davallieæ*.

104. **Hooker's Arrangement.**

- Sub-Order I. GLEICHENIACEÆ. (2 genera.)
- Sub-Order II. POLYPODIACEÆ. (61 genera.)
 - Tribe 1. CYATHEÆ. (6 genera.)
 - Tribe 2. DICKSONIÆ. (6 genera—*Onoclea*, *Woodisia*, *Dicksonia*.)
 - Tribe 3. HYMENOPHYLLEÆ. (3 genera—*Trichomanes*.)
 - Tribe 4. DAVALLIÆ. (2 genera—*Cystopteris*.)
 - Tribe 5. LINDSAYÆ. (2 genera.)
 - Tribe 6. PTERIDEÆ. (13 genera—*Adiantum*, *Cheilanthes*, *Cryptogramme*, *Pellæa*, *Pteris*, *Ceratopteris*, *Lomaria*.)
 - Tribe 7. BLECHNEÆ. (4 genera—*Blechnum*, *Woodwardia*.)
 - Tribe 8. ASPLENIEÆ. (4 genera—*Asplenium*.)
 - Tribe 9. SCOLOPENDRIÆ. (1 genus—*Scolopendrium*, including *Camptosorus*.)
 - Tribe 10. ASPIDIEÆ. (6 genera—*Aspidium*‡, *Nephrodium*‡, *Nephrolepis*.*

* Not recognized by Mettenius as a distinct order.

‡ United under *Aspidium* by American botanists.

- Tribe 11. POLYPODIEÆ. (1 genus—*Polypodium*, including *Fhegopteris*.)
- Tribe 12. GRAMMITIDEÆ. (11 genera—*Notholaena*, *Gymnogramme*, *Vittaria*.)
- Tribe 13. ACROSTICHEÆ. (2 genera—*Acrostichum*.)
- Sub-Order III. OSMUNDACEÆ. (2 genera—*Osmunda*.)
- Sub-Order IV. SCHIZÆACEÆ. (5 genera—*Schizæa*, *Aneimia*, *Lygodium*.)
- Sub-Order V. MARATTIACEÆ*. (4 genera.)
- Sub-Order VI. OPHIOGLOSSACEÆ*. (3 genera — *Ophioglossum*, *Botrychium*.)

105. It will thus be seen that the fern world comprises 77 genera. Other authors, narrowing the limits of generic characters, recognize a greater number. Smith, for example, publishes 220, and Presl 230, yet the tendency among most botanists is to restrict the number. While many of our leading systematists differ in minor point of classification, there is a general agreement in all these attempts at a natural system, which is the end of all classification because founded on morphological resemblances.

*Not recognized by this author as orders.

CHAPTER VII.

HOW TO STUDY FERNS.

The great benefit which a scientific education bestows, whether as training or as knowledge, is dependent upon the extent to which the student * * * learns the habit of appealing directly to Nature.—HUXLEY.

105. Determination of Species. The first thing to learn about a plant or animal is not its name, but its structural characteristics, knowing which the name can be readily determined. Having provided ourselves with a strong lens, two or more needles mounted in wooden handles for dissecting purposes, and a few well fruited ferns taken with the roots, we are prepared to commence our study. In investigating any plant we should be systematic and accurate in our observations, and no subject will develop order and accuracy of description or enlarge our powers of observation as will the subject of botany rigidly pursued. In order to fix the characters of the fern in question, it is well to note them down in some systematic order, and the preparation of blanks like the following is suggestive for the purpose :

<i>Synoptical Characters of</i>	
.....	
ROOT.	
RHIZOMA.	
STIPE.	
FROND.	
VEINS.	
SORI.	
SPORANGIA.	
SPORES.	

The characters thus commence with the lowest parts and continually advance upwards to completion.

106. Taking now a common fern we will notice its characteristics. Suppose it to be the one commonly called "Maiden-hair" in the Northern States. We take the parts in order and give them a searching examination: the character of the root; the direction of growth, position, and appearance of the rhizoma; the appearance, color, and method of growth of the stipe; the method of cutting of the frond and the character of its surface; the method of veining; the position of the fruit clusters on the frond and veins, and the peculiar form of the indusium, if present. The sporangia and spores are best studied with a microscope, yet the shape of the sporangia and the character of the ring can be determined with a strong lens.

107. The characters of the Maidenhair can be summed up as follows:

<i>Synoptical Characters of</i>	
ADIANTUM PEDATUM. L.	
ROOT.	Many delicate fibres, somewhat matted.
RHIZOMA.	Scaly, somewhat creeping.
STIPE.	Separate, slender, polished, black, forked at base of frond forming two recurved rachises.
FROND.	Roundish in outline, formed of several pinnæ, which branch from the recurved rachises; pinnules unequal sided, oblong or deltoid; upper margins irregularly lobed; surfaces smooth.
VEINS.	Free, several times forked.
SORI.	Borne at the end of the veins on the under side of the reflexed margins of the lobes which form somewhat kidney-shaped membranous indusia.
SPORANGIA.	Globose with a nearly complete vertical ring.
SPORES.	[Too minute for examination with an ordinary lens.]

108. We are now prepared to determine the specific name, and for this purpose will turn to the ARTIFICIAL SYNOPSIS OF GENERA. Reading the two statements under A we find our plant agrees with the first, bearing the sporangia at the margin of

a leafy frond, so we proceed to B as indicated at the right hand margin. There being an indusium present, we are directed to C, where we find four statements. Our fern agrees with the second, as the indusium is formed of a reflexed portion of the frond. Passing to D we find it agreeing with the first statement. Passing to E the statement, "Sporangia at the ends of the veins, borne on a reflexed portion of the margin of the frond," answers our purpose, and the marginal reference, VI., refers us to the genus numbered VI., *Adiantum*. Under this genus we find two statements designated by *, and **; the latter referring to the "dichotomously forked" fronds, answers our purpose, and we find our fern to be number 5, *Adiantum pedatum*, L., the scientific name of the Maidenhair, which we can now place in our description. Turning to the glossary of technical terms we find the application of the generic name; in the glossary of specific terms we find the application of the name *pedatum*. Were we in Florida or any of the Southern States, instead of *A. pedatum* we would probably have found the Venus' Hair (*A. Capillus-Veneris*), or in California the Californian Maidenhair (*A. emarginatum*) either of which would agree with the common Eastern species in all respects save the method of branching of the frond and the shape of the pinnules. In like manner we can trace any of our native species to their scientific names, by carefully noting their structure and methods of fruiting.

109. In a few ferns it will be necessary to exercise great care in the examination of the indusia. In the genera *Cystopteris*, *Dicksonia* and *Woodsia*, and in a few species of *Aspidium* the indusia wither away after fruiting, so that one is likely to classify them under the non-indusiate genera if he carelessly examines them in this condition. In such cases a large number of sori should be carefully examined and the least trace of an indusium should be noted. Five-sixths of our genera, including four-fifths of our species, are indusiate.

110. **Histology.** The minute structure of the ferns will furnish unlimited opportunity for observation with the highest magnifying powers of the compound microscope. Sections for examination should be shaved very thin with a razor or with knives made for the purpose, so as to be transparent, otherwise they must be illuminated from above by a condenser or stage mirror. In this way sections of stipes, foliage, epidermis or sori can be examined to advantage, illustrating the various forms of tissue. The scales, hairs, tomentum, and glands of various species will

also furnish interesting material for study. The sporangia are small enough to be examined entire and can be viewed at different stages of growth. The annulus or ring can be seen in all its positions and the method of bursting determined. The spores form an interesting subject for investigation, and require the highest powers for successful observation. Practice only will develop methods of observing that cannot be easily placed in the form of suggestions. The interest will become deeper at every step, and the subject of determination of species or study of the more apparent characters, is incomparable with the subject of microscopic investigation in inspiring wonder or stimulating the mental powers.

III. Germination. The germination of the fern spores can be studied by sowing fresh spores on a glass slide and keeping them moist and warm; they can be kept to advantage under a glass dome and taken out at intervals and examined. The examination of the sexual organs will require skillful manipulation and enduring patience, but the success attained by careful toil will prove an abundant reward.

A LITTLE FERN LITERATURE.

A. AMERICAN.

Ferns of North America. By Prof. Daniel C. Eaton. Illustrated with colored plates drawn by J. H. Emerton. 4to. This finely executed work contains descriptions of the North American species miscellaneously arranged; it contains also a systematic arrangement with brief synoptical descriptions. It was originally published in parts, and though somewhat expensive, ought to be in the library of every lover of the subject. The reputation of its author is a sufficient recommendation.

Ferns of Kentucky. By John Williamson. Illustrated by the author with etchings of the ferns of that state. 8vo.

Fern Etchings. By John Williamson. 1879. Containing descriptions and figures of all the ferns of the Northeastern United States and Canada.

Notes on Botrychium Simplex. By George E. Davenport. 4to, paper. Containing valuable notes on this variable species and its allies.

Ferns in Their Homes and Ours. By John Robinson. Illustrated with twenty-two plates. 12mo. A valuable outline of fern cultivation, indispensable to those desiring to undertake the cultivation of ferns either in conservatories or Wardian cases.

The only strictly American work on structural botany that treats of fern structure is the recently issued botany of the "American Science Series," published by Henry Holt & Co. It devotes twelve of six hundred pages to the subject of ferns.

In addition to these works, which represent the entire fern literature of our country, there are several catalogues of American ferns, the best of which is the "Catalogue of the Davenport Herbarium," by George E. Davenport, published in pamphlet form and containing valuable notes, especially on geographical distribution. Three other lists have been published; one by John Robinson and a second by William H. Edwards, both of which are now deficient, owing to recent discoveries and changes in nomenclature; a third has been published by Prof. Eaton (Sept. 1880), which is especially intended for an exchange list.

It is almost unnecessary to add that no botanist or lover of the science should be without the admirable *Bulletin of the Torrey Botanical Club*, which furnishes valuable notes on ferns, as well as other botanical orders.

B. FOREIGN.

Species Filicum. By Sir W. J. Hooker. 5 vols. 8vo. Containing nineteen plates of American ferns.

Synopsis Filicum. By Sir W. J. Hooker and J. G. Baker, 8vo. London, 1874. Contains descriptions of all ferns known at that date, and is valuable for the determination of species from beyond our limits. It lacks one very essential feature of a systematic work, namely, a key to the genera, and the grouping of the species is such as to make it often difficult in identification.

Genera Filicum. By Sir W. J. Hooker. Large 8vo. Illustrated by magnificent plates, representing 135 genera and sub-genera.

Historia Filicum. By John Smith. 8vo. Contains a review of the classifications of various authors and a statement of the author's system.

Ferns, British and Foreign, with a treatise on cultivation. By John Smith. 12mo.

British Ferns. By Margaret Plues. 12mo. London, 1866. Illustrated by colored plates and giving outlines of fern structure.

A Fern Book for Everybody. By M. C. Cooke. Small 12mo.

Introduction to Cryptogamic Botany. By M. G. Berkeley. 8vo.

Text-Book of Structural and Physiological Botany. By Otto W. Thome. Small 8vo.

Text Book of Botany. By Julius Sachs. 4to. Oxford, 1875. Without doubt the best work yet published on the subject of botanical morphology, physiology, and the principles of classification.

Text-Book of Botany. By Dr. K. Prantl. Translated by S. H. Vines. 8vo. Similar in plan to the larger work by Dr. Sachs.

OUR NATIVE FERNS.

I love not man the less, but Nature more,
From these our interviews, in which I steal
From all I may be, or have been before,
To mingle with the Universe, and feel
What I can ne'er express, yet cannot all conceal.

—BYRON.

SYSTEMATIC ARRANGEMENT OF SUB-ORDERS,
TRIBES AND GENERA.

ORDER FILICES.

Vascular Cryptogamia with fronds usually raised on a stipe, usually from a prostrate, ascending or erect rhizoma, circinate in veneration. Sporangia modified trichomes of the leaves, reticulated, one-celled, encircled by a more or less complete, jointed elastic ring, collected in clusters of various forms on the under surface of the frond, with or without an indusium or covering; or panicled or spiked and naked; or borne on receptacles of various kinds. Spores of various forms, minute. Prothallium above ground, green, monœcious.

SUB-ORDER I.—POLYPODIACEÆ.

Sporangia pedicelled, surrounded more or less completely by a jointed, vertical and elastic ring, bursting transversely. Sori dorsal or marginal, borne on a leafy frond, with or without indusia.

Tribe I. ACROSTICHEÆ. Sporangia spread in a stratum over the under surface, or rarely over both surfaces of the frond. Indusia wanting.

I. Acrostichum, L. Sori covering the entire surface of the upper pinnæ.

Tribe II. POLYPODIEÆ. Sori dorsal, borne at or near the ends of the veinlets, without indusia.

II. Polypodium, L. Possessing characters of the tribe,

Tribe III. GRAMMITIDEÆ. Sori dorsal, variously arising from the veins, usually linear. Indusia absent.

III. Gymnogramme, Desv. Sori oblong or linear, following the course of the veinlets.

IV. Notholæna, R. Br. Sori on the veins or near their extremities, roundish or oblong, soon confluent into a narrow marginal band.

Tribe IV. VITTARIEÆ. Sporangia borne in a continuous marginal or intra-marginal furrow.

V. Vittaria, Sm. Fronds simple, linear, grass-like.

Tribe V. **PTERIDEÆ**. Sori marginal or intra-marginal, provided with an indusium formed of the reflexed margin of the frond, and opening inwardly.

* *Terrestrial.*

† *Sporangia borne on a reflexed portion of the margin of the frond.*

VI. **Adiantum**, L. Sori usually numerous and distinct. Midrib of the pinnules near the lower margin or wanting.

†† *Sporangia borne on a continuous vein-like receptacle which connects the apices of the veins.*

VII. **Pteris**, L. Sori continuous. Indusium delicate, whitish. Midribs of pinnules central.

††† *Sporangia at or near the ends of unconnected veins, borne on the under surface of the frond.*

VIII. **Cheilanthes**, Swz. Sori minute at the ends of the veins. Indusium continuous or interrupted.

IX. **Cryptogramme**, R. Br. Sporangia on the back or near the ends of the veins forming oblong or roundish sori, which are at length confluent and cover the back of the pinnules. Sterile and fertile fronds unlike, smooth.

X. **Pellæa**, Link. Sori on the upper part of the veins, distinct, or mostly forming a marginal band of sporangia. Sterile and fertile fronds usually similar, smooth.

** *Aquatic.*

XI. **Ceratopteris***, Brong. Sori placed on two or three veins which run down the frond longitudinally. Indusia meeting at the midrib.

Tribe VI. **BLECHNEÆ**. Sori dorsal, linear or oblong, borne on transverse veins, parallel to the midrib. Indusium fixed at its outer margin, opening at the inner.

* *Veins free.*

XII. **Lomaria**, Willd. Sori in a continuous band next the midrib. Indusium elongated, formed of the recurved and altered margin of the pinnæ, or else sub-marginal. Fronds of two sorts, elongated, pinnate.

XIII. **Blechnum**, L. Sori linear, elongated, continuous near the midrib. Indusia continuous. Fronds pinnate.

*This anomalous genus is placed provisionally among the *Pteridæ*, but it will probably demand a separate tribe for its reception. Prof. Eaton places it in a new sub order, CERATOPTERIDEÆ.

** *Veins more or less reticulated.*

XIV. Woodwardia, Sm. Sori linear or oblong, forming chain-like rows. Indusia separate.

Tribe VII. ASPLENIEÆ. Sori dorsal, linear or oblong, oblique to the midrib, or rarely sub-parallel with it. Indusium fixed by one margin to the veinlet, opening at the other, sometimes^S double.

* *Veins free.*

XV. Asplenium, L. Sori on the upper side of a fertile veinlet, rarely on both sides.

XVI. Scolopendrium, Sm. Sori linear, confluent in pairs, which appear like a single sorus with the double indusium opening in the middle.

** *Veins reticulated.*

XVII. Camptosorus, Link. Sori oblong or linear, borne partly on veins parallel to the midrib, partly on veins oblique to the midrib.

Tribe VIII. ASPIDIEÆ. Sori dorsal, round or roundish, on the back or rarely on the apex of a vein. Indusium usually membranous, rarely wanting.

* *Without indusia.*

XVIII. Phegopteris, Fee. Sori round, rather small, borne on the back of the free veins.

** *With indusia.*

† *Indusia superior.*

XIX. Aspidium, Swz. Indusium orbicular and fixed by the centre or reniform and fixed by the sinus, opening all round the margin. Sori mostly on the back of the veins.

XX. Nephrolepis, Schott. Indusium reniform, fixed at the sinus or at the arcuate base, opening toward^{the} the margin of the frond. Sori at the end of free veins.

†† *Indusia fixed by a broad base partly under the sorus.*

XXI. Cystopteris, Bernh. Indusium convex, usually reflexed as the sporangia ripen. Texture delicate.

††† *Indusia obscure. Fertile frond much contracted, very unlike the sterile.*

XXII. Onoclea, L. Sori dorsal on the veins of the contracted pinnæ, concealed by their revolute margins.

†††† *Indusia inferior.*

XXIII. Woodsia, R. Br. Indusium roundish or stellate, delicate, cleft into irregular lobes.

Tribe IX. **DICKSONIÆ**. Sori roundish or transversely elongated, borne at the ends of the veins or on marginal cross-veinlets, with an indusium attached at the base or base and sides and opening toward the margin of the segment.

XXIV. *Dicksonia*, L'Her. Sori marginal, small, the indusium cup-shaped, somewhat two-valved, the under portion confluent with a lobule of the frond.

SUB-ORDER II. — HYMENOPHYLLACEÆ.

Sporangia borne on an elongated, often filiform, receptacle, surrounded by a complete transverse ring, opening vertically. Sori terminal or marginal from the apex of a vein. Indusium inferior, usually of the same texture as the fronds. Fronds delicately membranous and pellucid.

XXV. *Trichomanes*, Sm. Indusia tubular, cup-shaped, or funnel-shaped, sometimes two-lipped.

SUB-ORDER III. — SCHIZÆACEÆ.

Sporangia ovate, sessile, arranged in spikes or panicles, having a complete, transverse, articulated ring at the apex, and opening by a longitudinal slit.

**Stems scandent.*

XXVI. *Lygodium*, Swz. Sporangia borne in a double row on narrow fertile segments, each on a separate veinlet and provided with a special indusium.

***Stems not scandent.*

XXVII. *Aneimia*, Swz. Sporangia naked, attached by their bases to the narrow divisions of the panicked fertile segments of the frond.

XXVIII. *Schizæa*, Sm. Sporangia naked, fixed in a double row to the midrib of the narrow fertile segments. Sterile fronds simple or dichotomously forked.

SUB-ORDER IV. — OSMUNDACEÆ.

Sporangia naked, globose, mostly pedicelled, with no ring or mere traces of one around the apex, opening into two halves by a longitudinal slit.

XXIX. *Osmunda*, L. Fertile pinnæ or fronds much contracted, bearing the large and abundant sporangia on the margins of the narrow segments.

ORDER OPHIOGLOSSACEÆ.

Vascular Cryptogamia with fronds usually from a fleshy, sometimes bulbous root, straight or inclined in veneration. Sporangia formed of the interior tissue of the frond, spiked or paniced, naked, not reticulated, destitute of a ring, opening by a transverse slit into two valves discharging copious sulphur-colored spores. Prothallium (so far as known) subterranean, not green, monœcious.

XXX. *Ophioglossum*, L. Sporangia cohering in one or more simple spikes. Veins reticulated.

XXXI. *Botrychium*, Swz. Sporangia in pinnate or compound spikes or panicles. Veins free.

ARTIFICIAL SYNOPSIS OF THE GENERA.

- | | | | |
|----|---|--|-------|
| A. | { | Sporangia collected in sori and borne on the back or margin of a leafy frond, | B. |
| | | Sporangia in spikes or panicles not on the leafy portion of the frond, | T. |
| B. | { | Sori covered with indusia, | C. |
| | | Sori naked, | P. |
| C. | { | Fertile frond closely rolled together, entirely unlike the sterile, its segments berry-like or neck-lace-like, | XXII. |
| | | Sori marginal, covered with a reflexed portion of the frond, | D. |
| | | Sori marginal or terminal borne on an elongated receptacle, | XXV. |
| | | Sori dorsal or marginal, provided with special indusia, | H. |
| D. | { | Terrestrial, growing mostly in rocky places, . . | E. |
| | | Aquatic, sterile fronds floating on the water, . . | XI. |
| E. | { | Sporangia at the ends of the veins, borne on a reflexed portion of the margin of the frond, . . | VI. |
| | | Sporangia borne on a continuous, marginal, vein-like receptacle connecting the apices of the veins, | VII. |
| | | Sporangia at or near the ends of unconnected veins, borne on the under surface of the frond, | F. |

F.	{ Fronds conspicuously dimorphous; stipes light-colored,	IX.
	{ Fronds nearly uniform; stipes usually dark,	G.
G.	{ Sori on the upper part of the veins, mostly forming a continuous marginal band; indusium membranous, continuous round the segment,	X.
	{ Sori minute, at the ends of the veins; indusium interrupted or if continuous, the ultimate segments usually small and bead-like; fronds mostly chaffy, woolly, or farinose,	VIII.
H.	{ Sori roundish; indusia not more than twice as long as broad,	I.
	{ Sori linear or oblong; indusia more than twice as long as broad,	L.
I.	{ Indusium superior, attached by the centre or sinus,	J.
	{ Indusium convex, fixed by a broad base partly under the sorus,	XXI.
	{ Indusium inferior,	K.
J.	{ Sori mostly on the back of the veins; indusium orbicular or reniform, opening all round the margin,	XIX.
	{ Sori at the end of a free vein; indusium reniform, opening toward the margin of the frond; fronds simply pinnate, the pinnæ articulated to the rachis,	XX.
K.	{ Indusium roundish or stellate, delicate,	XXIII.
	{ Indusium cup-shaped, somewhat two-valved,	XXIV.
L.	{ Sori all parallel to the midribs or rachises,	M.
	{ Sori all oblique to the midribs,	O.
	{ Sori partly oblique and partly parallel to the midrib; frond simple, tapering to a point,	XVII.
M.	{ Veins free,	N.
	{ Veins reticulated,	XIV.

N.	{	Indusium near the margin; fertile frond much contracted,	XII.
		Indusium remote from the margin; fronds nearly uniform,	XIII.
O.	{	Sori on the upper side of a veinlet, rarely on both sides,	XV.
		Sori confluent in pairs, with an apparently double indusium opening in the middle,	XVI.
P.	{	Sori spread in a stratum on the under surface of the frond,	I.
		Sori roundish, or not more than twice as long as broad,	Q.
		Sori usually linear, always more than twice as long as broad,	R.
Q.	{	Stipes articulated to the rhizoma; fronds (in our species) entire or simply pinnate,	II.
		Stipes not articulated to the rhizoma; fronds (in our species) bi—tripinnatifid or ternate,	XVIII.
R.	{	Fronds narrow, grass-like,	V.
		Fronds not grass-like,	S.
S.	{	Sori marginal, more or less confluent in a marginal band,	IV.
		Sori following the veinlets, simple, forked, pinnated, or variously anastomosing,	III.
T.	{	Sporangia opening by a longitudinal slit; veneration circinate,	U.
		Sporangia opening by a transverse slit; veneration straight or inclined,	X.
U.	{	Sporangia ovate, with transverse ring at apex,	V.
		Sporangia globose without a ring,	XXIX.
V.	{	Stems scandent, pinnæ palmate,	XXVI.
		Stems not scandent,	W.

W.	{	Sporangia in close distichous spikes, . . .	XXVIII.
		Sporangia in copiously branching panicles,	XXVII.
X.	{	Sporangia cohering in simple spikes; veins re-	
		ticulated,	XXX.
		Sporangia mostly paniced; veins free.	XXXI.

SYSTEMATIC DESCRIPTIONS OF GENERA AND SPECIES.

NOTE.—Species peculiar to North America are indicated by an asterisk (*). Roman numerals following the species indicate geographical sub-divisions. (See page 22.)

I. ACROSTICHUM, L.

Sporangia spread over the whole surface of the frond or upper pinnæ, or occasionally over both surfaces. Venation and cutting various (in our species simply pinnate).

‡ CHRYSODIUM.

1. *A. aureum*, L. Stipes 1^o—2^o long, tufted, strong, erect, glossy; fronds 2^o—6^o long, 1^o—2^o broad, upper pinnæ fertile, slightly smaller than the barren ones; texture coriaceous; areolæ small, copious, without free veinlets. Fla. VI.

II. POLYPODIUM, L. POLYPODY.

Sori round, naked, dorsal, in one or more rows each side of midrib, or irregularly scattered. Stipes articulated to rhizoma.

‡ I. EUPOLYPODIUM. *Vein free; fronds (in our species) pinnate.*

* *Sori large.*

1. *P. vulgare*, L. Stipes 2'—4' long, firm, erect; fronds 4'—10' long, 1'—3' broad cut nearly or quite to the rachis into entire or slightly toothed, usually blunt pinnæ; veins once or twice forked. Larger fronds with their pinnæ sharply serrated and long pointed form the *var. occidentale*, Hook. N. Eng. westward to Ore. and southward to Ala. III.

2. *P. falcatum**, Kellogg. Stipes 5'—8' long, stramineous; fronds 12'—15' long, 4'—8' broad; pinnæ numerous, tapering to a slender point, sharply serrate; sori nearest the midrib; veins with 2—4 veinlets. Cal. to W. T. IV.

** *Sori smaller, often minute.*

3. *P. plumula*, H. B. K. Stipes 1'—4' long, black, slender; fronds narrowly lanceolate, 9'—18' long, 1'—2' broad; pinnæ numerous, narrow, entire, blunt, lower gradually reduced; surfaces naked except the black wiry rachis; veinlets forked, obscure. Fla. VI.

4. *P. pectinatum*, L. Stipes rigid 2'—6' long; fronds elliptical-lanceolate, 1° — $2\frac{1}{2}^{\circ}$ long, 2'—6' broad, cut to the rachis into horizontal, entire or toothed pinnæ, the lower ones much reduced; rachis naked or finely villose; veinlets pellucid, once or twice forked; sori in long rows, of medium size. Fla. VI.

‡ 2. *GONIOPHLEBIUM*, Blume. *Veins forming ample regular areolæ, (almost imperceptible in No. 5) each with a single distinct free included veinlet, bearing a sorus at its terminus.*

**Under surface squamous.*

5. *P. incanum*, Swz. Stipes 1'—4' long, erect, densely scaly; fronds 2'—6' long, 1'— $1\frac{1}{2}$ ' broad, cut to the rachis into entire pinnæ; texture coriaceous; sori small; veins indistinct, united or frequently free. Va. to Ill., and southward. VI.

***Under surface mostly smooth.*

6. *P. Californicum**, Kaulf. Rhizoma creeping, chaffy; stipes 3'—6' long, stramineous when dry, naked; fronds ovate to oblong-lanceolate, 6'—9' long, 3'—5' broad, cut nearly or quite to midrib into finely-toothed pinnæ; texture papyraceo-herbaceous; sori large; veinlets 4—6 to each vein. (Including *P. intermedium*, H. & A.) Cal. IV.

7. *P. Scouleri**, H. & G. Rhizoma stout, creeping, scaly; stipes 2'—4' long, erect, naked; fronds thick 3'—12' long, 2'—6' broad, cut down to rachis into from 5—29 close, blunt pinnæ; texture coriaceous, fleshy when recent; sori very large; veinlets regularly anastomosing forming a single series of large areolæ. Cal. and northward. IV.

‡ 3. *PHLEBODIUM*, R. Br. *Veins forming ample areolæ, each with two or more distinct free included veinlets bearing sori on their united points.*

8. *P. aureum*, L. Rhizoma stout, densely scaly; stipes 1° — 2° long, castaneous, naked; fronds 3° — 5° long, 9'—18' broad, cut nearly to the rachis into broad entire or slightly undulate pinnæ; areolæ copious. Fla. VI.

‡ 4. *CAMPYLONEURON*, Presl. *Primary veins distinct from midrib to the edge, connected by parallel transverse veinlets, areolæ similar, containing two or more sori.*

9. *P. Phyllitidis*, L. Rhizoma stout, scaly; stipes short or none; fronds simple 1° — 3° long, 1'—4' broad, the point acute, lower part gradually narrowed; texture rigid, coriaceous; areolæ in rows of 6—12 from midrib to edge. Fla. VI.

III. GYMNOGRAMME, Desv.

Sori oblong or linear, following the course of the veinlets and like them, simple, forked, pinnated, or variously anastomosing, without indusia.

‡ 1. EUGYMNOCGRAMME. *Veins free, under surface not farinose.*

1. *G. hispida*, Mett. Rhizoma creeping; stipes grayish, puberulent, 3'—5' long; fronds 5-angled, 1'—3' each way, hispid above, tomentose beneath, pinnate; lower pinnæ much the largest, unequally triangular, pinnate; upper pinnæ lobed or crenated. (*G. pedata*, of check lists). Tex., N. Mex., Ariz. V.

‡ 2. CEROPTERIS, Link. *Fronde farinose below.*

2. *G. triangularis*, Kaulf. (GOLD-FERN, GOLDEN-BACK). Stipes densely tufted, slender, blackish-brown, polished, 6'—12' long; fronds 2'—5' each way, deltoid, pinnate; lower pinnæ much the largest, triangular, bipinnatifid; upper pinnæ more or less pinnately lobed; lower surface coated with yellow or white powder, finally more or less obscured by the fruit. Cal. and northward. IV.

IV. NOTHOLÆNA, R. Br. CLOAK-FERN.

Sori marginal, at first roundish or oblong, soon confluent into a narrow band, without indusium, but sometimes covered at first by the inflexed edge of the frond. Veins free.

‡ 1. EUNOTHOLÆNA. *Fronde not farinose beneath, scaly, hairy, or tomentose.*

**Fronde simply pinnate.*

1. *N. sinuata*, Kaulf. Rhizoma short, thick, very chaffy; stipes 2'—4' long, erect; fronds 6'—2° long, 1'—2' broad; pinnæ numerous, short-stalked, roundish or ovate, entire to pinnately lobed, lower surface densely scaly. Tex. to Ariz. V.

2. *N. ferruginea*, Hook. Rhizoma creeping, covered with dark rigid scales; stipes tufted, 2'—4' long, wiry, blackish, woolly at first; fronds 8'—12' long, ½'—1' broad, narrowly lanceolate; pinnæ numerous, ovate, pinnatifid, hairy above, densely tomentose beneath, the wool at first whitish, but becoming ferruginous. Tex. to Ariz. V.

***Fronde tri—quadripinnate.*

3. *N. Parryi*,* D. C. Eaton. Rhizoma short, scaly; stipes 2'—4' long, dark brown, pubescent with whitish jointed hairs; fronds 2'—4' long, oblong-lanceolate, tripinnate, lower pinnæ distinct; segments crowded, roundish-obovate, one line broad, densely covered above with entangled white hairs, beneath with a heavier pale-brown tomentum. Utah, Cal., Ariz. V.

4. **N. Newberryi**,* D. C. Eaton. (COTTON-FERN). Rhizoma with very narrow dark bristly scales; stipes tufted 3'—5' long, blackish-brown, woolly when young, with pale ferruginous tomentum; fronds 3'—5' long, lanceolate-oblong, covered most densely beneath with fine whitish hairs, tri—quadripinnate; ultimate segments roundish-obovate $\frac{1}{3}$ "— $\frac{1}{2}$ " broad. Cal. IV.

‡ 2. CINCINALIS, Desv. *Fronds farinose, with white or yellow powder (in one species naked).*

**Fronds farinose below.*

†*Fronds deltoid or pentagonal, barely bipinnate.*

5. **N. candida**, Hook. Rhizoma creeping, with narrow rigid nearly black scales; stipes tufted, 3'—6' long, wiry, black and shining; fronds shorter than stipe, deltoid-ovate, pinnate, lowest pinnæ having the lowest inferior pinnules elongated and again pinnatifid, three or four next pairs of pinnæ lanceolate, pinnatifid into oblong segments; upper pinnæ like segments of the middle ones; segments whitish farinose beneath, green above, margin slightly revolute. Tex. to Cal. V.

6. **N. Hookeri**, D. C. Eaton. Rhizoma short, densely covered with rigid lanceolate dark-brown scales; stipes tufted, 4'—8' long, reddish-brown, wiry, shining; fronds 2'—3' each way, nearly pentagonal, composed of three divisions; the middle one slightly stalked, rhomboid-ovate, pinnatifid into a few toothed segments, the second pair larger than the first; the side divisions sessile, deltoid, pinnatifid on upper side as in middle division, but each bearing on the lower side a single large pinnatifid basal segment, and above it smaller segments like those of the upper side; lower surface covered with pale yellow powder. (*N. cretacea* of check lists). Tex., N. Mex. V.

††*Fronds lanceolate or linear-oblong, bipinnate or tripinnatifid.*

7. **N. Grayi**,* Dav. "Stipes tufted, ? $1\frac{1}{4}$ '— $3\frac{1}{2}$ ' long, terete, chestnut-brown, with nearly black, rigid, linear-acuminate scales below, paler, deciduous scales above; fronds 2'—4' long, $\frac{3}{4}$ '— $1\frac{1}{4}$ ' broad, oblong-lanceolate, once or twice pinnate, upper surface sparingly, under thickly covered with white powder; rachises brown like the stipes, coated with a granular substance extending down the stipes, and clothed with long, slender, entire or ciliated, pale or whitish scales; pinnæ short-stalked, oblique, unequally triangular-ovate, ovate-lanceolate, or lanceolate, deeply pinnatifid or pinnately divided into 1 or 2 pairs of short-stalked or sessile, oblong, pinnatifid, obtuse pinnules, the remaining portion obliquely pinnatifid with alternate, lobed or entire segments; mar-

gins unchanged, reflexed; sori brown in a continuous line at the ends of the free veins." South-eastern Ariz. V. *Bulletin Torr. Bot. Club, May, 1880.*

8. **N. Lemmoni**,* D. C. Eaton. "Rootstock short, scaly with narrow, pointed, rigid, dark-brown chaff; stalks dark reddish-brown, wiry, 4'—6' long, chaffy at the base with scales a little wider and more scarious margined than those of the rootstalk, otherwise smooth; fronds 6'—9' long, 1'—1½' wide, linear-oblong, pinnate with numerous deltoid or ovate, once or twice pinnatifid pinnæ, the lowest ones a little shorter than the middle ones; upper surface herbaceous-green smooth; lower surface covered with white or slightly yellowish ceraceous powder; sori forming a narrow sub-marginal line; margins of the segments very slightly recurved." Ariz. V. *Bulletin Torr. Bot. Club, June, 1880.*

†† Fronds deltoid-ovate, tri—quadripinnate at base.

‡ Rachises straight or nearly so.

9. **N. dealbata**,* Kunze. Stipes densely tufted, nearly black; rachis and all its branches straight, capillary; fronds deltoid-ovate, quadripinnate at base gradually simpler above; pinnæ mostly opposite; ultimate pinnules oval, entire or some of them 3-lobed. Upper Missouri to N. Mex. and Ariz. V.

‡† Rachises zigzag and flexuous.

10. **N. nivea**, Desv. Rhizoma short, chaffy with narrow scales; stipes tufted, 4'—6' long, wiry, black and polished; fronds 3'—6' long, 1½'—2' broad, pyramidal-ovate, tripinnate; primary pinnæ mostly opposite the rachises, nearly straight; pinnules long-stalked with blunt oblong or roundish, entire or more or less lobed segments; upper surfaces green, smooth, lower densely coated with pure white powder; sori brown, often descending the free veins half-way to the midvein. Ariz., N. Mex., 1880. V.

11. **N. Fendleri**,* Kunze. Stipes densely tufted, dark-brown, 3'—5' long; rachis and all its branches zigzag and flexuous; fronds broadly deltoid-ovate 3'—5' each way, quadripinnate below, gradually simpler above; pinnæ alternate; ultimate pinnules oval or elliptical, simple or 3-lobed. Col., N. Mex., Ariz. V.

** Fronds naked below.

12. **N. tenera**, Gillies. Stipes tufted, brownish, smooth and shining; fronds 3'—4' long, ovate-pyramidal, bi—tripinnate; pinnæ mostly opposite, distant, the lower ones somewhat triangular; ultimate pinnules ovate, often sub-cordate, obtuse, smooth and naked on both surfaces. Southern Utah. V.

V. VITTARIA, Sm. GRASS-FERN.

Sori linear, continuous, in two-lipped marginal grooves or in slightly intramarginal lines, with the unaltered edge of the frond produced beyond and often rolled over them, but without special indusia. Fronds narrow, grass-like. Veins free.

‡ TÆNIOPSIS, J. Sm.

1. *V. lineata*, Swz. Fronds 6'—18' long, 1''—5'' broad, narrowed gradually downward to a stout compressed stem, the edge often reflexed. Sori in a broad intramarginal line in a slight furrow, the edge of the frond at first wrapped over it. Fla. VI.

VI. ADIANTUM, L. MAIDENHAIR.

Sori marginal, short, covered by a reflexed portion of the more or less altered margin of the frond, which bears the sporangia on its under side from the approximated tips of free, forking veins.

‡ EUADIANTUM.

*Fronds at least bipinnate, pinnules flabellate or cuneate.

†Fronds smooth.

1. *A. Capillus-Veneris*, L. (VENUS' HAIR). Stipes nearly black, polished, very slender; fronds ovate-lanceolate, delicate, bipinnate, the upper half or third simply pinnate; pinnules and upper pinnæ wedge-obovate or rhomboid, rather long-stalked, the upper margin rounded and more or less incised, crenated, or acutely dentato-serrate, except where the margin is recurved to form the lunulate separated indusia. Va., Ky. and Fla. to Utah and Cal. VI.

2. *A. tenerum*, Swz. Stipes 1° high, erect, glossy; fronds 1°—3° long, 9'—18' broad, deltoid, tri—quadripinnate; pinnules articulated to their petioles, falling off at maturity, cuneate, the upper edge rounded or somewhat angular, broadly often, rather deeply lobed; sori numerous, roundish or transversely oblong. Fla. VI.

3. *A. emarginatum*,* Hook. Stipes rather stout, nearly black, polished; fronds ovate or deltoïd-pyramidal, bi—tripinnate; pinnules and upper pinnæ ample, smooth or nearly so, rounded or even reniform, upper margin rounded, slightly incised; sori 2—5 transversely-linear-oblong, subcontinuous. (*A. Chilense* of check lists). Cal. and northward. IV.

††Fronds pilose with whitish hairs.

4. *A. tricholepis*, Fee. Stipes smooth, polished, deep black; fronds oval; pinnules roundish, moderately long petioled; sori few (3—7), of unequal size; indusia very velvety. (*A. pilosum* of check lists). Western Tex. V. *Very rare*.

****Fronds dichotomously forked, with numerous pinnæ springing from the upper side of the two branches.**

5. *A. pedatum*, L. Stipes 9'—15' long, dark chestnut-brown, glabrous; fronds nearly circular in outline; central pinnæ 6'—9' long, 1'—2' broad; pinnules triangular-oblong, short-stalked; sori roundish or transversely oblong. N. C. to Cal. and northward. III.

VII. PTERIS, L. BRAKE.

Sori marginal, linear, continuous, occupying a slender filiform receptacle which connects the tips of the free veins. Indusium membranous, formed of the reflexed margin of the frond.

‡ I. EUPTERIS. *Veins free, stipes tufted, indusium single.*

**Lower pinnæ linear, undivided.*

1. *P. longifolia*, L. Stipes 6'—12' long, clothed more or less below with pale brown scales; fronds 1°—2° long, 4'—9' broad, oblong-lanceolate; pinnæ sessile, 2''—5'' broad, linear, entire; veins close and fine, usually once branched; indusium yellowish-brown. Fla. VI.

*** Lower pinnæ forked or slightly pinnate below.*

2. *P. Cretica*, L. Stipes 6'—12' long, erect, stramineous or pale-brown; fronds 6'—12' long, 4'—8' broad, lateral pinnæ usually in 2—6 opposite sessile pairs, the sterile ones considerably the broadest and spinulose-serrate, the lower pairs often cleft nearly to the base, into two or three linear pinnules; veins fine, parallel, simple or once forked; indusium pale. Fla. VI.

3. *P. serrulata*, Linn. f. Stipes 6'—9' long, naked, pale or brownish; fronds 9'—18' long, 6'—9' broad, ovate, bipinnatifid, the main rachis margined with a wing which is 1''—2'' broad at the top and grows narrower downwards; pinnæ in six or more distant opposite pairs, upper ones simple, the lower ones with several long linear pinnules on each side, the edge of the barren ones spinulose-serrate; veins simple or once forked. Ala. VI.

‡ 2. PÆSIA, St. Hilare. *Veins free, rhizoma creeping, stipes sub-distant, indusium more or less double.*

4. *P. aquilina*, L. Rhizoma stout, wide-creeping, subterranean; stipes 1°—2° high, erect, stramineous or brownish; fronds 2°—4° long, 1°—3° wide, ternate, the three branches each bipinnate; upper pinnules undivided, the lower more or less pinnatifid. North America everywhere. I.

Var. caudata,* Hook. Pinnules sometimes linear and entire, or with less crowded segments than the type and the terminal lobe linear and entire. N. J., Del., Fla. to Tex.

Var. lanuginosa,* Hook. Fronds silky-pubescent or tomentose, especially on the under surface; otherwise as in the typical form. Utah, Cal. and northward.

VIII. CHEILANTHES, Swz. LIP-FERN.

Sori terminal or nearly so on the veins, at first small and roundish, afterwards more or less confluent. Indusium formed of the reflexed margin of the frond, roundish and distinct or more or less confluent. Veins free.

‡ 1. ADIANTOPSIS, Fee. *Indusia distinct, roundish, confined to the apex of a single veinlet.*

1. **C. Californica**,* Mett. Rhizoma short, creeping, chaffy; stipes densely tufted, dark brown, glossy, 4'—8' long; fronds 4' or less each way, broadly deltoid-ovate, smooth on both surfaces, quadripinnatifid; lower pinnæ largest, triangular; upper ones gradually smaller and simpler; ultimate segments lanceolate, acute, incised or serrate; indusia membranous. Cal. IV.

‡ 2. EUCHEILANTHES. *Indusia more or less confluent, usually extending over the apices of several veinlets, but not continuous all round the segment; segments mostly flat, not bead-like.*

*Segments of the frond smooth.

†Pinnæ few, not more than 5—6 pairs.

2. **C. Wrightii**,* Hook. Stipes castaneous, slightly chaffy at base, 1'—2' high; fronds 2'—3' long, ovate-oblong, tripinnatifid, segments more or less incised; indusium sub-continuous or interrupted, similar to frond in texture. Western Tex. to Ariz. V.

††Pinnæ numerous.

3. **C. microphylla**, Swz. Rhizoma creeping, short; stipes dark-brown, glossy, rusty-pubescent on the upper side, 4'—6' long; fronds 4'—6' long, ovate-lanceolate, bi—tripinnate; pinnæ lanceolate, the lowest ones usually largest and more deltoid; pinnules oblong or deltoid-ovate, deeply incised or pinnate; indusium similar in texture to frond, interrupted or sub-continuous. Fla., Ark., N. Mex. IV.

4. **C. Alabamensis**,* Kunze. Rhizoma creeping clothed with slender brown scales; stipes black with scanty ferruginous wool; fronds 2'—10' long, narrowly lanceolate, bipinnate; pinnæ close, ovate-lanceolate, the lowest ones not enlarged usually smaller than those above; pinnules mostly acute, often auriculate on the upper side at the base; indusia pale, membranous, interrupted only by the incising of the pinnules. Va., Ala., Tenn. to Tex. VI.

**Segments of the frond glandular viscid.

5. *C. viscida*,* Dav. Stipes 3'—5' long, wiry, blackish, chaffy at the base with narrow ferruginous scales; fronds 3'—5' long, $\frac{3}{4}$ '—1' broad, narrowly oblong, pinnate, with 4—6 distant pairs of nearly sessile, deltoid, bipinnatifid pinnæ; segments toothed, minutely glandular and everywhere viscid; teeth of segments recurved, forming indusia. Cal. IV.

****Frond somewhat hairy and glandular not tomentose.*

†*Fronds deltoid-ovate; stipes stramineous.*

6. *C. leucopoda*, Link. Stipes 3'—4' long, stout, chaffy at base; fronds 2'—4' long, deltoid-ovate, quadripinnate at base, gradually simpler above, everywhere glandular-puberulent; lowest pair of pinnæ unequally deltoid-ovate, upper ones oblong; pinnules short-stalked; ultimate pinnules divided into minute rounded lobules, strongly revolute when fertile. Tex. V.

††*Fronds ovate-lanceolate; stipes brownish.*

7. *C. vestita*,* Swz. Stipes tufted, 2'—4' long, wiry, chestnut-brown; fronds 4'—9' long, 1'—2' broad, tripinnatifid; pinnæ somewhat distant, lanceolate-deltoid; segments more or less thickly covered with acute hairs; sori copious; indusia formed of the ends of roundish or oblong lobes. N. Y. to Kan., and southward. III.

8. *C. Cooperæ*,* D. C. Eaton. Stipes densely tufted, fragile, hairy with straitish nearly white articulated hairs which are usually tipped with a glandular and viscid enlargement; fronds 3'—8' long, bipinnate, the pinnæ rather distant, oblong-ovate; pinnules roundish-ovate, crenate and incised, the ends of the lobules forming herbaceous indusia. Cal. IV.

‡ 3. PHYSAPTERIS. Presl. *Ultimate segments minute, bead-like; indusium usually continuous all round the margin; fronds (in our species) bi—tripinnate, the lower surface scaly or tomentose or both.*

**Fronds tomentose beneath, not scaly (except the rachises in No. 12).*

†*Upper surface naked or nearly so.*

9. *C. gracillima*,* D. C. Eaton. (LACE-FERN.) Stipes densely tufted, 2'—6' long, dark brown; fronds 1'—4' long, narrowly ovate-lanceolate, bipinnate; pinnæ numerous, crowded, pinnately divided into about nine oblong-oval pinnules at first slightly webby above, soon smooth, heavily covered beneath with pale-ferruginous matted wool; indusia yellowish-brown, formed of the continuously curved margin. Cal. and northward. IV.

†† *Upper surface decidedly pubescent.*

‡ *Stipes tomentose or smooth.*

10. **C. lanuginosa**,* Nutt. Stipes densely tufted, slender, at first clothed with woolly hairs, at length nearly smooth; fronds 2'—4' long, ovate-lanceolate, tripinnate or tripinnatifid, rarely bipinnate; pinnæ deltoid below, oblong-ovate above, the lowest distant; ultimate pinnules minute, the terminal one slightly largest, crowded; upper surface scantily tomentose, the lower densely matted with whitish-brown, woolly hairs; indusia narrow formed of the unchanged margin. Rocky Mts., Ill. and Wis. south-westward to Ariz. V.

11. **C. tomentosa**, Link. Stipes tufted, 4'—6' long, rather stout, covered with pale-brown tomentum; fronds 8'—15' long, oblong-lanceolate, everywhere but especially beneath tomentose with slender brownish-white obscurely articulated hairs, tripinnate; pinnæ and pinnules ovate-oblong: ultimate pinnules $\frac{1}{2}$ "— $\frac{3}{4}$ " long, the terminal ones twice as large; indusium pale, membranous, continuous. Va., N. C., Tenn., Mo., Tex. III.

†† *Stipe and rachises covered with very narrow pale-ferruginous scales.*

12. **C. Eatonii**,* Baker. Stipes tufted 3'—8' long, wiry, brownish; fronds 4'—8' long, oblong-lanceolate, tripinnate; lower pinnæ rather distant, upper crowded, ovate-oblong; ultimate pinnules contiguous $\frac{1}{2}$ " long, rounded, the terminal ones often twice larger; upper surface gray-tomentose, under surface with heavy matted ferruginous tomentum; indusia very narrow hidden by the tomentum. Tex., N. Mex., Col., Ariz. V.

** *Fronds covered beneath with imbricated scales, not tomentose.*

13. **C. Fendleri**,* Hook. Stipes 2'—5' long, chaffy with minute slender scales; fronds 3'—4' long, ovate-lanceolate, tripinnate; scales of primary rachis like those of stipe, those of secondary and ultimate rachises larger, broadly-ovate, entire or nearly so, usually edged with white, imbricated and overlapping the ($\frac{1}{4}$ "— $\frac{1}{3}$ " broad) sub-globose ultimate segments; these are naked above, and commonly bear at their centre a single broad scale; indusium formed of the much incurved margin. Tex. and Col. to Cal. V.

14. **C. Clevelandii**,* D. C. Eaton. Stipes scattered, 2'—6' long, dark-brown, scaly when young, but at length nearly smooth; fronds 4'—6' long, ovate-lanceolate, tripinnate, smooth above, deep fulvous-brown below from the dense covering of closely imbricated, ciliated scales growing on the ultimate segments as well

as on the rachises; segments nearly round, $\frac{1}{3}$ "-- $\frac{1}{2}$ " broad, the terminal ones larger, margin narrowly incurved, Cal. IV.

****Under surface both tomentose and scaly.*

15. *C. myriophylla*, Desv. Rhizoma very short, scaly; stipes tufted, 2'—6' high, castaneous, covered with pale-brown scales and woolly hairs intermixed; fronds 3'—8' long, oblong-lanceolate, tri—quadripinnatifid, smooth or pilose above, beneath matted-tomentose and densely clothed with pale brown narrowly ovate-lanceolate ciliated scales, those of the ultimate segments with long tortuous cilia; pinnæ deltoid-ovate, narrower upwards; ultimate segments minute, $\frac{1}{2}$ " broad, crowded, innumerable, the margin unchanged, much incurved. Ariz., Nev., Cal. IV.

16. *C. Lindheimeri*,* Hook. Rhizoma long, slender, chaffy; stipes scattered, 4'—7' high, blackish-brown, at first covered with scales and woolly hairs; fronds 3'—5' long, ovate-lanceolate, tri—quadripinnate; ultimate segments $\frac{1}{4}$ " long, crowded; upper surface white tomentose, lower surface very chaffy, those of the midribs ciliate at base, those of the segments more and more ciliate passing into entangled tomentum. Western Tex. to Ariz. V.

‡ 4. ALEURITOPTERIS, Fee. *Indusia more or less confluent; fronds farinose below.*

17. *C. argentea*, Kunze. Stipes densely tufted, 3'—6' long castaneous; fronds 3'—4' long, 2' broad, deltoid, bi—tripinnatifid; lower pinnæ much the largest cut nearly to the rachis; rachis polished like the stipe; upper surface naked, lower thickly covered with white powder; sori numerous, very small. Alaska. II.

IX. CRYPTOGRAMME, R. Br. ROCK-BRAKE.

Sporangia on the back or near the ends of the free veins, forming oblong or roundish sori, which are at length confluent and cover the back of the pinnules. Indusium continuous, formed of the membranous somewhat altered margin of the pinnule, at first reflexed along the two sides and meeting at the midrib, at length opening out flat.

1. *C. acrostichoides*,* R. Br. Stipes densely tufted, stramineous; fronds dimorphous, sterile ones on shorter stalks tri—quadripinnatifid, with toothed or incised segments; fertile ones long-stalked, less compound, with narrowly elliptical or oblong-linear pod-like segments. Lake Superior, Col. to Cal. and northward. II.

X. PELLÆA, Link. CLIFF-BRAKE.

Sori intramarginal, terminal on the veins, at first dot-like or decurrent on the veins, at length confluent laterally, forming a marginal line. Indusium commonly broad and membranous, formed of the reflexed margin of the fertile segment.

‡ I. CHEILOPLECTON, Fee, Baker. *Texture herbaceous or sub-coriaceous, veins clearly visible, indusium broad, in most of the species rolled over the sorus till maturity.*

1. *P. Breweri*,* D. C. Eaton. Stipes densely tufted, covered with narrow crisped fulvous chaff; fronds 2'—6' high, simply pinnate, the pinnæ short-stalked, 6—8 pairs, membranous, mostly 2-parted, the upper segment larger; segments obtuse, in the fertile frond narrower; indusium continuous, pale; veins repeatedly forked. Col. to Cal. and southward. IV.

2. *P. gracilis*, Hook. Stipes scattered, slender, 2'—3' long, stramineous or pale brown; fronds 2'—4' long, 1'—2' broad, ovate, bi—tripinnatifid; pinnæ lanceolate-deltoid, cut to the rachis into a few broad blunt slightly lobed pinnules; texture thinly herbaceous, flaccid; indusium broad, continuous, membranous; veins of the fertile fronds mostly only once forked. Labrador to Pa., Ill., Col. and northward. II.

‡ 2. ALLOSORUS, Baker. *Texture coriaceous, the veins not perceptible; indusium broad, conspicuous.*

*Pinnules or segments obtuse or barely acute.

†Fronds pinnate or bipinnate, never tripinnate.

3. *P. atropurpurea*, Link. Stipes tufted, 2'—6' long, dark-purple; fronds 4'—12' long, 2'—6' broad, lanceolate or ovate-lanceolate, simply pinnate or bipinnate below; pinnules and upper pinnæ 1'—2' long, $\frac{1}{4}$ ' broad or less, nearly sessile, smooth; indusium formed of the slightly altered incurved edge of the pinnules. Ariz., N. Mex., Tex. to Vt. and northward. III.

4. *P. aspera*,* Baker. Stipes slender, 2'—3' long, black with scurfy pubescence; fronds 4'—6' long, oblong-lanceolate, bipinnate; pinnæ and pinnules deltoid-lanceolate or oblong, pinnules next to main rachis often lobed; all of them rough on both surfaces with short harsh hairs. (*Cheilanthes aspera*, Hook.) Western Tex. and N. Mex. V.

††Fronds bi—quadripinnate, ultimate segments oval or cordate.

5. *P. andromedæfolia*, Fee. Stipes scattered, erect, pale brown, 2'—12' long; fronds 6'—12' long, 3'—6' broad, ovate, bi—quadripinnate usually tripinnate; pinnæ rather distant, spreading;

ultimate pinnules 2''—5'' long, oval, slightly cordate, coriaceous, the margin of the fertile ones sometimes revolute to the midrib; veins numerous, parallel. Cal. IV.

6. *P. pulchella*, Fee. Stipes densely tufted, 3'—8' long, chaffy at base, nearly black; fronds 3'—9' long, 1'—5' broad, triangular-ovate, quadripinnate below, gradually simpler above; lower pinnæ deltoid, narrowly triangular above; ultimate pinnules numerous, 1''—3'' long, oval or often cordate-ovate, stalked, coriaceous, smooth, the edges often much reflexed. Western Tex. and N. Mex. V.

***Pinnules mucronulate or decidedly acute.*

†*Fronds narrowly linear in outline, usually bipinnate.*

7. *P. ternifolia*, Link. Stipes tufted, nearly or quite black, 2'—6' long, fronds 4'—10' long, narrowly linear; pinnæ usually 9—15 pairs all but the uppermost trifoliate; segments commonly linear, slightly mucronate, coriaceous, sessile or the middle one indistinctly stalked, the edges much inflexed in fertile fronds; indusium broad. Western Tex. V.

8. *P. brachyptera*,* Baker. Stipes 2'—8' long, stout, purplish-brown; fronds 3'—8' long, narrow in outline from the ascending secondary rachises, bipinnate; pinnules, crowded, 2''—5'' long, oblong-linear, simple or trifoliate, acute or mucronulate; margins inflexed to the midrib in fertile fronds. (*P. Ornithopus*, var. *brachyptera*, D. C. E.) Cal. IV.

††*Fronds broader, lanceolate to ovate, bi-tripinnate.*

9. *P. Ornithopus*,* Hook. Stipes tufted, 3'—8' long, rather stout, dark brown; fronds very rigid 3'—12' long, 2'—3' broad, broadly deltoid-lanceolate, bi-tripinnate; primary pinnæ spreading or obliquely ascending, linear, bearing 4—16 pairs of trifoliate (varying from simple to 5—7 foliate) mucronulate, pinnules, 1½''—2'' long; margins inflexed to midrib in fertile fronds. Cal. IV.

10. *P. Wrightiana*, Hook. Rhizoma short, thick, densely chaffy; stipes crowded, purplish-brown, 4'—6' long; fronds 3'—6' long, 1'—3' broad, lanceolate to deltoid, bipinnate; pinnæ nearly sessile, spreading; pinnules coriaceous, smooth, nearly sessile, at most about six pairs; those of the sterile frond oval 3''—5'' long, with a minute cartilaginous point; of the fertile inflexed to the midrib. Tex., Col. N. Mex., Ariz. V.

11. *P. densa*,* Hook. Rhizoma rather slender, chaffy with blackish scales; stipes densely tufted, wiry, very slender, castaneous, 3'—9' long; fronds ovate or triangular-oblong, 1'—3' long, densely tripinnate; segments 3''—6'' long, linear, nearly sessile,

sharp pointed or mucronate, in the fertile fronds entire, with the margin narrowly recurved, in the rare sterile fronds sharply serrated, especially toward the apices. Cal., Ore., Wyoming. IV.

‡ 3. PLATYLOMA, J. Sm., Baker. *Texture coriaceous, the veins usually hidden, the ultimate segments broad and flat, the indusium so narrow as to be soon hidden by the fruit.*

12. P. *Bridgesii*,* Hook. Stipes 2'—6' long, tufted, castaneous; fronds 4'—6' long, 1' or more broad, simply pinnate; pinnæ 5—18 pairs, mainly opposite, nearly sessile, glaucous green, coriaceous, rounded or cordate at the base; indusium narrow, formed of the whitish margin of the pinna, soon flattened out exposing the broad sorus. Cal. IV.

13. P. *flexuosa*, Link. Rhizoma creeping, rather slender; stipes reddish passing into a more or less flexuous or zigzag rachis; fronds 6'—30' long, ovate-oblong, bi—tripinnate; secondary and tertiary rachises usually deflected and zigzag, rusty puberulent or nearly smooth; pinnæ mostly alternate; ultimate pinnales 5''—10'' long, roundish-ovate, or sub-cordate, smooth; margins at first reflexed soon flattened out. W. Tex. to Cal. V.

XI. CERATOPTERIS, Brong. FLOATING-FERN.

Sori placed on two or three veins which run down the frond longitudinally, nearly parallel with both the edge and midrib. Sporangia scattered on the receptacles, sessile, sub-globose, with a complete, partial, or obsolete ring. Indusia formed of the reflexed margins of the frond, those of opposite sides meeting at the midrib.

1. C. *thalictroides*, Brong. Stipes tufted, thick, inflated, filled with large air cells; fronds succulent in texture, the sterile ones floating in quiet water, simple or slightly divided when young, bi—tripinnate when mature; fertile ones bi—tripinnate; ultimate segments pod-like. Fla. VI.

XII. LOMARIA, Willd.

Sori in a continuous band next the midrib of the contracted pinnæ of the fertile frond, covered till mature by an elongated indusium, either formed of the recurved and altered margin of the pinna or sub-marginal and parallel to the margin. Veins of sterile frond oblique to the midrib simple or forked and free. Fronds mostly elongated, of two kinds, the sterile foliaceous, the fertile commonly much contracted.

‡ EULOMARIA.

1. **L. Spicant**, Desv. (DEER-FERN.) Rhizoma short, thick, very chaffy; fronds tufted, erect, sterile ones nearly sessile, narrowly linear-lanceolate 8'—24' long, 1'—3' wide, tapering to both ends, cut to the rachis into oblong or oblong-linear closely set segments, the lower ones gradually diminishing to minute auricles; fertile fronds sometimes three feet high, long-stalked, pinnate; pinnæ somewhat fewer and more distant, longer and much narrower than in the sterile frond; indusia distinctly intramarginal. Cal., Ore. and northward. IV.

XIII. BLECHNUM, L.

Sori linear, continuous or nearly so, parallel with the midrib and usually contiguous to it. Indusium membranous, distinct from the edge of the frond. Veins usually free.

‡ EUBLECHNUM.

1. **B. serrulatum**, Michx. Stipes 6'—12' long, stout, erect, nearly naked; fronds oblong-lanceolate, 1°—1½° long, 3'—6' broad, with 12—24 pairs of distinct linear-oblong pinnæ, the margins finely incised; texture coriaceous; veins very fine and close; fertile pinnæ narrower. Fla. VI.

XIV. WOODWARDIA, Sm. CHAIN-FERN.

Sori oblong or linear, sunk in cavities in the frond, arranged in a chain-like row parallel to the midribs of the pinnæ and pinnules and near them. Indusium sub-coriaceous, fixed by its outer margin to the fruitful veinlet and covering the cavity like a lid. Veins more or less reticulated.

‡ 1. EUWOODWARDIA. *Fronds uniform, the veins forming at least one series of areolæ between the sori and margins.*

1. **W. radicans**, Sm., *var. Americana*, Hook. Caudex stout, erect, and rising a little above the ground; stipes stout, 8'—12' long; fronds 3°—5° high, sub-coriaceous, pinnate; the pinnæ 8'—15' long, 2'—4' broad, oblique to the rachis, pinnatifid nearly to the midrib; segments spinulose-serrate; veinlets forming a single row of oblong sorus-bearing areolæ next the midvein besides a few oblique empty areolæ outside the fruiting ones thence free to the margin. Cal. IV.

‡ 2. ANCHISTEA, Presl. *Fronds uniform, the veins free between the sori and the margins.*

2. **W. Virginica**,* Sm. Stipes stout, 12'—18' high; fronds oblong-lanceolate, 12'—18' long, 6'—9' broad; pinnæ linear-lanceolate, 4'—6' long, ¾'—1' broad, cut nearly to the rachis into linear-oblong lobes. Canada to Fla. III.

‡ 3. LORINSERIA, Presl. *Fronds dimorphous, veins everywhere forming areolæ.*

3. *W. augustifolia*,* Sm. Sterile frond with slender stipes 9'—12' long, 6'—8' broad, deltoid-ovate, with numerous oblong-lanceolate sinuate pinnæ; rachis broadly winged; fertile frond with an elongated, castaneous stem; pinnæ 3'—4' long, narrowly linear. Mass. to Fla. near the coast. III.

XV. ASPLENIUM, L. SPLEENWORT.

Sori oblong or linear, oblique, separate; indusium straight or rarely curved, opening toward the midrib when single, sometimes double. Veins free in all our species.

‡ 1. EUASPLENIUM. *Veins free, simple or branched; indusium straight or slightly curved attached to the upper side of a vein.*

* *Fronds simple.*

1. *A. serratum*, L. Fronds growing in a crown from a short, stout, erect rhizoma, $1\frac{1}{2}^{\circ}$ — $2\frac{1}{2}^{\circ}$ long, 2'—4' broad, simple, spatulate or linear-oblong-lanceolate, the margin crenulate or irregularly but finely serrate, sub-coriaceous; midrib prominent, keeled and often blackish purple beneath; veins closely placed, free, once forked; sori much elongated, following the veins of the upper half of the frond from near the midrib half way to the margin; indusia single, the free edge entire. Fla. VI.

** *Fronds pinnatifid or pinnate below, tapering to a point.*

2. *A. pinnatifidum*,* Nutt. Stipes tufted, 2'—4' long; fronds 3'—6' long, 1'— $1\frac{1}{2}$ ' broad, lanceolate, pinnatifid, or pinnate below, tapering to a slender prolongation above; lobes roundish-ovate, or the lowest pair acuminate; sori numerous. Pa. to Ill., Ky. and Ala. III.

3. *A. ebenoides*,* R. R. Scott. Fronds 4'—9' long, broadly lanceolate, pinnatifid, pinnate below; apex prolonged and slender; divisions lanceolate from a broad base, the lower ones shorter; stipes black and polished, as is the lower part of the midrib especially beneath. N. Y., Pa., Ct., Ala., Ky., Ill. III. Rare.

*** *Fronds once pinnate.*

† *Pinnæ* $\frac{1}{4}$ '— $\frac{3}{4}$ ' long, mostly blunt.

‡ *Rachis* chestnut-brown or blackish.

4. *A. ebenum*, Ait. Stipes tufted, 3'—6' long, chestnut-brown, nearly naked; fronds 8'—16' long, linear-lanceolate; pinnæ 20—40, lanceolate, subfalcate, or the lower oblong, $\frac{1}{4}$ '—1' long, the dilated base auricled on the upper or both sides; sori often 10—12 on each side. Canada to Fla., Ky. and northward. III.

5. *A. parvulum*, Mart. & Gale. Fronds tufted, erect, rigid, 4'—10' long, narrowly linear-lanceolate; stipe and rachis black and shining; pinnæ numerous, oblong, obtuse, entire or crenulate, auricled on the upper side, nearly sessile; middle pinnæ longest, the lower gradually shorter and deflexed; sori short, abundant. (*A. ebeneum*, var. *minus*, Hook.) Va., S. C. and Fla. to Ark. and N. Mex. VI.

6. *A. Trichomanes*, L. Stipes densely tufted, purple-brown, shining; fronds 3'—8' long, $\frac{1}{2}$ ' or more broad, linear; pinnæ 15—30 pairs, nearly opposite, roundish-oblong or oval, the two sides unequal, obliquely wedge-truncate at the base, attached by a narrow point, the edge slightly crenate, the midvein forking and evanescent; sori 3—6 on each side of the midrib. Eastern U. S. to the Pacific coast. I.

Var. incisum, Moore. Fronds larger, often $\frac{3}{4}$ ' or more broad, pinnæ more or less deeply incised. Cal., Vt.

†*Rachis green.*

7. *A. viride*, Huds. Stipes densely tufted, 2'—4' long, naked, the lower part chestnut-brown; fronds 2'—6' long, $\frac{1}{2}$ ' broad, with 12—20 pinnæ on each side, which are ovate or rhomboidal in outline, the upper edge narrowed suddenly at the base, the lower obliquely truncate, the outer part deeply crenated; rachis naked; sori copious. Vt., Canada, and N. B. II.

8. *A. dentatum*, L. Stipes tufted, 2'—6' long, naked, ebeneous below; fertile fronds 2'—3' long, 1' broad, with 6—8 pairs of stalked, oblong-rhomboidal pinnæ, the lower side truncate with a curve, the outer edge irregularly crenate; sterile fronds smaller on shorter stipes; rachis naked; sori copious in parallel rows. Fla., S. C. VI.

††*Pinnæ only 2—5, linear-cuneate.*

9. *A. septentrionale*, Hoffm. Stipes densely tufted, 3'—6' long, slender, naked, ebeneous toward the base; fronds irregularly forking, consisting of two to five narrowly linear rather rigid segments, which are entire or more frequently cleft at the end into a few long narrow teeth; sori much elongated, placed near the margin, usually facing each other in pairs, commonly only two or three to each segment. Col., N. Mex. V.

†††*Pinnæ numerous, linear or linear-oblong, acute or acuminate.*

10. *A. angustifolium*,* Michx. Stipes 1° or more long, brownish, slightly scaly below; fronds $1\frac{1}{2}$ °—2° long, 4'—6' broad, lanceolate-oblong, flaccid; pinnæ 20—30 pairs, linear-lanceolate, acuminate, entire or crenulate, those of the fertile frond narrower;

texture thinly herbaceous; sori linear 20—40 each side of the midvein. N. Eng. to Ky. and Wis. III.

11. **A. firmum**, Kunze. Stipes 4'—8' long, erect, grayish, naked; fronds 6'—12' long, 3'—4' broad; pinnæ 12—20 pairs, oblong-lanceolate, the point bluntish, the margin inciso-crenate, the upper one narrowed suddenly at the base, the lower one obliquely truncate; sori short, falling short of both midvein and margin. Fla. VI.

****Fronds bi—tripinnatifid.*

†*Texture somewhat coriaceous.*

12. **A. Ruta-muraria**, L. Stipes tufted, 2'—4' long, naked; fronds ovate-deltoid, 1'—2' long, bi—tripinnate below, simply pinnate above; the divisions rhombic-wedge-shaped, toothed or incised at the apex; veins flabellate; sori few, elongated, soon confluent. Vt. to Mich. and Ky. III.

13. **A. montanum**,* Willd. Stipes tufted, 2'—3' long, naked; fronds 2'—5' long, ovate-lanceolate, pinnate; pinnæ 3—7 parted below, incised or toothed above; veins obscure; sori short, the basal ones sometimes double. N. Y. to Ky., Ala., and Ark. III.

††*Texture thinly herbaceous or membranous.*

14. **A. Bradleyi**,* D. C. Eaton. Stipes tufted, 2'—3' long, ebeneous, as is also the lower half of the rachis; basal scales brown-black, lanceolate-acuminate; fronds 3'—7' long, oblong-lanceolate, bipinnatifid; pinnæ 8—12 pairs, short-stalked or sessile, ovate-oblong, the lowest not reduced, the largest pinnatifid with oblong lobes toothed at the tip; sori short near the midvein. N. Y., E. Tenn., Ky., and Ark. III.

15. **A. myriophyllum**, Presl. Stipes tufted, 2'—6' long; fronds 3'—10' high, delicately membranous, lanceolate, narrowed below bi—tripinnate; ultimate segments obovate-oblong, entire or 2—3 lobed; veins single in each segment, bearing below the middle a solitary oblong sorus. Fla. VI.

16. **A. cicutarium**, Swz. Stipes tufted, 4'—8' long, greenish, naked; fronds 6'—15' long, 4'—6' broad, with 10—15 horizontal pinnæ on each side, the lower ones 2'—3' long, 1' broad, cut down to the rachis into linear or oblong segments, which are once or twice cleft at the apex; rachis compressed and often winged; sori principally in two rows. Fla. VI.

‡ 2. **ATHYRIUM**, Roth. *Veins free; sori more or less curved, sometimes horseshoe-shaped, often crossing to the outer or lower side of the fruiting veinlet.*

17. **A. thelypteroides**, Michx. Stipes long, erect, stramineous; fronds 1° — 2° long, 6'—12' broad, bipinnatifid; pinnæ linear-lanceolate; segments crowded, oblong, minutely toothed; sori 5—6 pairs to each segment, slightly curved, the lower ones often double. N. Eng. to Ky. and Ill. III.

18. **A. filix-fœmina**, Bernh. (LADY-FERN). Stipes tufted, 6'—12' long, stramineous or brownish; fronds delicate, $1\frac{1}{2}^{\circ}$ — 3° long, broadly oblong-ovate, bipinnate; pinnæ 4'—8' long, lanceolate; pinnules oblong-lanceolate, pointed, more or less pinnately incised or serrate, distinct or confluent on the secondary rachises by a very narrow and inconspicuous margin; sori short; indusium straight or variously curved. Small starved specimens growing in mountainous places form the *var. exile*, D. C. Eaton, often fruiting when 3'—6' high. Eastern U. S., Cal., Nev., Utah, Ariz. III.

Var. ANGUSTUM, D. C. Eaton. Fronds 1° — 3° high, rather rigid, narrow in outline, nearly bipinnate; pinnæ obliquely ascending or curved upward, narrowly lanceolate; segments crowded, crenate, or serrate; sori usually abundant, straight or curved. (*Var. Michauxii*, Mett). N. Eng. to Ind., Utah, Cal. III.

Var. LATIFOLIUM, Hook. Fronds 2° — 3° high, oblong-lanceolate, nearly bipinnate; pinnæ 3'—4' long, oblong-linear, with a narrowly winged secondary rachis; pinnules broadly ovate and foliaceous, simply or doubly serrate; sori nearer the midvein than the margin; indusia straight or curved, the basal ones often horse-shoe-shaped. Ore., Pa. III.

Var. CYCLOSORUM, Rupr. Fronds very large, often 5° high, and 18'—20' broad, bipinnate—tripinnatifid; pinnules often 1' long, oblong-lanceolate, pinnatifidly incised, or nearly again pinnate; sori roundish; indusium very short. Vt., Ore., and northward. III.

XVI. SCOLOPENDRIUM, Sm. HART'S-TONGUE.

Sori linear elongated, almost at right angles to the midvein, contiguous by twos, one on the upper side of one veinlet, and the next on the lower side the next superior veinlet, thus appearing to have a double indusium opening along the middle.

1. **S. vulgare**, Sm. Stipes 2'—6' long, fibrillose below; fronds oblong-lanceolate from an auricled-heart-shaped base, entire or undulate, 7'—18' long, 1'—2' wide, bright green. Central N. Y., Canada and Tenn. Rare and local. II.

XVII. CAMPTOSORUS, Link. WALKING-LEAF.

Sori oblong or linear, irregularly scattered on either side of the reticulated veins of the simple frond, those next the midrib single,

the outer ones inclined to approximate in pairs, or to become confluent at their ends, thus forming crooked lines.

1. *C. rhizophyllus*,* Link. Fronds evergreen, tufted, spreading or procumbent, 4'—9' long, lanceolate from an auricled, heart-shaped or often hastate base, tapering above into a slender prolongation which often roots at the apex. N. Eng. to Wis. and southward. III.

XVIII. PHEGOPTERIS, Fee. BEECH-FERN.

Sori small, round, naked, borne on the back of the veins below the apex. Stipe continuous with the rhizoma. Veins free in our species.

**Fronds triangular, bipinnatifid; pinnæ sessile, adnate to a winged rachis.*

1. *P. polypodioides*, Fee. Stipes 6'—9' long; fronds 4'—9' long, 4'—6' broad, hairy on the veins especially beneath; pinnæ linear-lanceolate, the lowest pair deflexed, and standing forward; segments oblong, obtuse, entire, the basal ones decurrent and adnate to the main rachis; sori near the margin. N. Eng. to Va. and westward. II.

2. *P. hexagonoptera*,* Fee. Stipes 8'—18' long, stramineous, naked; fronds 7'—12' long, nearly as broad, slightly pubescent, and often finely glandular beneath; upper pinnæ oblong, obtuse, toothed or entire, the very large lowest pinnæ elongated and pinnately lobed; sori near the margin or some between the sinus and the midrib. Canada to Ill., Ky., Miss. and Fla. III.

***Fronds oblong-lanceolate, tripinnatifid; rachis wingless.*

3. *P. alpestris*, Mett. Rhizoma short, thick, erect or oblique; stipes 4'—10' long, with a few brown spreading scales near the base; fronds 1°—2° long, pinnæ deltoid-lanceolate, the lower ones distant and decreasing moderately; pinnules oblong-lanceolate, incised and toothed; sori small, rounded, sub-marginal. Cal. and northward. IV.

****Fronds ternate, the three divisions petioled; rachis wingless.*

4. *P. Dryopteris*, Fee. (OAK-FERN). Rhizoma slender, creeping; fronds broadly triangular. 4'—8' wide; the three primary divisions 1—2 pinnate; segments oblong obtuse, entire or toothed; sori near the margin. Northeastern U. S. to Ore. II.

5. *P. calcarea*, Fee. Stipes 6'—10' long, stramineous when dry, glandular; fronds 6'—8' long, 5'—7' wide, deltoid-ovate in outline, bipinnate, lowest pair of pinnæ far the largest, pinnatifid

or again pinnate; upper pinnæ smaller, pinnatifid, lobed, or entire; sori copious forming submarginal rows around the segments. Minn. II.

XIX. **ASPIDIUM**, Swz. SHIELD-FERN, WOOD-FERN.

Sori round borne on the back or rarely at the apex of the veins. Indusium flat or flattish, orbicular and peltate at the centre, or cordato-reniform and fixed either centrally or at the sinus. Stipe continuous with the rhizoma.

‡ I. **NEPHRODIUM**, Rich. (**DRYOPTERIS**, Adanson). *Indusium cordato-reniform or orbicular with a narrow sinus.*

* *Texture thin membranous, veins simple or once forked, fronds bipinnatifid.*

† *Lowest pinnæ gradually reduced to mere lobes.*

1. **A. Noveboracense**,* Swz. Rhizoma slender, creeping; fronds 1°—2° long, 4'—6' broad, lanceolate, tapering both ways from the middle; pinnæ lanceolate, the lowest two or more pairs gradually shorter and deflexed, those of the barren frond broader; segments flat, oblong, basal ones often enlarged; veins simple or forked in basal lobes; sori distinct, near the margin; indusium minute, the margin glanduliferous. N. C., Ky., and Northern U. S. III.

2. **A. conterminum**, Willd., *var.* **strigosum**, Eaton. Rhizoma stout, erect, often extending a foot above ground, bearing a crown of fronds; stipes very short, narrowly wing-margined at the base; fronds 1°—4° long, lanceolate in outline, caudate-acuminate, much narrowed at the base, somewhat rigid, pinnate; pinnæ sessile, narrowly lanceolate from a broader base, acuminate, deeply pinnatifid into oblong obliquely sub-falcate obtuse segments, under surface copiously dotted with resinous globules; veins free, simple; sori near the margin; indusium reniform, minute, glandular, somewhat pilose, evanescent. Fla. 1880. VI.

3. **A. Nevadense**,* D. C. Eaton. Rhizoma creeping, densely covered with the persistent bases of former stalks; fronds in a crown, 1½°—3° high, lanceolate; pinnæ linear-lanceolate from a broad base, deeply pinnatifid, the lower pairs distant and gradually reduced to mere auricles; segments crowded, oblong, slightly hairy on the veins beneath, and sprinkled with minute resinous particles; veins about seven pairs to a lobe; sori close to the margin; indusium minute furnished with a few dark colored marginal glands and bearing several straight jointed hairs on the upper surface. Cal. IV.

4. **A. Oreopteris**, Swz. Rhizoma short, erect or decumbent, scaly; stipes short, tufted, scaly below; fronds $1\frac{1}{2}^{\circ}$ — 2° long, firm membranous, broadly lanceolate, gradually tapering and attenuated below, glandular; pinnæ $2'$ — $3'$ long, sessile from a broad base, lanceolate-acuminate, deeply pinnatifid, gradually shorter to the lowest which are more distant, deltoid and less than $1'$ long; segments flat, nearly entire, oblong; sori quite marginal; indusia delicate membranous, more or less toothed at the margin. Cal.? Unalaska. IV.

†† *Lower pinnæ little smaller than those above.*

5. **A. Thelypteris**, Swz. (MARSH-FERN). Rhizoma slender; fronds 1° — 2° long, $4'$ — $6'$ broad, lanceolate, pinnæ mostly horizontal, linear-lanceolate; segments oblong, entire, obtuse or appearing acute in fruit from the strongly revolute margins; veins mostly forked, bearing the sori near their middle; indusium minute, smooth and naked. Northern U. S. to Fla. III.

6. **A. patens**, Swz. Rhizoma rather stout bearing several fronds at the growing end; fronds 2° — 3° long, $4'$ — $10'$ broad, ovate-oblong, softly pubescent beneath; pinnæ closely placed, linear-acuminate, lowest pair somewhat deflexed, all cut three-fourths of the way to the midrib; segments numerous, acutish, basal ones longest; veinlets evident, lowest ones of adjoining segments often uniting; sori near the margin, indusia very pubescent. Fla., S. C., Tex., Cal. VI.

** *Texture firmer or sub-coriaceous, veins forking freely.*

† *Fronds pinnate; pinnæ cut into spreading triangular lobes; sori confluent.*

7. **A. unitum**, R. Br., *var. glabrum*, Mett. Stipes 1° — $1\frac{1}{2}^{\circ}$ long, brownish, naked; fronds $1\frac{1}{2}^{\circ}$ or more long, $5'$ — $8'$ broad; pinnæ narrow cut from one-third to half-way down into sharp pointed lobes; lower pinnæ not reduced; veins pinnate in the broad lobes with 6—8 veinlets on each side, the lower ones of contiguous groups united; sori near the ends of the veins principally in the lobes. Fla. VI.

†† *Fronds bipinnatifid or bipinnate; indusia rather large; segments not spinulose.*

‡ *Fronds small, narrowly lanceolate.*

8. **A. fragrans**, Swz. Fronds $4'$ — $12'$ high, glandular and aromatic; pinnæ linear-oblong, pinnately parted: segments toothed or nearly entire, nearly covered beneath with the very large thin imbricated indusia, which are orbicular with a narrow sinus, the margin ragged and sparingly glanduliferous. N. New England to Wis. and northward. II.

‡‡ *Fronds larger, mostly 2°—4° high.*

A. *Fronds bipinnatifid or nearly twice pinnate; indusia large thinnish and flat.*

9. A. *Floridanum*,* D. C. Eaton. Stipes 6'—10' long, sparingly clothed with ovate scales; fronds 18'—20' long, 5'—8' broad, lanceolate; fertile pinnæ confined to the upper half of the frond, narrowly lanceolate, cut down to the narrowly winged secondary rachises into oblong, distinct pinnules; the sterile pinnæ broader, shorter and sub-deltoid below, less deeply cut. (*A. cristatum*, var. *Floridanum*, Hook. Fla. to La. VI.

10. A. *cristatum*, Swz. Fronds linear-oblong or lanceolate in outline, 1°—2° long; pinnæ short, 2'—3' long, triangular-oblong or the lowest nearly triangular, deeply pinnatifid; segments, 6—10 pairs, finely serrate or cut-toothed; sori as near the midvein as the margin; indusium smooth, naked. Northern U. S. III.

Var. *Clintonianum*,* D. C. Eaton. Fronds much larger, 2½°—4° long; pinnæ oblong-lanceolate, broadest at base, 4'—6' long, 1'—2' broad, deeply pinnatifid; segments 8—16 pairs, crowded or distant, linear-oblong, obscurely serrate; veins pinnately forking bearing the sori near the midvein. N. Eng., N. Y. and westward. III.

11. A. *Goldianum*,* Hook. Fronds broadly ovate, 2°—4° long; pinnæ 6'—9' long, broadest in the middle, pinnately parted; the segments, about 20 pairs, oblong-linear, sub-falcate, serrate with appressed teeth; veins bearing the sori very near the midvein; indusia very large, orbicular with a narrow sinus. N. Eng. to Ky. and northward. III.

B. *Fronds mostly bipinnate; indusia convex, without marginal glands.*

12. A. *felix-mas*, Swz. (MALE-FERN). Rhizoma short, stout; fronds in a crown, 1°—3° high, broadly oblong-lanceolate, slightly narrowed toward the base, bipinnatifid or bipinnate; pinnules oblong, smooth, polished beneath, the larger ones pinnately incised; sori large near the midvein commonly on the lower half or two-thirds of the segment; indusia firm, smooth; rachis more or less chaffy. Canada, L. Superior to Col., Ore. and northward. II.

13. A. *marginale*,* Swz. Fronds smooth, nearly coriaceous in texture, 6'—2° long, ovate-oblong; pinnæ lanceolate, broadest just above the base; pinnules oblong or oblong-falcate, entire or crenately toothed; sori close to the margin. Northern U. S. III.

††† *Fronds bipinnate or tripinnatifid; segments spinulose-toothed.*

14. **A. rigidum**, Swz., *var. argutum*, D. C. Eaton. Rhizoma short, stout; fronds in a crown on chaffy stalks, half-evergreen, smooth above, paler and more or less glandular beneath, 1°—3° high, ovate-lanceolate or triangular-lanceolate, bipinnate; pinnæ broadly oblong-lanceolate, the lowest ones broadest scarcely shorter than the middle ones; pinnules oblong, incised or doubly serrate with spinulose teeth; indusia firm, convex, the edge bearing short-stalked glands. (*A. argutum*, Kf.) Cal., Ore. IV.

15. **A. spinulosum**, Swz. Stipes with a few, pale-brown, deciduous scales; fronds ovate-lanceolate, bipinnate, the pinnæ oblique to the rachis, elongated triangular, the lower pairs broadly triangular; pinnules oblique to the midrib, connected by a very narrow wing, oblong, incised or pinnatifid with lobes spinulose toothed; indusia smooth without marginal glands. N. Y. and N. Eng. II.

Var. dilatatum, Horneman. Scales of the stipes large, brown with a darker centre; fronds broadly ovate or triangular-ovate, oftenest tripinnate; pinnules lance-oblong the lowest often much elongated; indusium smooth and naked. N. Eng. to Ore. and northward. II.

Var. intermedium, D. C. Eaton. Scales of the stipes few, brown with a darker centre; fronds oblong-ovate, bi—tripinnate; pinnæ spreading oblong-lanceolate, the lowest unequally triangular-ovate; pinnules crowded, pinnately divided; margin of indusium denticulate and beset with stalked glands. Northern U. S. II.

16. **A. Boottii**, Tuckerman. Scales of the stipes pale brown; fronds elongated oblong or elongated lanceolate in outline; pinnules broadly oblong, very obtuse, the lower pinnatifid, the upper and smaller merely serrate; indusia minutely glandular. (*A. spinulosum*, *var. Boottii*, Gray.) N. Eng., N. Y. and northward. II.

‡ 2. POLYSTICHUM, Roth. *Indusium orbicular and entire, peltate, fixed by the depressed centre; pinnæ and pinnules usually auricled on the upper side at base, mucronately serrate; veins free.*

* *Fronds simply pinnate.*

† *Fronds long-stalked, lanceolate.*

17. **A. acrostichoides**,* Swz. (CHRISTMAS-FERN). Stipes 6'—8' long, densely clothed below with pale brown lanceolate scales; fronds ½°—2° high; 3'—5' broad; pinnæ linear-lanceolate somewhat falcate, half-halberd shaped at the base, serrulate with appressed bristly teeth; the fertile ones contracted and smaller, bear-

ing contiguous sori near the middle, soon covering the entire surface. A form with cut-lobed, often strongly falcate pinnæ, set obliquely to the rachis, and with the tips of nearly all bearing sori, is the *var. incisum*, Gray. N. Eng. to Fla., Miss. and northward. III.

18. **A. munitum**,* Kf. Stipes 4'—12' long, chaffy like the rachis with brown scales; fronds growing in a crown, 1°—4° long, tapering slightly toward the base; pinnæ numerous, linear-acuminate, 3'—4' long, very sharply and often doubly serrate, with appressed needle-like points; sori numerous forming a single row each side of the midrib half-way to the margin. Cal. and northward. IV.

Var. NUDATUM, D. C. Eaton. Fronds smaller, the scales almost entirely lacking; pinnæ few, rather remote, short and broad, the teeth closely appressed; sori scanty on the ends of the uppermost pinnæ. Cal. IV.

Var. IMBRICANS, D. C. Eaton. Fronds small not narrowed at the base; pinnæ crowded, lanceolate-oblong, pale, ascending and imbricated; sori nearer the margin than the midvein; stipes with brown scales at the base, otherwise almost naked. Cal. IV.

†† *Fronds scarcely stalked, linear-lanceolate.*

19. **A. Lonchitis**, Swz. Fronds 9'—20', rigid; pinnæ 1' or more long, broadly lanceolate-falcate or the lowest triangular, strongly auricled on the upper side, the lower obliquely truncate, densely spinulose-toothed; sori contiguous and near the margin. Canada and Wis. to Utah, and northward. II.

** *Fronds bipinnate or nearly so.*

20. **A. mohrioides**, Bory. Stipes tufted, 2'—6' long, more or less densely clothed with lanceolate dark-brown scales; fronds 6'—12' long, 2'—3' broad, with numerous dense, often imbricated, lanceolate pinnæ, which are cut below into slightly toothed oblong-rhomboidal pinnules; teeth blunt or mucronate; texture coriaceous; both surfaces naked; rachis stout, compressed, scaly; veins close, immersed; sori copious. Cal. IV.

21. **A. aculeatum**, Swz. Rhizoma stout, erect; stipes variable in length, very chaffy with large and small scales intermixed as in the rachis; fronds 1°—2° long, growing in a crown, oblong-lanceolate, pinnate; pinnæ closely placed, lanceolate from a broad base, mostly curved upwards, incisely pinnatifid or again pinnate; segments or pinnules of variable shape, oval-rhomboidal, or unequally triangular-ovate and auriculate on the upper side of the slightly stalked base, the teeth aculeate in various degrees; under

surface more or less chaffy-fibrillose; sori in two rows on the segments nearer the midvein than the edge. Cal. IV.

Var. Californicum, D. C. Eaton. Fronds elongated, narrow, tapering slightly at the base; pinnæ but slightly incised above the middle, more and more deeply cleft toward the rachis, the lower superior segment largest, but scarcely distinct as a pinnule, and not at all auricled. (*A. Californicum*, D. C. E.) Cal. IV.

Var. angulare, D. C. Eaton. Fronds oblong-lanceolate, scarcely or not at all narrowed at the base, truly bipinnate; pinnules distinctly short-stalked, mostly auricled and slightly incised; the basal one largest and again pinnatifid; under surface chaffy-fibrillose. Cal. IV.

Var. Braunii, Koch. Fronds oblong-lanceolate; pinnæ numerous, oblong-lanceolate, the lower gradually reduced in size and obtuse; pinnules ovate or oblong, truncate and almost rectangular at the base, sharply toothed, beset with long soft hairs as well as chaffy ones. Me. to N. Y. and northward. II.

‡ 3. CYRTOMIUM, Presl. *Indusium as in ‡ 2; fronds simply pinnate with broad pinnæ; veinlets usually uniting slightly near the margin.*

22. *A. juglandifolium*, Kunze. Stipes tufted, clothed below with large scales; fronds 6'—2° long, coriaceous; pinnæ 2—12 pairs, short-stalked, ovate-oblong or broadly lanceolate, the terminal one distinct, and in small fronds the largest, appressed-serulate, smooth on both surfaces; veins pinnated, the veinlets few, free or uniting near the margin; sori scattered in several irregular rows. Western Tex. V.

XX. NEPHROLEPIS, Schott.

Sori round, arising from the apex of the upper branch of a vein, usually near the margin. Indusium reniform or roundish. Veins all free, the fronds simply pinnate, the pinnæ articulated at the base, and bearing white cretaceous dots on the upper surface.

I. *N. exaltata*, Schott. Stipes tufted, 4'—6' long, naked or slightly scaly; fronds 1°—6° long, 3'—6' broad; pinnæ close, lanceolate, the edge entire or slightly crenate, the upper side auricled at the base, the lower rounded; rachis nearly naked; sori submarginal; indusium firm, distinctly reniform. Fla. VI.

XXI. CYSTOPTERIS, Bernh. BLADDER-FERN.

Sori roundish, borne on the back of the veins. Indusium delicate, hood-like, or arched, attached by a broad base on the inner

side partly under the sorus, early opening, free at the other side, and thrown back or withering away. Veins free.

**Fronds ovate-lanceolate, bi—tripinnate.*

1. *C. bulbifera*,* Bernh. Stipes 4'—6' long; fronds lanceolate elongated, 1°--2° long; bi—tripinnatifid, pinnæ lanceolate-oblong; pinnules crowded, toothed or pinnatifid; rachis wingless often bearing bulblets underneath; indusium short truncate on the free side. N. Eng. to Va. and N. C. III.

2. *C. fragilis*, Bernh. Fronds oblong-lanceolate, 4'—8' long, 1'—2½' broad, bi—tripinnate; pinnæ and pinnules lanceolate or ovate in outline, decurrent along the margined or winged rachis; indusium tapering or acute at the free end. Narrower, less divided, specimens, barely bipinnate with obtuse and bluntly toothed pinnules form the *var. dentata*, Hook. Like many other so-called varieties it passes insensibly into the typical form. N. Eng. to Cal. and northward. II.

***Fronds deltoid-ovate, tri—quadripinnate.*

3. *C. montana*, Bernh. Rhizoma long, slender, creeping; stipes 6'—9' long, slender; fronds about 6' each way; lowest pinnæ deltoid-lanceolate, much larger than those above, their inferior pinnules 1'—1½' long; segments cut to the rachis into oblong lobes, deeply and sharply toothed; sori numerous. Col., L. Superior and northward. II.

XXII. ONOCLEA, L.

Sori round, borne on the back of the veins of the contracted fertile frond, and quite concealed by their revolute margins. Indusium very thin membranous, hemispherical or hood-like fixed at the inferior side of the sorus. Fronds conspicuously dimorphous.

‡ 1. EUONOCLEA. *Veins of sterile frond copiously anastomosing.*

1. *O. sensibilis*, L. (SENSITIVE-FERN.) Fertile fronds bipinnate, much contracted; pinnules short, usually rolled up and converted into berry-shaped closed involucre, and forming a one sided panicle; sterile fronds broadly triangular, deeply pinnatifid into lanceolate-oblong pinnæ, which are entire, undulate, or the lowest pair sinuate pinnatifid; veins copiously anastomosing. In *var. obtusilobata*, Torr., the sterile fronds are again pinnatifid, more or less contracted and revolute, and bear a few sori. N. Eng. to Fla. and Kan. III.

‡ 2. STRUTHIOPTERIS, Willd. *Veins all free.*

2. **O. Struthiopteris**, Hoffm. (OSTRICH-FERN.) Fertile fronds 1° — $1\frac{1}{2}^{\circ}$ long, simply pinnate with necklace-shaped pinnæ formed of the strongly revolute margins; sterile frond, 2s—6s long, growing in a crown, broadly lanceolate, bipinnatifid, the lowest pinnæ gradually much shorter; veins pinnate, free, and simple; sori crowded and confluent. Sterile fronds sometimes partially contracted and bearing sori analogous to *var. obtusilobata* above. (*Struthiopteris Germanica*, Willd.) N. Eng. to Ill. II.

XXIII. WOODSIA, R. Br.

Sori round, borne on the back of simply-forked free veins. Indusium inferior, thin and often evanescent, either small and open, or early bursting at the top into irregular pieces or lobes.

‡ 1. EUWOODSIA. *Indusium minute or evanescent, open and flat from an early stage, concealed under the sorus, its margin cleft into slender hairs or cilia.*

**Stipes obscurely jointed near the base; cilia of the indusium long, inflexed over the sporangia.*

†*Fronds thickly clothed underneath with rusty bristle-like chaff.*

1. **W. Ilvensis**, R. Br. Fronds broadly lanceolate, smoothish above, pinnate; pinnæ crowded, sessile, pinnately-parted, the crowded segments oblong, obscurely crenate; sori near the margin somewhat confluent when old. Va. to Ky. westward and northward. II.

††*Fronds glabrous or nearly so.*

2. **W. hyperborea**, R. Br. Stipes and rachis sometimes slightly hairy; fronds linear-lanceolate, pinnate; pinnæ cordato-ovate, pinnatifid with few (5—7) broadly obovate entire lobes. Vt., N. Y., and northwestward. II.

3. **W. glabella**, R. Br. Smooth and naked throughout; fronds linear, tapering slightly below, 2'—5' high, pinnate; pinnæ deltoid or ovate, the lower rather remote, cut into 3—7 rounded or sub-cuneate entire lobes. Vt., N. Y. and northward. II.

***Stipes not jointed; cilia of the indusium very short, hidden by the sporangia.*

4. **W. scopulina**,* D. C. Eaton. Rhizoma short, creeping very chaffy; stipes 2'—4' long, puberulent like the rachis and under surface of the frond with minute flattened hairs and stalked glands; fronds lanceolate, 4'—8' long, pinnate; pinnæ numerous, oblong-ovate, pinnatifid with 10—16 short ovate or oblong toothed divi-

sions; indusium very delicate, deeply cleft into laciniae which terminate in short hairs. Col., Ariz., Cal., Ore., and northward. IV.

5. **W. Oregana**,* D. C. Eaton. Stalks and fronds smooth; fertile fronds taller than the sterile ones; pinnæ triangular-oblong, pinnatifid; segments oblong or ovate, toothed or crenate; teeth often reflexed and covering the submarginal sori; indusium very minute, divided almost to the centre into a few beaded hairs. Ariz., Utah, Col., Ore. and northward. II.

‡ 2. **HYPOPELTIS**, Torr. *Indusium conspicuous, at first enclosing the sporangia, but early opening at the top, and splitting into several spreading jagged lobes.*

6. **W. obtusa**, Torr. Stipes not jointed, 3'—6' long; fronds broadly lanceolate, minutely glandular-hairy, 6'—12' high, nearly bipinnate; pinnæ rather remote, triangular-ovate or oblong, pinnately parted; segments oblong, obtuse, crenately toothed, the lower ones pinnatifid; veins forked. N. Eng. to Ky. and westward. III.

XXIV. DICKSONIA, L'Her.

Sori small, globular, marginal or intra-marginal. Sporangia borne in an elevated, globular receptacle, enclosed in a membranous, cup-shaped indusium, which is open at the top, and on the outer side partly adherent to a reflexed toothlet of the frond.

‡ **SITOLBIUM**, J. Sm.

1. **D. punctilobula**,* Kunze. Rhizoma slender, extensively creeping, naked; stipes stout, chaffless; fronds 1°—2½° long, 5'—9' broad, ovate-lanceolate and pointed, usually tripinnatifid; pinnæ lanceolate, pointed; pinnules cut into oblong and obtuse cut-toothed lobes; rachis and under surface minutely glandular and hairy; sori minute, each on a recurved toothlet, usually one at the upper margin of each lobe. Can. to Tenn. III.

XXV. TRICHOMANES, Sm. FILMY-FERN.

Sori marginal, terminating a vein more or less sunken in the frond. Sporangia sessile on the lower part of a cylindrical, filiform, often elongated receptacle. Indusia tubular or funnel-shaped, entire or two-lipped at the mouth. Fronds delicate, pellucid.

‡ **EUTRICHOMANES**.

1. **T. Petersii**,* Gray. Stipes 1''—2'' long; fronds 3''—10'' long, 1''—2'' broad, oblong-lanceolate or obovate, entire or variously pinnatifid, the younger ones with a few black hairs along the

margins; indusium solitary, terminal, funnel-shaped, the mouth expanded and slightly two-lipped, the receptacle included. Ala., Fla. VI.

2. *T. radicans*, Swz. Rhizoma wiry, tomentose; stipes ascending, 1'—3' long, naked or nearly so, usually broadly winged; fronds 2'—8' long, 1'—1½' wide, lanceolate or ovate-lanceolate, bipinnatifid; pinnæ ovate, obtuse, the upper side of the base parallel and appressed to the winged rachis, the lower side cuneate; divisions toothed or divided into linear lobes; indusia terminal on short lobes, tubular or funnel-shaped, the mouth slightly two-lipped; receptacle exerted little or very much. Ala., Tenn., Ky. VI.

XXVI. LYGODIUM, Swz. CLIMBING-FERN.

Sporangia ovoid solitary or occasionally in pairs, in the axils of large imbricated scale-like indusia, which are fixed by their broad bases to short oblique veinlets. Fronds scandent, twining, bearing stalked and variously lobed divisions in pairs. Veins mostly free.

‡ EULYGODIUM.

1. *L. palmatum*,* Swz. Stipes slender, flexile and twining; fronds 1°—3° long, the short alternate branches or petioles 2-forked, each fork bearing a round-cordate palmately 4—7 lobed pinnule; fertile pinnules above, contracted, several times forked, forming a terminal panicle; surfaces naked; texture thinly herbaceous. Mass. and N. Y. to Ky. and Fla. III.

XXVII. ANEIMIA, Swz.

Sporangia ovate, sessile, placed in two rows on the back of the very narrow branchlets of the two long-stalked paniced lower branches of a pinnately divided frond, the fertile branches in a few species entirely distinct from the sterile frond. Veins free or anastomosing.

‡ EUANEIMIA.

1. *A. adiantifolia*, Swz. Rhizoma creeping; stipes 1°—1½° long, firm, naked; fronds sparingly pubescent, the two lower branches elongated, pinnately decomposed, fertile; sterile portion deltoid-ovate, bi—tripinnate; ultimate segments obovate or cuneate, entire or lobed, striate above with numerous flabellate veins. Fla. VI.

2. *A. Mexicana*, Klotzsch. Rhizoma creeping, covered with narrow blackish chaff; stipes slender, scattered, 6'—12' long; the

two lower branches of the frond fertile, long-stalked, glandular, bipinnate with densely clustered fructification; the rest of the frond like the sterile ones, deltoid-ovate, simply pinnate; pinnæ about six pairs and a rather large terminal one, short-stalked, ovate-lanceolate, subcoriaceous, smooth and somewhat glossy; midrib distinct, veins free, oblique, parallel, closely placed, once or twice forked. Western Tex. V.

XXVIII. SCHIZÆA, Sm.

Sporangia large, ovoid, striate rayed at this apex, naked, vertically sessile in a double row along the single vein of the narrow divisions of the fertile appendages to the slender and simply linear, fan-shaped, or dichotomously many cleft fronds.

‡ EUSCHIZÆA.

1. *S. pusilla*,* Pursh. Sterile fronds linear, very slender, flattened and tortuous; fertile ones equally slender, 3'—4' high, and bearing at top the fertile appendage consisting of about five pairs of crowded pinnæ, forming a distichous spike. N. J., N. S., Newfoundland (?). III.

XXIX. OSMUNDA, L. FLOWERING-FERN.

Fertile fronds or fertile portions very much contracted, bearing short pedicelled, naked sporangia on the margins of the rachis-like divisions. Sporangia globular, large, opening by a longitudinal cleft into two halves, bearing near the apex a few parallel striæ, the rudiment of a transverse ring. Spores green.

**Fronds bipinnate, fertile at the apex.*

1. *O. regalis*, L. Stipes tufted 1°—1½°, erect, naked; fronds 2°—4° long, 1° or more broad; sterile pinnæ 6'—12' long, 2'—4' broad; pinnules oblong-oval to lance-oblong, sessile or slightly stalked; the fertile pinnules cylindrical, paniced; texture subcoriaceous; rachis and both sides naked. Canada to Fla. and Miss. III.

***Sterile fronds bipinnatifid.*

2. *O. Claytoniana*, L. Stipes tufted 1° or more long, clothed with loose woolly tomentum when young, naked when mature; fronds 1°—2° long, 8'—12' broad; pinnæ oblong-lanceolate with oblong, obtuse divisions; 2—5 pairs of central pinnæ fertile; fertile pinnules dense, cylindrical; texture herbaceous. Canada to Ky. and northward. III.

3. *O. cinnamomea*, L. (CINNAMON-FERN.) Stipes densely tufted, 1° or more long, the sterile and fertile fronds distinct;

clothed when young with ferruginous tomentum; sterile fronds smooth when mature, the pinnæ lanceolate, cut into broadly oblong, obtusé, divisions; fertile fronds contracted, bipinnate, with cinnamon-colored sporangia. In *var. frondosa*, Gray, some of the fronds are sterile below and sparsely fertile at the summit. N. E. and Wis. to Fla. III.

XXX. OPHIOGLOSSUM, L. ADDER-TONGUE.

Sporangia large, coriaceous, connate, coherent in two ranks on the edges of a simple spike. Veins anastomosing. Spores copious, sulphur-yellow.

‡ 1. EUOPHIOGLOSSUM. *Fertile spike single arising of the base of the sterile segment.*

**Sterile portion near the middle of the stalk.*

1. *O. vulgatum*, L. Rhizoma short, oblique; stalk 6'—12' high, the sterile segment ovate or elliptical-oblong 1½'—4' long, somewhat fleshy, somewhat narrowed at the base, sessile; fertile spike 1' or more long. Me. to Ky., Tenn., Tex. and Ariz. III.

***Sterile portion near the base of the stalks.*

2. *O. crótalophoroides*, Walt. Rhizoma tuberous, 3''—5'' thick; stalk 3'—6' high, the sterile segment ½'—1' long, ovate, slightly petioled, the veins somewhat indistinct; fertile spike short and thick, 3''—6'' long. (*O. bulbosum*, Michx.) Fla. to La. VI.

3. *O. nudicaule*, Linn. f. Rhizoma slightly tuberous; stalk 1'—4' high, the sterile segment ½'—1½' long, ovate or oblong, the veins indistinct; fertile spike linear-acuminate, 6'' long, the peduncle very slender. Fla., Ga. VI.

‡ 2. CHEIROGLOSSA, Presl. *Fertile spikes several, arising from the base of the sterile segment.*

4. *O. palmatum*, Plumier. Rhizoma fleshy, tuberous, covered with fine wool-like chaff; plant fleshy, 6'—2° high, the sterile segment cuneate at the base, 2—6 lobed or rarely entire, the lobes elongated and tapering; fertile spikes 1—8 or more, borne on the sides of the stipe just below the sterile segment or on its margin. Fla. VI.

XXXI. BOTRYCHIUM, Swz. GRAPE-FERN.

Rhizoma very short, erect, with clustered fleshy roots, the bud for the next year's growth usually imbedded in the base of the stipe. Sterile segment of frond pinnately or ternately divided or compound. Fertile segment 1—3 pinnate with double rows of sessile, naked sporangia. Veins free. Spores copious, sulphur-yellow.

* *Vernation wholly straight.*

1. *B. simplex*, Hitch. Plant 2'—7' high, fleshy; sterile segment stalked, very nearly approximate to the rhizoma, or even above the middle, ovate, obovate, or oblong, entire, incised, or pinnately parted into 1—3 pairs of roundish or semi-lunate lobes; fertile spike long-stalked, simple or 1—2 pinnate; spores the largest of the genus, closely covered with small points; bud smooth; apex of both sterile and fertile segments erect. (Fig. 29.) Specimens with the sterile segment composed of two or three pinnately incised divisions form the *var. compositum*, Lasch. N. Eng., N. Y. and northward, the variety in Wy. T. and Cal. II.



Fig. 29. Vernation of *B. simplex*, Hitchcock. (After Davenport.)

** *Vernation partly inclined in one or both portions.*

† *Buds smooth; sterile segments sessile or short-stalked.*

2. *B. lunaria*, Swz. (MOONWORT.) Plant 5'—8' high, fleshy; sterile segment nearly sessile, borne near the middle of the stalk, oblong, simply pinnate with 5—15 lunate or fan-shaped lobes which are crenate, incised, or entire, close and overlapping, or distant; fertile segment bi—tripinnate, paniced, about the height of the sterile. Apex only of sterile segment bent over and outside of the nearly straight fertile segment in veneration; divisions of sterile frond arranged nearly perpendicularly. (Fig. 30.) Ct., N. Y., L. Superior, Col. and British Columbia. II.



Fig. 30. Vernation of *B. lunaria*, Swz. (After Davenport.)

3. *B. boreale*, Milde. Plant 2½'—7' high, smooth, fleshy; sterile segment placed above the middle, sessile, cordate, ovate or deltoid, pinnately parted, acute; lowest segment spreading from a narrower base, ovate or cordate-ovate, acute, all entire, or here and there flabellately incised with acute lobes, or pinnately parted; secondary segments from a narrowed base, ovate, acute, serrate, the upper spreading, quickly decreasing, finally elliptical, acute; fertile segment bi—tripinnate, paniced. Apex of sterile segment bent over inside of the nearly erect fertile one in veneration; divisions of the sterile segment arranged on an angle. Unalaska. II.

4. *B. matricariæfolium*, A. Br. Plant 2'—12' high, usually fleshy; sterile segment placed above the middle, short-stalked or sessile, ovate or oblong, pinnately parted into ovate-oblong, obtuse, rounded, entire, incised, pinnatifid, or pinnately parted segments, the narrow divisions linear; fertile segment 1—3 pinnate, paniced, often very much branched; spores thickly covered with large rounded warts. Apex of both segments turned down in veneration; sterile segment clasping the fertile with its apex overlapping the whole. (Fig. 31.) N. Eng. and N. Y. II.

†† *Buds pilose; sterile segments usually long-stalked.*

5. *B. ternatum*, Swz. Frond fleshy, the common stalk very short; sterile segment broadly pentagonal or triangular, ternate; the three primary divisions also stalked, as broad as long, pinnately decomposed; ultimate divisions varying from round-reniform to triangular-lanceolate, entire or variously toothed and incised; fertile segment long-stalked, bi—quadripinnate. Apex of both segments bent down with a slight curve inward in veneration. (Fig. 32.) N. Eng., N. Y., westward to Cal. and British Columbia, and southward to Florida. III.

Var. LUNARIOIDES, Milde. Segments very small uniformly lunate; plant smaller than the typical form. S. C., Ala. III.

Var. obliquum, Milde. Larger, 6'—17' high; the fructification more compound; sterile segment with oblong or lanceolate divisions, either obtuse or oblique at the base, nearly entire, toothed or irregularly pinnatifid. N. England to Wis. and southward. III.

Var. dissectum, Milde. Divisions of the sterile segment compoundly and laciniately

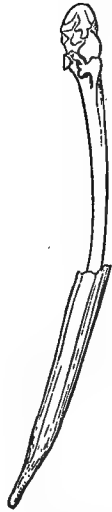


Fig. 31. Veneration of *B. matricariæfolium*, A. Br. (After Davenport.)

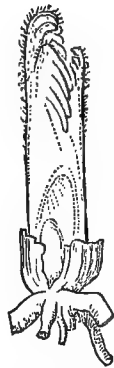


Fig. 32. Veneration of *B. ternatum*, Swz. (After Davenport.)

cut into narrow small lobes and teeth, otherwise as the last. N. Eng. to Wis. and southward. III.

****Vernation wholly inclined, in the fertile segment recurved.*

6. *B. lanceolatum*, Angs. Plant 3'—9' high, somewhat fleshy; sterile segment closely sessile at the top of a long common stalk, in the smallest forms three-lobed, in larger ones broadly triangular, twice pinnatifid, the divisions lanceolate entire or toothed, all set at an oblique angle; fertile segment short-stalked, slightly overtopping the sterile, bi—tripinnate. Bud smooth; the fertile segment recurved its whole length, the shorter sterile segment reclined upon it. (Fig. 33.) N. Eng. to Lake Superior and Ccl. III.



Fig. 33. Vernation of *B. lanceolatum*, Angs. (After Davenport.)

7. *B. Virginianum*, Swz. (RATTLE-SNAKE-FERN.) Plant from a few inches to two feet high; sterile segment sessile above the middle of the stalk, broadly triangular, thinly herbaceous, ternate; the short-stalked primary divisions once to twice pinnate, then once or twice pinnatifid; lobes oblong, cut-toothed toward the apex; fertile segment long-stalked, bi—tripinnate. Bud pilose, enclosed in a smooth upright cavity at one side of the lower part of the stalk; fertile segment recurved its whole length, the longer sterile segment reclined upon it. N. Brunswick to Fla. and westward to Cal., Ore. and W. T. III.

LIST OF THE NORTH AMERICAN PTERIDOPHYTA.

(*Excluding Orders FILICES and OPHIOGLOSSACEÆ.*)

Order Equisetaceæ.

I. EQUISETUM, L.

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| <p>1. EQUISETUM ARVENSE, L.</p> <p>2. EQUISETUM TELMATEIA,
Ehrh.</p> <p>3. EQUISETUM PRATENSE,
Ehrh.</p> <p>4. EQUISETUM SYLVATICUM, L.</p> <p>5. EQUISETUM PALUSTRE, L.</p> <p>6. EQUISETUM LIMOSUM, L.</p> <p>7. EQUISETUM LITTORALE,
Kuhl.</p> | <p>8. EQUISETUM FLUVIATILE, L.</p> <p>9. EQUISETUM LÆVIGATUM,
A. Br.</p> <p>10. EQUISETUM ROBUSTUM,
A. Br.</p> <p>11. EQUISETUM HIEMALE, L.</p> <p>12. EQUISETUM VARIEGATUM,
Schleicher.</p> <p>13. EQUISETUM SCIRPOIDES,
Michx.</p> |
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Order Lycopodiaceæ.

I. LYCOPODIUM, L., SPRING.

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| <p>1. LYCOPODIUM LUCIDULUM,
Michx.</p> <p>2. LYCOPODIUM SELAGO, L.</p> <p>3. LYCOPODIUM INUNDATUM, L.
Var. PINNATUM, Chapm.</p> <p>4. LYCOPODIUM ALOPECUROIDES, L.</p> <p>5. LYCOPODIUM ANNOTINUM, L.</p> | <p>6. LYCOPODIUM DENDROIDEUM
Michx.</p> <p>7. LYCOPODIUM CLAVATUM, L.</p> <p>8. LYCOPODIUM CAROLINIANUM, L.</p> <p>9. LYCOPODIUM COMPLANATUM, L.</p> <p>10. LYCOPODIUM CERNUUM, L.</p> <p>11. LYCOPODIUM ALPINUM, L.</p> |
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II. PSILOTUM, R. BR.

1. PSILOTUM TRIQUETRUM, Swz.

Order Selaginellaceæ.

I. SELAGINELLA, BEAUV.

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| <p>1. SELAGINELLA SELAGINOIDES, Link.</p> <p>2. SELAGINELLA RUPESTRIS,
Spring.</p> <p>3. SELAGINELLA TORTIPILA,
A. Br.</p> | <p>4. SELAGINELLA OREGANA.
D. C. Eaton.</p> <p>5. SELAGINELLA DOUGLASII,
Spring.</p> <p>6. SELAGINELLA LEPIDOPHYLLA,
Spring.</p> <p>7. SELAGINELLA APUS, Spring.</p> |
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Order Isoetaceæ.

I. ISOETES, L.

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| 1. ISOETES LACUSTRIS, L.
2. ISOETES TUCKERMANI,
A. Br.
3. ISOETES BOLANDERI,
Engelm.
4. ISOETES PYGMÆA, Engelm.
5. ISOETES RIPARIA, Engelm.
6. ISOETES ECHINOSPORA,
Durieu.
Var. BRAUNII, Engelm.
Var. MURICATA, Engelm.
Var. BOOTHII, Engelm.
7. ISOETES SACCHARATA,
Engelm. | 8. ISOETES CALIFORNICA,
Engelm.
9. ISOETES ENGELMANNI,
A. Br.
Var. GRACILIS, Engelm.
Var. VALIDA, Engelm.
10. ISOETES MELANOSPORA,
Engelm.
11. ISOETES FLACCIDA,
Shuttleworth.
Var. CHAPMANI, Engelm.
12. ISOETES BUTLERI, Engelm.
13. ISOETES MELANOPODA,
J. Gay.
14. ISOETES NUTTALLII, A. Br. |
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Order Marsiliaceæ.

I. MARSILIA, L.

- | | |
|---|---|
| 1. MARSILIA QUADRIFOLIA, L.
2. MARSILIA VESTITA, H. & G.
3. MARSILIA UNCINATA, A. Br. | 4. MARSILIA TENUIFOLIA,
Engelm.
5. MARSILIA MACROPODA,
Engelm. |
|---|---|

II. PILULARIA, L.

- I. PILULARIA AMERICANA, A. Br.

III. AZOLLA, LAM.

- I. AZOLLA CAROLINIANA, Willd.

The above list is merely preliminary, and the compiler will be pleased to receive corrections and especially notes on the distribution of species. It is hoped that an authentic account of the distribution of our native PTERIDOPHYTA may be presented to botanists at an early day. Specimens of the rarer species will be thankfully received in exchange for ferns or other plants.

GLOSSARY OF SPECIFIC NAMES.

Of Latin origin unless otherwise specified.

A.

- acrostichoides: Gr. having the appearance of *Acrostichum*.
 aculeatum: needle-pointed.
 adiantifolia; having leaves like the Maidenhair (*Adiantum*).
 Alabamensis: growing in Alabama.
 alpestris: alpine.
 Americana—um: American.
 andromedæfolia: having leaves like *Andromeda*, a genus of plants in the *Ericaceæ*
 or Heath Family.
 angulare: having angles or corners.
 angustifolia—um: narrow-leaved.
 angustum: narrow.
 aquilina: eagle like.
 argutum: sharply serrated.
 aspera: rough, harsh.
 atropurpurea: dark purple (stipes).
 aureum: golden.

B.

- Boottii: named for Dr. Francis Boott.
 boreale: northern.
 brachyptera: Gr. short-winged, alluding to the shortened pinnæ.
 Bradleyi; named for Prof. F. H. Bradley.
 Braunii: named for A. Braun.
 Breweri: named for Prof. Wm. H. Brewer of New Haven, Ct.
 Bridgesii: named for Thomas Bridges, the discoverer.
 bulbifera: bulb-bearing.
 bulbosum: having a bulbous root.

C.

- Californica—um: Californian, growing in California.
 candida: shining white.
 Capillus-Veneris: Venus' hair.
 caudata: tailed, alluding to the elongated pinnules.
 cicutarium: like *Cicuta* a genus of the *Umbelliferæ*.
 cinnamomea: cinnamon colored (fertile fronds).
 Claytoniana: in honor of John Clayton, one of our earliest botanists.
 Clevelandii: named for Daniel Cleveland of San Diego, Cal.
 Clintonianum: in honor of Hon. G. W. Clinton of Buffalo, N. Y.
 compositum: composed of many parts.
 conterminum: having a border.
 Cooperæ: named for Mrs. Elwood Cooper, Santa Barbara, Cal.
 Cretica: Cretan, growing in Crete.
 cristatum: crested.
 crotalophoroides: Gr. having the form of a rattlesnake's tail.
 cyclosorum: Gr. having curved clusters.

D.

- dealbata: covered with a white substance, powdered.
 densa: thickly clustered, alluding to the pinnules.
 dentatum: toothed.
 dissectum: finely cut.

Dryopteris: oak-fern; an old generic name.

E.

Eatoni: named for Prof. D. C. Eaton of Yale College.

ebeneum: like ebony, alluding to the stipe.

ebenoides: having the form of *Asplenium ebeneum*.

emarginatum: emarginate, notched at summit.

exaltata: raised up; alluding to the habit of growing indefinitely at the apex.

exile: small.

F.

falcatum: scythe-shaped.

Fendleri: named for August Fendler.

ferruginea: having the appearance of iron rust, alluding to the tomentum.

filiX-fœmina: female-fern, lady-fern.

filiX-mas: male-fern.

firmum: strong, stout.

flexuosa: full of windings, tortuous.

Floridanum: growing in Florida.

fragilis: brittle, easily broken.

fragrans: sweet-scented.

frondosa: leafy.

G.

glabella: smooth, without hairs.

Goldianum: in honor of Mr. Goldie.

gracilis: graceful, delicate.

gracillima: most graceful.

Grayi: named for Dr. Asa Gray.

H.

hexagonoptera: Gr. hexagon-winged.

hispida: hairy, shaggy.

Hookeri: named for Sir W. J. Hooker.

hyperborea: growing in the extreme north.

I.

Ilvensis: growing in Elba (ancient Ilva) ?

imbricans: breaking joints like shingles.

incanum: hoary.

incisum: cut-toothed.

intermedium: intermediate between the type and *var. dilatatum*.

J.

juglandifolium: having leaves like the black walnut (*Juglans*).

L.

lanceolatum: lance-shaped.

lanuginosa: woolly.

latifolium: broad-leaved.

Lemmoni: named for Prof. J. G. Lemmon, of Oakland, Cal.

leucopoda: Gr. with white feet (stalks).

Lindheimeri: named for Mr. F. Lindheimer.

lineata: like a line, very narrow.

Lonchitis: Gr. resembling a spear. An old Greek name for some kind of fern.

longifolia: long-leaved.

lunaria: moon-shaped.

lunarioides: having the form of *B. lunaria*.

M.

- marginale: having the sori near the margin.
 matricariæfolium: having the foliage of Wild Chamomile (*Matricaria*).
 Mexicana: Mexican, growing in Mexico.
 microphylla: Gr. small-leaved.
 mohrioides: having the form of *Mohria*, a genus of African ferns.
 montana—um: growing in the mountains.
 munitum: fortified, defended.
 myriophylla - um: Gr. many-leaved.

N.

- Nevadense: growing in the Sierra Nevadas.
 Newberryi: named for Dr. J. S. Newberry of Columbia College.
 nivea: snowy; alluding to the powdered under surface.
 Noveboracense: growing in New York.
 nudatum: naked.
 nudicaule: naked stemmed.

O.

- obliquum: turned sidewise.
 obtusa: blunt, alluding to the divisions of the indusia (?),
 obtusilobata: having blunt lobes.
 occidentale: western; literally, toward the setting (sun).
 Oregana: growing in Oregon.
 Oreopteris: Gr. mountain-fern.
 ornithopus: Gr. resembling bird's feet.

P.

- palmatum: palmate, hand-shaped.
 Parryi: named for Dr. C. C. Parry of Davenport, Ia.
 parvulum: very small.
 patens: open.
 pectinatum: toothed like a comb.
 pedatum: shaped like a foot.
 Petersii: named for Hon. T. M. Peters of Alabama.
 Phyllitidis: Gr. bearing leaves but no flowers.
 pinnatifidum: pinnatifid.
 plumula: a little feather.
 polypodioides: resembling a *Polypodium*.
 pulchella; pretty.
 punctilobula: with pointed lobes.
 pusilla: small.

R.

- radicans: rooting.
 regalis: royal.
 rhizophyllus: Gr. root-leaved, alluding to the occasional habit of rooting at apex of frond.
 rigidum: stiff, inflexible.
 Ruta-muraria: wall rue.

S.

- scopolina: growing in rocky places.
 Scouleri: named for its discoverer.
 sensibilis: sensitive (to frost).

septentrionale: northern; literally, toward the seven-stars (The Great Dipper.)

serratum: saw-toothed.

serrulatum: slightly saw-toothed.

simplex: simple, alluding to the sterile segments.

sinuata: curved.

spinulosum: spiny at the apex of the lobes.

strigosum: beset with sharp-pointed, appressed hairs.

Struthiopteris: Gr. ostrich-fern.

T.

tenera—um: soft, delicate.

ternatum: divided into three main branches.

ternifolia: having the leaves in threes.

thalictroides: having the form of Meadow-Rue (*Thalictrum*.)

Thelypteris: Gr. female fern; an old generic name.

thelypteroides: Gr. resembling *Thelypteris*.

tomentosa: covered with tomentum or wool.

triangularis: triangular.

tricholepis: Gr. having hair-like scales.

Trichomanes: a generic name.

U.

unitum: united, alluding to the lower veins which anastomose, or possibly to the sori which are somewhat confluent when mature.

V.

Virginianum: Virginian, growing in Virginia.

Virginica: growing in Virginia.

viride: green, alluding to the stipes.

viscida: sticky.

vulgare: common.

vulgatum: common, ordinary.

W.

Wrightiana: in honor of Charles Wright.

Wrightii: named for Charles Wright.

GLOSSARY OF TECHNICAL TERMS AND INDEX.

Derivations from the Latin unless otherwise stated. An asterisk (*) indicates an illustration at the page thus marked.

A.

Acrogen, (Gr. *akron*, the highest part, and *gennan*, to produce), a plant whose growth takes place at the summit. 48.

Acrosticheæ, 52, 61.

Acrostichum, (Gr. *akron*, the highest part, and *stichion*, a row), a tropical genus containing 172 species. Forms the type of Tribe *Acrosticheæ*. 68; also 20, 21, 30, 36*, 61.

Aculeate, (*aculeus*, diminutive of *acus*, a needle), armed with prickles.

Adder-tongue. *Vide Ophioglossum*.

Adiantum. (Gr. *a*, without, and *diainein*, to wet; alluding to the smooth foliage.) Contains 82 ferns mostly from tropical America. 78; also 20, 31, 38*, 39*, 62.

Adnate, (*ad* to, *nasci*, to be born), growing fast to some other portion of the plant.

Allosorus. *Vide Cryptogramme*.

Analogy, (Gr. *ana*, according to, *logos*, ratio, proportion), similarity in function; distinguished from *homology*, indicating similarity in structure.

Anastomose, (Gr. *anastomoun*, to open into), forming a net-work; said of veins which unite with each other.

Ancimia, (Gr. *anaimia* ? without blood), a small genus found chiefly in tropical America; contains 27 species. 97; also 35, 64.

Annulus, (Lat. a ring), the ring partly or completely surrounding the sporangium.

Anophyte, (Gr. *ano*, upward, and *phuton*, a plant), a group of plants including the mosses and liverworts. 49.

Antheridium, (plu. antheridia). (Lat. *anthera*, an anther, and Gr. *eidōs*, form), the part containing the male element. 37.

Antherozoid, (Lat. *anthera*, an anther, Gr. *zōon*, an animal, and *eidōs*, form), the male element of cryptogams. 33*.

Archegonium, (plu. archegonia), (Gr. *archa*, beginning, and *gonos*, seed), the part containing the female element. 38*.

Arcuate, (*arcus*, a bow), curved like a bow.

Areola, (plu. areolæ), (Lat. diminutive of *area*, an open place), a space enclosed by anastomosing veinlets.

Asexual Generation, the growth of a Cryptogam produced from the fertilized oosphere. 39.

Aspidiæ, 51, 63.

Aspidium, (Gr. *aspidion*, a small shield), a cosmopolitan genus containing 344 species. Forms the type of Tribe *Aspidiæ*, 88; also 18, 20, 26, 27, 33*, 42, 63.

Aspleniæ, 51, 63.

Asplenium, (Gr. *α*, without, and *splen*, spleen; alluding to shape of the indusia), a cosmopolitan genus containing 331 species. Type of *Aspleniæ*. 83; also 18, 19, 20, 21, 32, 43, 63.

Auriculate, (*auricula*, diminutive of *auris*, an ear), furnished with ear-like appendages.

B.

Beech-fern. *Vide Phegopteris*.

Bipinnate, (*bis*, twice, and *pinna*, a feather), twice pinnate.

Bipinnatifid, (*bis*, twice, *pinna*, a feather, and *findere*, to cleave), pinnate with the pinnae again pinnatifid.

Bladder-fern. *Vide Cystopteris*.

Blechnæ, 51, 62.

Blechnum, (Gr. *blechnon*, an old name for some kind of fern), a tropical and South Temperate genus containing 19 species. 82; also 32, 62.

Botrychium, (Gr. *botrus*, a bunch of grapes, alluding to the clustered sporangia), containing ten species. 99; also 18, 19, 20, 29*, 36, 40, 44, 65.

Brake or Bracken. *Vide Pteris.*

Bulblets, 43.

C.

Calamariaceæ, an extinct order of plants allied to the scouring rushes. 50.

Camptosorus, (Gr. *kamptos*, bent, and *soros*, a heap, fruit-dot), containing only two species. 86; also 20, 21, 33, 63.

Capillary, (*capillus*, a hair), hair-like.

Capsule, (*capsula*, a little box or case), a sporangium.

Carboniferous Age, number of American species of ferns, 25.

Castaneous, (*castanea*, a chestnut), chestnut colored.

Caudate, (*cauda*, a tail), furnished with a slender tip or appendage resembling a tail.

Caudex, (Lat. a stem), the upright rhizoma forming the trunk of a tree-fern.

Cellulose, (*cellula*, a little cell), the substance composing the wall of cells, containing the elements, carbon, hydrogen, and oxygen (C⁶ H¹⁰ O⁵).

Ceraceous, (*cera*, wax), having the nature of wax.

Ceratopteris, (Gr. *keras*, horn, and *ptēris*, a fern), containing a single tropical species. 81; also 21, 32, 62.

Chartaceous, (*charta*, a leaf of paper), having the texture of paper or parchment.

Cheilanthes, (Gr. *cheilos*, a lip, and *anthos*, flower; alluding to the lip-like indusia), a genus of 63 species of tropical and temperate zones. 75; also 19, 21, 31, 42, 43, 62.

Chlorophyll, (Gr. *chlōros*, green, and *phyllon*, leaf), the green grains forming the coloring matter of plants.

Christmas-fern. *Vide Aspidium.*

Ciliate, (*cilium*, an eye-lash), having on the margin a fringe of hairs resembling the fringing eyelashes.

Cinnamon-fern. *Vide Osmunda.*

Circinate, (*circinus*, a pair of compasses), rolled inward from the apex.

Classification, of the Cryptogamia, 48; of Filices, 51; of Pteridophyta, 50; of the Vegetable Kingdom, 49; Principle of, 48.

Cliff-brake. *Vide Pellæa.*

Climbing-fern. *Vide Lygodium.*

Cloak-fern. *Vide Notholæna.*

Confluent, (*con*, together, and *fluere*, to flow), blended together.

Connate, (*con*, together, and *nasci*, to be born), united together from the first.

Cordate, (*cor*, the heart), heart-shaped.

Coriaceous, (*corium*, a hide), leathery.

Cotton-fern. *Vide Notholæna.*

Crenate, (*crena*, a notch), having the margin scalloped with rounded teeth.

Crenulate, (*crenula*, diminutive of *crena*, a notch), scalloped with small rounded teeth.

Cryptogamia, (Gr. *kruptos*, hidden, *gamos*, marriage), flowerless plants.

Cryptogramme, (Gr. *kruptos*, concealed, and *gramma*, line, alluding to the concealed fructification), a boreal genus containing two species. 78; also 31, 36*, 62.

Cuneate, (*cuneus*, a wedge), wedge-shaped.

Cystopteris, (Gr. *kustis*, a bladder, and *ptēris*, a fern; named for the inflated indusia), inhabiting the temperate zones of both hemispheres; contains 5 species. 93; also 20, 21, 34, 36*, 43, 63.

D.

- Decurrent**, (*de*, down, and *currere*, to run), prolonged on the rachis.
Deer-fern. *Vide* Lomaria.
Deltoid, (Gr. *delta*, the letter D, and *eidōs*, form), triangular like the Greek delta.
Dentate, (*dens*, a tooth), toothed.
Denticulate, (*denticulus*, diminutive of *dens*, tooth), finely toothed.
Devonian Age, Number of American species of ferns, 25.
Dichotomous, (Gr. *dicha*, asunder, and *temnein*, to cut), two-forked.
Dicksonia, (Named for James Dickson, an English Botanist, 1738—1822), a genus of 44 species, nearly half of which are arborescent. 96; also 20, 35, 64.
Dicksoniæ, 51, 64.
Dimorphism, 18.
Dimorphous, (Gr. *dis*, twice, and *morphe*, shape, form), of two forms; said of ferns whose fertile fronds are unlike the sterile.
Distichous, (Gr. *dis*, twice, and *stichos*, a row), disposed in two rows.
Distribution of Ferns. Climatic, 22; Geographical, 21; Geological, 24; Local, 19, 23.
Dorsal, (*dorsum*, the back, pertaining to or situated on the back).

E.

- Ebeneous**, (*ebenus*, ebony), black like ebony.
Endospore, (Gr. *endon*, within, and *sporos*, a seed), the inner wall of the spore.
Epidermis, (Gr. *epi*, upon, and *derma*, the skin), the external covering of a plant.
Epiphytic, (Gr. *epi*, upon, and *phuton*, a plant), growing upon another plant, but not nourished by it.
Equisetaceæ, (*equus*, horse, and *seta*, bristle), the scouring rushes, or horse-tails, 50, 103.
Exospore, (Gr. *exo*, outside, and *sporos*, a seed), the external covering of the spore.

F.

- Falcate**, (*falx*, a sickle), scythe-shaped; slightly curved upward.
Farinose, (*farina*, ground corn), covered with a white or yellowish powder.
Ferruginous, (*ferrum*, iron), resembling iron rust.
Fertilization, 38.
Fibrillose, (*fibra*, a thread), formed of small fibres.
Filices: Characters of, 17, 61; Classification of, 51; Definition of, 17; Distribution of, 11, 21; Fossil, 25; Position in Vegetable Kingdom, 48.
Filiform, (*filum*, a thread, *forma*, form), thread-like.
Flabellate, (*flabellum*, a fan), fan-shaped; broad and rounded at the summit and narrow at the base.
Flaccid, (*flaccus*, flabby), soft and weak.
Floating-fern. *Vide* Ceratopteris.
Flowering-fern. *Vide* Osmunda.
Foliaceous, (*folium*, a leaf), having the nature of a leaf.
Fossil-ferns, 25.
Fronde, (*frons*, a leafy bough), that which answers to the leaf in ferns. 26, 42.
Fruiting, Time of, in ferns, 19.
Fulvous, (*fulvus*, reddish-yellow), tawny.

G.

- Genera**, 47; Number of, 52.
Generic Names, 45.
Geographical Distribution of ferns, 21.
Geological Distribution of ferns, 24.
Germination, 37, 56.

Glabrous, (*glaber*, smooth), smooth.

Glanduliferous, (*glandula*, a little kernel, and *ferre*, to bear), furnished with glands.

Glaucous, (Gr. *glaukos*, sea-green), covered with a bloom like a plum.

Globose, spherical in form or nearly so.

Gold-fern. *Vide* **Gymnogramme**.

Grammitideæ, 52, 61.

Grape-fern. *Vide* **Botrychium**.

Gymnogramme, (Gr. *gymnos*, naked, and *gramma*, line), contains 97 species mostly tropical. 70; also 26, 30, 36*, 61.

H.

Hartford-fern. *Vide* **Lygodium**.

Hart's-tongue. *Vide* **Scolopendrium**.

Hastate, (*hasta*, a spear), furnished with spreading lobes on each side at the base.

Herbaceous, (*herba*, an herb), having the texture of common herbage.

Heterosporous, (Gr. *heteros*, other, and *sporos*, a seed), producing two kinds of spores as in *Selaginella*, etc.

Histology, (Gr. *histos*, web, tissue, and *logos*, a discourse), the study of the microscopic characters of the tissues of plants and animals. 55.

Hymenophyllaceæ, 29, 42, 64.

I.

Imbricated, (*imbrex*, a hollow tile), breaking joints like slates or shingles.

Indusium, (plu. *indusia*) (*induere*, to clothe), the membranous covering of the sporangia in many species of ferns. 28.

Inferior, attached below; said of an indusium below the sporangia as in *Woodsia*.

Intramarginal, (*intra*, within, and *margo*, a border), near the margin.

Involucre, (*involvere*, to wrap up), the indusium.

Isoetaceæ, (Gr. *isoetes*, an evergreen plant), the quillworts. 50, 104.

Iso-sporous, (Gr. *isos*, equal, and *sporos*, a seed), producing spores of one kind.

L.

Lace-fern. *Vide* **Cheilanthes**.

Lacinia, (plu. *lacinix*) (Lat. the lappet of a garment), a long narrow lobe.

Lady-fern. *Vide* **Asplenium**.

Lanceolate, (*lanceola*, a little spear), lance-shaped.

Lepidodendraceæ, an extinct order of plants allied to the club mosses, 50.

Life History of a fern, 29.

Linear, (*linea*, a line), long and narrow.

Lip-fern. *Vide* **Cheilanthes**.

Lobule, (*lobulus*, diminutive of *lobus*, a lobe), a small lobe.

Lomaria, (Gr. *loma*, a fringe, and *aria*, diminutive), allied to *Blechnum* and found principally in South Temperate zone; contains 45 species. 81; also 32*, 62.

Lunate, (*luna*, the moon), crescent-shaped.

Lunulate, (*lunula*, diminutive of *luna*, the moon), smaller than lunate.

Lycopodiaceæ, (Gr. *lukos*, a wolf, and *pous*, foot), the ground-pines or club-mosses. 50, 103.

Lygodium, (Gr. *lugodes*, flexible, alluding to the scandent stems), contains 16 species widely diffused. 97; also 35, 36*, 64.

M.

Maidenhair. *Vide* **Adiantum**.

Male-fern. *Vide* **Aspidium**.

Marattiaceæ, an order of fern allies, 48, 50.

Marsiliaceæ, (named for Aloysius Marsili, an Italian botanist), the pepperworts, 50, 104.

Midvein, the middle or main vein of a frond, pinna, pinnule, or segment.

Monœcious, (Gr. *monos*, single, and *oikia*, house), bearing the male and female organs on different parts of the same plant.

Moonwort. *Vide Botrychium*.

Morphology, (Gr. *morphe*, form, shape, and *logos*, a discourse), that department of biology treating of the form of organisms, 26.

Mucronate, (*mucro*, a sharp point), having the midvein prolonged beyond the pinnule, forming a sharp point.

N.

Nephrodium *Vide Aspidium*.

Nephrolepis, (Gr. *nephros*, a kidney, and *lepis*, a scale), a tropical and sub-tropical genus containing 7 species. 93; also 21, 34, 63.

Nomenclature, 45.

Notholæna, (*nothus*, spurious, and *læna*, a cloak, alluding to the rudimentary indusia; *Nothoclæna*, has the better etymology), resembling *Cheilanthes* in habit and distribution; contains 35 species. 70; also 21, 26, 30, 36*, 43, 61.

O.

Oak-fern. *Vide Phegopteris*.

Oblong, from two to four times as long as broad.

Obovate, (*ob*, reversed, and *ovum*, an egg), inverted ovate.

Onoclea, (Gr. *onos*, a vessel, and *kleiein*, closed, alluding to the fertile fronds). Inhabiting cold temperate regions and containing 3 species. 94; also 18, 20, 27, 34, 63.

Oophore, (Gr. *oon*, an egg, and *pherein*, to carry), the same as sexual generation, q. v.

Oosphere, (Gr. *oon*, an egg), the female element of Cryptogams. 38.

Oospore, (Gr. *oon*, an egg, and *sporos*, a seed), the fertilized oosphere. 38.

Ophioglossaceæ, 29, 40, 43, 65.

Ophioglossum, (Gr. *ophis*, a serpent, and *glossa*, a tongue), containing 10 species. 99; also 21, 35, 65.

Orbicular, (*orbiculus*, diminutive of *orbis*, a circle), circular.

Orders, 48.

Osmunda, (from *Osmunder*, a Saxon name for the divinity, Thor.), a genus of 6 species mostly north temperate. 98; also 20, 29*, 35, 64.

Osmundaceæ, 29, 64.

Ostrich-fern. *Vide Onoclea*.

Ovate, (*ovum*, an egg), having the form of the longitudinal plane of an egg with the base downward.

Ovoid, (*ovum*, an egg, and Gr. *eidos*, form), having the form of an egg.

P.

Palmate, (*palma*, the hand), with the divisions spreading from the end of the stalk like the fingers of the hand.

Panicle, (*panicula*, a tuft on plants), an open cluster, consisting of more or less branching stems bearing fruit.

Papyraceous, (*papyrus*, paper reed), having the texture of paper.

Pedicel, (*pediculus*, diminutive of *pes*, foot), the stalk of a sporangium.

Pellæa, (Gr. *pellos*, dusky, alluding to the dark colored stipes), closely allied to *Cheilanthes*, in habit and distribution; contains 55 species. 79; also 19, 21, 31*, 62.

Peltate, (*pelta*, a small shield), shield-shape; said of an indusium borne on a stalk attached at its centre.

Pentagonal, (Gr. *penta*, five, and *gonia*, angle), having five sides.

Petiole, (*petiolus*, diminutive of *pes*, foot), the stalk of a pinna or pinnule.

Phegopteris, (Gr. *phegos*, a beech-tree, and *ptēris*, a fern), contains 95 species. 87; also 20, 27, 33, 63.

Pilose, (*pilus*, hair), covered with soft hairs.

Pinna, (Lat. a feather), the primary division of a compound frond.

Pinnate, (*pinna*, a feather), having the divisions of the frond arranged on the two sides of a common rachis.

Pinnatifid, (*pinna*, a feather, and *findere*, to cleave), having the sides of the frond, pinna, or pinnule, cut half way or more to the midvein.

Pinnule, (*pinnula* diminutive of *pinna*, a feather), the secondary division of a frond twice or more compound.

Polypodiaceæ, 28, 61.

Polypodiæ, 52, 61.

Polypodium, (Gr. *pōhus*, many, and *pous*, foot, alluding to the branching rhizoma), the largest, most cosmopolitan genus of ferns; containing 345 species, 68; also 21, 27, 28*, 30, 36*, 61.

Pro-embryo, the thread-like prolongation between the germinating spore and the prothallium.

Prothallium, (Gr. *pro*, previous to, and *thallos*, a young shoot), the sexual generation of a fern, 37.

Pterideæ, 51, 62.

Pteridoid, (Gr. *ptēris*, fern, and *ēidos*, form), fern-like in appearance.

Pteridophyta, (Gr. *ptēris*, fern, and *phuton*, plant), ferns and their allies; a synonym of Vascular Cryptogams. Classification of, 50; Geological Distribution of, 50; List of, 103.

Pteris, (Gr. *ptēris*, a fern, from *pteron*, wing, alluding to the prevalence of pinnate fronds), a cosmopolitan genus the type of *Pterideæ*, containing 103 species. 74; also 20, 31, 37*, 38*, 62.

Q.

Quadripinnate, (*quattuor*, four, and *pinna*, feather), four times pinnate.

Quadripinnatifid, (*quattuor*, four, *pinna*, a feather, and *findere*, to cleave), four times pinnatifid.

R.

Rachis, (Gr. the spine), the continuation of the stipe through a compound frond.

Rattlesnake-fern. *Vide Botrychium*.

Receptacle, (*recipere*, to receive), the part to which the sporangia are attached especially in the Hymenophyllaceæ.

Reniform, (*renes*, the kidneys), kidney-shaped.

Revolute, (*revolvere*, to roll back), rolled backward; said of the margin of many fronds.

Rhizoma, (Gr. *rhiza*, a root), a rootstock, or underground stem, usually creeping at or below the surface of the earth, 26.

Rhomboidal, (Gr. *rhombos*, a rhomb, and *ēidos*, form), approaching a rhomb in shape.

Rock-brake. *Vide Cryptogramme*.

Roots, 41.

S.

Scandent, (*scandere*, to climb), climbing.

Schizæa, (Gr. *schizein*, to split, alluding to the forked sterile fronds of foreign species), contains 16 species. 98; also 29*, 35*, 36*, 64.

Schizæaceæ, 29, 64.

Scolopendrium, (Gr. *skolopendra*, a centipede, alluding to the position of the sori,) contains 5 species. 86; also 18, 20, 33*, 36, 42, 63.

Segment, one of the divisions of a pinnatifid frond.

Selaginellaceæ, (diminutive of *Selago* the ancient name of a club-moss), 50, 103.

Sensitive-fern. *Vide Onoclea*.

Serrate, (*serra*, a saw), having the margin cut into teeth pointing forward.

Sessile, (*sedere*, to sit), without a stalk or petiole.

Sexual Generation, the growth of the prothallium from the spore producing the sexual organs, archegonia and antheridia, 37.

Shield-fern. *Vide Aspidium*.

Sigillariaceæ, an extinct order of plants allied to the club-mosses, 50.

Sinuate, (*sinus*, a bending), having the margin alternately bending inward and outward.

Sinus, (Lat. a bending), a recess or bay; the re-entering space between two lobes.

Sorus, (plu. sori) (Gr. *soros*, a heap or cluster), the clusters of fruit in the **POLY-PODIACEÆ**.

Spatulate, (*spatula*, a little spoon), shaped like a spatula.

Species, 46.

Specific Names, 45.

Spinulose, (*spina*, a thorn), thorny.

Spleenwort. *Vide Asplenium*.

Spore, (Gr. *sporos*, a seed), the fruit of the higher cryptogams, produced asexually, 28; Structure of, 36; Number of, 36.

Sporangium, (plu. sporangia) (Gr. *sporos*, a seed, and *aggeion*, a vessel), the case or capsule enclosing the spores, 28.

Sporophore, (Gr. *sporos*, seed, and *pherein*, to carry), the same as asexual generation, q. v.

Stellate, (*stella*, a star), star-shaped.

Stipe, (*stipes*, a stock), the stem of a frond, 26, 42.

Stoma, (plu. stomata) (Gr. a mouth), the breathing pores of plants, 43.

Stramineous, (*stramen*, straw), straw-colored.

Struthiopteris. *Vide Onoclea*.

Sub- (as a prefix), about, nearly, somewhat.

Sub-Orders, 48.

Superior, higher, applied to indusia that are attached above the sorus as in *Aspidium*.

Synonymy, 46.

T.

Ternate, (*terni*, three each), branching into three nearly equal divisions.

Thallogen, (Gr. *thallos*, a young shoot, and *gennan*, to produce), a group of cryptogams including the lichens and fungi, 48.

Thalloid, (Gr. *thallos*, a young shoot, and *eidos*, form), having the form of a thallogen.

Tissues, 41.

Tomentose, (*tomentum*, a stuffing of wool), covered with densely matted woolly hairs.

Tomentum, (Lat. a stuffing of wool), the dense matted woolly hair found on some ferns as many species of *Cheilanthes*.

Tribes, 47.

Trichomanes, (Gr. *trichomanes*, the name of some fern, from *thrix*, hair, and *mainomai* producing frenzy, alluding to some supposed property), tropical or temperate, contains 91 species. 96; also 21, 29*, 35*.

Trichomes, (Gr. *trichōma*, a growth of hair), hairs, variously modified as scales, indusia, sporangia, etc., produced from the epidermal cells, 42.

Tripinnate, (*tris*, three, and *pinna*, a feather), three times pinnate.

Tripinnatifid, (*tris*, three, *pinna*, a feather, and *findere*, to cleave), three times pinnatifid.

Truncate, (*truncare*, to cut short), cut off abruptly.

Tufted, growing in clusters.

U.

Undulate, (*undula*, a little wave), wavy-margined.

V.

Variation among species, 18.

Varieties, 47.

Vascular, (*vasculum*, diminutive of *vas*, a vessel), containing vessels as ducts, etc.

Venation, (*vena*, a vein), the veining of the frond, 27.

Vernation, (*ver*, spring), the arrangement of the leaves or fronds in the bud, 26, 43.

Vittaria, (*vitta*, a fillet or head-band), a genus of tropical ferns containing 13 species; the type of *Vittariæ*, 73; also 21, 30, 61.

Vittariæ, 61.

W.

Walking-leaf. *Vide* *Camptosorus*.

Wood-fern. *Vide* *Aspidium*.

Woodsia, (In honor of Joseph Woods, an English botanist), a genus of high temperate or boreal ferns, containing 14 species, 95.

Woodwardia, (In honor of Thomas J. Woodward, an English botanist), containing 6 species, mostly north temperate. 82; also 20, 27, 63.

