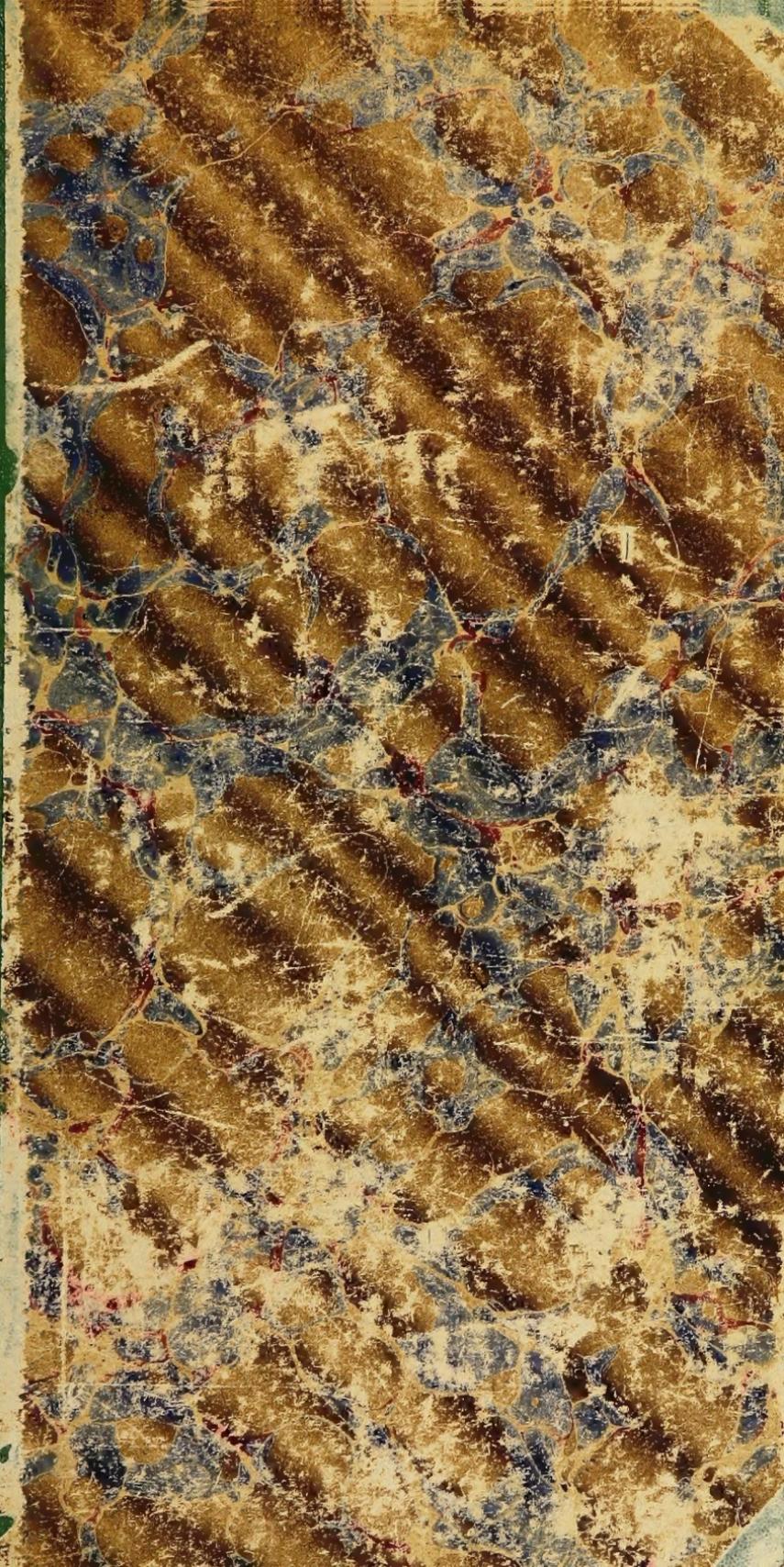


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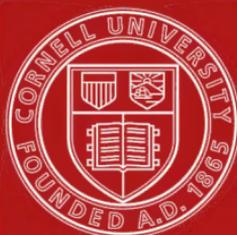
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AN INTRODUCTION

TO THE

STUDY OF LICHENS

BY

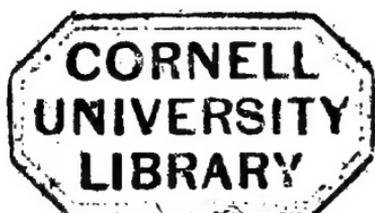
HENRY WILLEY.

WITH A SUPPLEMENT AND TEN PLATES.

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PREFACE.

My object in writing the following pages has been, first, to give a general answer, to the best of my ability, to questions which are frequently addressed to me, to which I cannot devote the time to reply to individually ; and second, to prepare the way in some measure for the study of the great writers on the subject, and especially of the late Professor Tuckerman, whose works, in the present state of our knowledge, are the best authority and guide to the American student. If these objects shall in any degree have been accomplished, my aim will have been reached.

*“ If I could put my woods in song,
And tell what 's there enjoyed,
All men would to my Garden throng,
And leave the cities void.
In my plot no tulips blow ;
Snow-loving pines and oaks instead ;
And rank the savage maples grow,
From Spring's first flush to Autumn red.
My Garden is a forest ledge,
Which older forests bound.”*

* * * * *

*“ Wings of what wind the Lichen bore,
Wafting the puny seeds of power,
Which, lodged in rock, the rock abrade? ”*

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CORRECTION.—By a typographical error in the body of the work, Chapters V and VI are numbered IV and V.

CHAPTER I.

ON THE COLLECTING AND PRESERVATION OF LICHENS.

“No! them’s mosses,” was the reply of the worthy farmer who looked suspiciously on the intruder who was whittling at his old fence, on being told that he was collecting Lichens; and he went on to expatiate on the injury the “mosses” did to the trees in his neighbor’s orchard, and to intimate that it was a waste of time for reasonable people to trouble themselves about such things. Country folk are apt to think that plants belong exclusively to the feminine domain, and that a man who goes about collecting them is not far from being *non compos*. It was of no use to argue the moss question with him, and so the intruder pocketed his knife and withdrew.

The Cladonias, Usneas, and even the Southern Tillandsia, which is a parasitic flowering plant, are commonly spoken of as “cup-moss” or “hanging-moss.” But no one who has once been instructed will confound a moss with a Lichen. The former stand higher in the grade of vegetable organisms, and have entirely different organs of fructification. { Lichens are among the most common vegetable objects, covering rocks and walls, the trunks and branches of trees, and the earth, with varied forms of gay hues. } Although their specific determination is difficult, and there are many unsolved and perplexing questions in regard to their structure, there is a charm in collecting and studying them, and a great insight to be gained into the processes of nature, in her minutest sphere of action. Unlike the flowering plants, they can be collected at all seasons of the year. They need little labor in their mounting and preservation. Many of them are objects of beauty, and there is no daily walk which will not be rewarded by fresh objects of interest to the watchful observer and student of Lichens.

Deferring for the present the question as to the definition, structure and classification of Lichens, we will assume that the reader is able to recognize a Lichen at sight, and consider how he may best collect them and mount them for his herbarium. He will have no lack of material, for they will be all around him. Whether on the seashore or on the tops of our highest mountains, they will equally

abound. He will perceive the larger and more conspicuous ones without difficulty, but it will require experience and a practiced eye to detect the minute, often almost invisible forms, which, however they may seem to differ, have yet a bond of connection with the largest and most beautiful. It is the tracing of such connections that lends its greatest attraction to the study of nature.

He or she (for ladies are by no means to be excluded from the ranks of the Lichenists, and they have been among the best students) who would collect Lichens, will need a somewhat special outfit. As a place of deposit for the plunder, the common tin vasculum may be used, or, as Lichens do not wither, a basket may be carried. I have found it more convenient than either to have a coat with very large pockets on the inside of the skirts, which are very capacious and serve also to carry the hammer and the wrapping paper, and the indispensable luncheon for an all-day tramp. As Lichens are often brittle when dry, it is well to moisten them so as to make them soft and flexible. Rock specimens should be wrapped in paper to prevent bruising by attrition, and the more delicate plants, like *Calicium*, should be well wrapped up and put into a separate pocket or the vasculum. A small sponge is useful to carry water, as dry Lichens might be broken in detaching. The crustaceous earth lichens should be taken with a good thickness of soil to keep them entire, and they will crumble less easily if the soil is moist and they are well wrapped up. A well-tempered knife with large blades is indispensable. A very good knife of this kind is made at New Britain, Conn. A poorer knife, which it is not so necessary to keep sharp, is good to separate earth lichens from the soil. The bark of trees is most easily detached in spring and early summer, and it is advantageous to carry as little timber about as possible. Small branches may be cut off entire. Lichens should not be scraped from rocks. For their collection there is needed a cold-chisel, which may be six or seven inches long, of half-inch steel, well tempered but not too hard, and should be carried in a sheath to be attached to the inside of the coat. If placed in the pocket it will soon eat its way through and be lost. The hammer may be carried in one of the large pockets. A common geological hammer will do, but I have preferred a combined hammer and hatchet, the latter being very useful in many cases where the knife is insufficient, as on large branches or very hard dry wood. The blade, however, should be

enclosed in a strong leather guard, to prevent accidents. A spool of stout linen or cotton thread will hold a large supply for tying packages, or, if something stronger is desired, twine can be obtained on spools at the stationers'. A good pocket lens is requisite. Stones are often difficult things to deal with, but a little experience will enable the collector so to direct his blows as to obtain his specimens with as little as may be of superfluous material. On stratified rocks this is not usually difficult, but the granite rocks are generally very refractory.

Pains should be taken to obtain fertile specimens. Sterile specimens of *Cladonias* and of crustaceous Lichens are of little or no value. Inexperienced persons are too apt to collect and send for determination such specimens, and the merest fragments. They had better at first confine themselves to large and perfect plants. As they acquire familiarity with Lichens they will come to perceive that these inferior things are often mere conditions of species which they already know. Still, many of the larger lichens occur without or rarely with fruit, and the collector must be satisfied with the best he can get. He should collect several specimens of each species, and note the localities, so as to be able to return to the spot where a plant has been found in case more should be desirable. The colors of Lichens are heightened by moisture, and after wet weather they become more conspicuous, and some may be more easily detected at such times. But in descriptions the colors are noted as in the dry state.

Having returned from a tramp well laden with Lichens of all kinds, the next thing is to prepare them for the Herbarium. The plants will be separated and sorted. The leafy and shrubby ones will be placed between paper under light pressure to dry and flatten. Those on bark may be reduced in thickness on the under side, and then placed under considerable pressure for several days, till they are thoroughly dry, so that they may not curl and take up room in the herbarium. If they have become curled and hard they may be placed in cold water till soft, and then put into the press. Cold water does not harm recently collected plants, though wetting those in the herbarium that have lost their vitality should be avoided, and warm or hot water is decidedly injurious at all times.

Rock lichens may, with proper pains, often be considerably reduced in thickness so as to reduce the space they occupy; but pains

should be taken to preserve a portion at least of the external contour of the thallus, so as to know whether it is uniform or effigurate. The earth specimens should be reduced in thickness while moist, and a thin solution of mucilage applied on the under side, sufficient to saturate the earth, but without coming through to the upper side. When this is dry the specimen will be hard as stone and in no danger of crumbling. The specimens should be cleaned of dirt and extraneous matter as much as possible without injury. When all these operations are completed the plants will be ready for the herbarium.

The methods of mounting for final preservation will vary with the taste of the collector, the extent of his collection, and the space at his disposal. Some prefer to place the specimens in paper wrappers; others to mount them on paper. In a small collection, and one in which it is desired to make a show of the specimens, the latter is preferable. Nice white paper should be selected, of which it will be well to have two sizes, one for the large Lichens and the other for small ones. Lichens become brittle with age, and are therefore not so likely to get broken when firmly attached to paper. The plants should be perfectly dry when mounted, as if damp they will contract in drying and curl the paper. It is well to attach them first at the centre, and when they have become dry to fasten them at the edges. As the features of the lower side are often important, two specimens of each species should be mounted, so as to exhibit both sides. Some lichens, like the Caliciums, are difficult to preserve. These may be softened by moisture and gently pressed till dry, so as somewhat to depress the stipes, and they may then be placed in envelopes, or, if space is not a consideration, in boxes. On the wrappers or on the paper on which the specimen is mounted should be a written or printed label, giving the name of the species, the time and place of collection, a note of any peculiar features, especially of the internal ones of the thallus or fruit, which may have been observed with the microscope, and a sketch of the spores and note of their dimensions. As the proper way of mentioning the name of the author of a species seems not to be always understood, it may be well to note it here. Where a writer is the author of a species which has been referred to but one genus, his name, or an abbreviation of it, follows the name of the species, thus, "*Roccella Leucophæa*, Tuckerm." But if the plant was at first referred to one genus

by its author, and has afterwards been referred to another genus, by another authority, and the latter is accepted, the name of the first authority is placed in a parenthesis and followed by that of the second, thus: "Ramalina ceruchis (Ach.) De Not." Acharius called the plant "Borrera ceruchis," while De Notaris placed it in its proper genus, Ramalina. Some authors insist that when a variety is raised to the rank of a species, the name attached should be that of him who gave the name to the variety. But the better rule appears to be that stated by Tuckerman (*Genera*, p. 179) that "the name which may happen to be given to a variety has no precedence; but may be adopted or not, if the plant be taken up as a species. The other method has at least the objection that it makes the earlier writer whose variety-name it is sought to elevate into a species-name responsible for an opinion which he has expressly disclaimed." The same rules apply to genera and their divisions. The authority for a species-name is either a published description or the distribution of the species in a published collection of exsiccati. Unpublished herbarium names are not entitled to preference over subsequently published ones, nor can names be preempted by anticipation. The collection should be occasionally overlooked to see if insects or mould have made their appearance, in which case the plants should be poisoned. But this will seldom be necessary if the collection is kept in a dry place. Handsome specimens, neat mounting, clearly written labels, and methodical arrangement, add greatly to the appearance of a collection. The genera should be placed in distinct wrappers. In short, the general rules applicable to all collections of plants will serve for Lichens also.

CHAPTER II.

THE LICHEN: ITS STRUCTURE AND ORGANS.

A Lichen is a cryptogamic plant of the order of Thallophytes, having neither stem, leaf, flower, or root. It consists of a Thallus containing green cells called Gonidia, which supports the fruit, Apothecium, containing the germinating cells, Spores, which are enclosed in cells or sacks here called Thekes. It also possesses certain minor organs, Spermogones and Pycnides. We will consider each of these parts in order.

The Thallus, in its simplest form, consists merely of elongated cells or filaments, Hyphæ, among which the Gonidia are scattered, and which lie under the surface of the bark on which the Apothecia only are visible externally. Such a Thallus is called Hypophlœoid, subcortical. It is sometimes made evident by a mere stain or discoloration of the bark within which it grows. When the Thallus becomes superficial (Ektophlœoid) it constitutes the horizontal Thallus, and is scurfy, powdery, granular, crustaceous, often lobed at the circumference, and scaly (squamulose.) The crustaceous thallus is either uniform or cracked, (rimose and areolate,) or mealy, (tartareous,) or warty, (verrucose,) or turgid. The horizontal thallus is often surrounded by a pale or dark fringe or border, the Hypothallus. The scaly thallus tends to become ascendant, and to pass into the shrubby or fruticulose state, or into the still depressed, foliaceous state, which constitutes its highest degree of development. There are all degrees of transition of these different states. All of them contain the essential features, the Hyphæ and the Gonidia, excepting a considerable number of parasitic Lichens, in which the Thallus is wanting. . But it is with the higher forms that the student can best begin his studies in the anatomy and physiology of Lichens.

For this purpose let him then take some foliaceous Lichen, a *Parmelia*, for instance, and (being supposed to be acquainted with the simple methods of manipulation, and to be possessed of a compound microscope) let him make a thin section of the Thallus and place it under a moderate magnifying power. He will see that it is composed (looking from above), (1) of a more or less thick and dense cellular (parenchymatous) cortical layer; (2) of a stratum of green cells (Gonidia); (3) of a filamentous tissue, more or less compact, (Hyphæ) in which the gonidia are imbedded; (4) of a parenchymatous inferior layer, to which are often attached fibrils, by which the plant is attached to the substrate, and which in these Lichens represent the hypothallus. All these parts are typically present in all Lichens; but sometimes the cortical parenchymatous layer is deficient and the upper surface consists of a mere epidermis. The inferior cortical layer is also sometimes absent, as in *Peltigera*. The hyphoid or medullary layer is sometimes very compact, as in the central cord of *Usnea*, but generally more or less cottony. In the shrubby lichens the gonidia are on all sides of the stem, and the

central portion is sometimes empty (fistulous.) In other lichens, as in *Collema*, this tissue is very lax, consisting of few filaments, among which the gonidia are scattered. The under side is usually of a different color from the upper, and either pale or black. It is sometimes veiny, and sometimes covered with little cup-like white or yellow depressions, *Cyphellæ*. The spermogones occur on the upper surface, or along the edges of the *Thallus*, as minute black (sometimes colored) globules, and frequently in considerable numbers. The *Pycnides* resemble them in appearance, and are similarly situated. The *Gonidia* frequently burst into mealy excrescences, *Soredia*, and the surface is often powdery, or with erect, coralloid excrescences (*Isidia*.) Many merely sterile crusts were formerly designated *Lepraria*, *Variolaria* or *Spiloma*; but these are merely sterile or degenerate conditions, not deserving a separate rank. The medullary layer frequently contains crystals of oxalate of lime; and in almost all lichens there is a starchy gelatinous substance, *Lichenine*, formed by the dissolution of the *Hyphæ* and the *Gonidia*, which in the apothecia, but not solely there, is usually colored blue, violet or red, by iodine, and which there is called the *Hymenial gelatine*. Certain *Gonidia* which occur in the nucleus of *Pyrenocarpous* Lichens are called *Hymenial Gonidia*; and certain filaments, resembling *Paraphyses*, surrounding the inner part of the ostiole of such fruits are called *ostiolary filaments* or *anaphyses*.

The Gonidia.

The *Gonidia* vary in size, form, and color. The most common kind are those of a yellowish-green color surrounded by a thick membrane. Such are those of *Ramalina*, *Parmelia*, *Lecanora*, and most of the genera. Another kind are of a bluish-green color, not possessing a thick membrane, which are called *gonimia*. These are either solitary, or grouped, or concatenate, strung like a chaplet. They occur most frequently in the *Collemacei*, but also in other genera. A third kind are of a bright green or often reddish color, connected together in a chain, and occur most frequently in the *Graphidei*. In a few Lichens the gonidia are represented by a central conferva-like filament with green contents. These various kinds of gonidia have been referred by the supporters of the Schwendener theory to different genera of unicellular Algae. Dr. Th. M. Fries, who has endeavored to construct a system based on the *Gonidia*,

divides Lichens into six classes: (1) Archilichenes, with bright green gonidia; (2) Sclerolichenes, with bright green or red gonidia, concatenate; (3, 4, 6) Phycolichenes, Glaeolichenes, Byssolichenes, with various kinds of blueish-green gonidia (gonimia); and (5) Nematolichenes, with conferva-like gonidia. But this matter is hardly one for the beginner. Some lichens possess both gonidia and gonimia. There are also dark-colored gonidia, which have been called Melanogonidia.

The Apothecium.

We now come to the Apothecium, with its contents, the most important organ of the Lichen. The Apothecia are easily recognized by the naked eye as variously colored disks on the thallus, yellow, brown, or black, or as more minute globose bodies, with a pore (ostiole) at the top. Occasionally they are immersed in the thallus, or even rarely included in it. They are sometimes scattered over the surface of the thallus, sometimes confined to its borders, sometimes at the tips of the branches, or of a thalline stalk (Podetium) and sometimes prolonged downward into a stem (Stipe.) They are divided into two series: (1) Gymnocarpous, with open fruit, scutellaform, patellaform, lirellate, or goblet-shaped (crateriform); (2) Angiocarpous, with closed fruit (Pyrenocarpous); and these series are divided into five tribes, of which four belong to the first series, viz.: (1) Parmeliacei, (2) Lecideacei, (3) Graphidacei, (4) Caliciacei, (5) Verrucariacei. The definitions of these tribes will be found in the summary of the system, in the last chapter, so that it is not necessary to repeat them here. But the first thing for the Lichen student to do is to recognize to which tribe a lichen belongs, by observation of the character of the fruit; then, to ascertain the genus by the combined observation of the Thallus, the Apothecia, and the Spores; and lastly to determine the species by comparison with published descriptions or with authentic specimens.

The most general division of the Apothecia is into (1) the Lecanorine, those having a disk enclosed in a margin, (exciple) formed from the thallus; (2) the Lecideine, in which the margin is not formed from the thallus, and is called a proper exciple, as distinguished from the thalline; and (3) the nucleiform, or Pyrenocarpous, belonging to the fifth Tribe. The exciples in Tribes 3 and 4 are like those in Tribe 2. When the proper exciple is not coal black (carbonaceous) but col-

ored or blackening, it is called Biatorine. In many species of the first Tribe the thalline exciple is often obscured, or depressed, when the Apothecium appears Biatorine, and it may not always be easy to determine at first sight to which tribe the plant belongs. In this tribe there is also often a proper exciple enclosed in the thalline. Such a composite exciple is called Zeorine. Some apothecia become tubercular and appear to have no margin, and in some genera of the third Tribe the exciple is altogether deficient. Sometimes there are numerous apothecia situated on a common receptacle called a Stroma; and some Lecideine apothecia are inclosed in a pseudothalline, or as it is called Thalloid exciple, more of the nature of a Stroma. The external covering of the Apothecia of the fifth Tribe is called a Perithecium, and within it is usually an inner envelope, the Amphithecium, within which is the globular nucleus. In one genus of the first Tribe, *Pertusaria*, many of the apothecia have one to six pores, but the general character of the fruit is that of the Tribe. Undeveloped Apothecia of other members of this tribe have sometimes the appearance of those of the fifth Tribe.

Now let us examine the Apothecium internally as we already have the Thallus, by making a thin section of that, for example, of a *Parmelia*. Before making the section, by the way, the plant should be saturated with water, as Lichens swell when filled with water, especially some of the *Collema*cei. Such a section will show us (looking from above) (1) a thin epithecium, sometimes granular above; (2) around the borders the thalline exciple containing Gonidia; (3) included within this the Hymenium, containing the Paraphyses and the Thekes; and (4) below this, a colorless or brownish or black portion, the Hypothecium. The Paraphyses are elongated cells or filaments, proceeding from the medullary layer, arranged perpendicularly to the plane of the section, sometimes closely agglutinated by the hymenial gelatine, sometimes lax, sometimes obsolete or hardly perceptible, as in the nucleus of most apothecia of the fifth Tribe, and sometimes deficient; sometimes jointed, often swollen (clavate) at the tips. The Hymenium is now colorless, now brown or black, sometimes bluish.

Between the Paraphyses are the Thekes, containing the Spores. The Thekes are of various form and size. In form they are mostly club-shaped, (clavate,) but now cylindrical, acuminate, pear-shaped,

or globose, largest in species with very large spores, or with those having very numerous spores in the Theke.

The Spores.

The Spores, the germinating organs of the Lichen, demand particular attention. To obtain a better view of them the thin section of the Apothecium may be crushed with the knife and spread out as thinly as possible, or one may take off a portion of the upper part of the apothecium, with as little as possible of the surrounding parts, or when the Apothecia are small one or more may be taken entire and crushed in the same manner. In the case of the Apothecia of the fifth Tribe, which have a hard and horny perithecium, this may be lightly crushed, when the nucleus can usually be detected by a lens and separated with the point of the knife. But it is desirable to make sections of Apothecia of all the Tribes, so as to study the structure as a whole. Most Apothecia will stand a good deal of crushing; but in species with very large spores some care is requisite to avoid crushing the spores themselves. In every species the observer should seek to see the spores in the thekes, so as to be sure of their character and number. Otherwise he will be liable to mistake other cells which may be mixed in the preparation, for spores. In the case of the Pertusarias, in which the Thekes are colored blue by iodine, and are conspicuous under the lens, it is well after a slight crushing to apply the iodine, thus rendering them visible, when they can be separated with the point of the knife from the other parts. Two re-agents are useful in this part of the study: (1) a phial of liquor potassa, which to a certain degree dissolves the hymenial gelatine and renders the hymenium more easily separable; (2) a solution of iodine, of which the formula is iodine 1 grain, iodide of potassium 3 grains, pure water 1 ounce. As liquor potassa is caustic and poisonous it must be handled with care. The best mode of application is after the preparation is placed in water under the covering glass, to press with the finger on one edge of the glass, then to place a drop of the solution against the opposite edge, and raise it slightly with the point of the knife, when the solution will flow under. For softening the hymenium with aqua potassa it may be soaked for some minutes in a fifty per cent. dilution of it. The effect of iodine is to color the hymenium, and sometimes the spores, blue, violet, or various shades of red. This color is removed by the addition of a

little aqua potassa. The medullary layer of lichens is also often colored blue by iodine. In most *Placodiums* the addition of aqua potassa gives a beautiful violet reaction; this reagent also often gives a yellow or red color to the surface or the medullary layer of the *Thallus* of many Lichens. The variations of color produced by both reagents have been much used by many Lichenists, especially by Nylander, as the basis of specific differences. Nylander has created a great many species based solely on these chemical reactions. But the conclusion of Tuckerman, after an examination, was that while they may be of instructive application to imperfect fragments of specimens, and sometimes afford clues to affinity where there is little to direct, as a whole their value as criteria is doubtful, as Dr. Th. M. Fries had maintained in the introduction to his *Lichenographia Scandinavica*.

The spores vary in number in the *Thekes* from one to an indefinite number. The most usual number is eight; but it varies to a limited extent in the same species or even in the same *Apothecium*. By some authors the variation in number is made the basis of generic or of specific distinctions; by others, as distinctive only of varieties or subdivisions of genera. In form they are globose, ovoid, elliptical, oblong, cylindrical, spindle-shaped (fusiform), finger-shaped (dactyloid), club-shaped, or needle-shaped (acicular.) The ovoid or elliptical is the most common form. In regard to color they are either without color or of various shades of brown, now deepening to almost black. Internally they are either simple, without any internal divisions or dissepiments, or divided transversely into two, four or more, or numerous partitions, and are called respectively 2, 4, 6, 8, &c., locular and finally pluri, or multilocular, according to the number of the separate divisions; or by those who look at the dissepiments, 2, 3, 4 septate, &c. When the transverse divisions are again divided longitudinally the spores are called wall-shaped (muriform.) The number of the loculæ may vary in the same plant, and in those with muriform spores, the spore may be seen in all stages of development. In its early stages the muriform spore is simple or only transversely divided. Colorless spores may often be seen associated with colored ones. Professor Tuckerman has distinguished between the typically colorless and the typically colored spore. The former, commencing with the simple spore and tending to elongation, becomes at length the acicular spore; the latter, be-

ginning in the same way and tending to distention, becomes the muriform spore, which when the color is absent, as is frequently the case, is called decolorate. Between these two is a well defined intermediate type, the polar-bilocular, in which the locules are situated at the two extremities of the spore. But there are apparent exceptions to this rule, as in the *Caliciums* and *Arthonias*, in which the spores, according to Minks, are formed on another plan; and some elongated spores show indications of color. The spores are expelled from the thekes most readily when the plant is in its fresh state, and it is therefore advisable to study a Lichen before it has been long collected. They are not always to be found in every hymenium, and in some Lichens, as *Arthonia*, they disappear by absorption or in some other way, very soon, and only the empty Theke is to be seen. Spring and early summer appear to be the most favorable seasons for collecting *Arthonias*. The absence of spores, especially in the lower Lichens, often renders it difficult to determine the species; and species with normally muriform spores often occur with unripe spores only transversely divided. Species have doubtless been separated on such specimens, of plants which are really one. The spore is often filled with granular contents. Sometimes there are two or more globules, but spores containing these are not to be mistaken for bi-quadrilocular spores. The addition of aqua potassa has the effect to render the internal divisions of the spore more distinct.

Spores vary greatly in size, from extremely minute to comparatively very large cells. The smallest will measure hardly a thousandth of a millimetre in diameter, while the largest may have a length of two hundred and fifty thousandths, and a breadth of sixty thousandths of a millimetre, or even more, and are easily visible under a common lens. The measurement of the spores is a matter of some importance, and this is not difficult. The microscope should be provided with an eye-piece micrometer. Then let a stage micrometer, divided by thousands of a millimetre, be placed on the stage of the instrument, and let the observer note how many of its divisions are equal to one division of the eye-piece micrometer. He will thus be enabled to construct a table of dimensions in thousandths of a millimetre, which may be written on a card for reference. If he has a small rule, say a decimetre in length, laid off to thousandths of a millimetre, he can at any time sketch a spore to scale of 1000

to 1 by making the length and breadth as ascertained by his table on the paper. If the spores are too large to be conveniently sketched to this scale, it can be reduced one half or more. It is customary to observe spores of the least and of the greatest size in a species, and to indicate the dimensions thus, $\frac{0.15}{0.06} - \frac{0.25}{0.12}$ mm.; the upper figures indicating the length, and the lower the breadth. Spores measured when swollen by water will have rather larger dimensions, especially in breadth, than if measured dry. But the above method will give a sufficiently close approximation to the dimensions given in the books; and after some experience the observer can form a fair idea of the size of a spore, unless of great size, without measuring it. Spores will vary in size in the same hymenium, some being twice as large as others. To what extent differences in the size of spores in specimens of the same genus are to be taken as specific is uncertain. There are apparently some species in which two forms of spores exist, those in one being constantly twice as large as those in the other. An averaged sized spore will measure from 15 to 18 thousandths of a millimetre in length, by 6 to 9 in breadth. Below these dimensions the spores may be called small or minute; above them, large to very large.

Other Organs.

It remains to notice one or two minor organs of Lichens. We have already mentioned the Spermogones, or minute globular bodies, resembling the Pyrenocarpous apothecia, which are situated upon the Thallus, or (especially in *Cetraria*) on its margin. Internally they contain filaments, now simple or branched, now jointed (*Arthrosterigmata*), called Sterigmas, to which are attached laterally or terminably ovoid or oblong cells called Spermata. The spermata are ovoid or oblong, staff-shaped and straight, or needle-shaped and bowed, the smaller ones now spindle-shaped, or fusiform-thickened at one or both extremities. They occur in great numbers, for which it is difficult to account, unless on the supposition that they are produced and thrown off in succession. They were once supposed to be sexual reproductive organs, but there is no proof that this is the case. They are regarded by Nylander as indicative of specific distinctions, according to their various forms. But spermata of different forms occur within the same genus. According to Minks, the office of the sterigmas is the development of the fruit-hyphæ,

which constitute the disk of the Apothecium, and he considers the Spermata, called by him Hyphidia, as, for the most part, at least, branches of the Hyphema, to be noticed hereafter. They are found in abundance in the young Apothecia.

Pycnides resemble Spermogones. Their contents are organs called Stylospores, situated on the ends of simple filaments. Their form is oblong and they are sometimes septate. Their office is unknown. Pycnides are called by Minks Clinosporangia, their filaments Clinidia, and the Stylospores Clinospores.

The Schwendener Theory.

This part of the subject would be incomplete without some mention of what has been the subject of much discussion for the last few years, the question of the autonomy of Lichens. The resemblance of the Thallus of Lichens to Algæ, and of the Apothecia to certain ascomycetous Fungi, had long been noted. Fries called Lichens aerial Algæ. Schwendener, in his first work, *Untersüchungen über den Flechtenthallus*, considered Lichens as autonomous; but in a second work, *Die Algentypen der Flechtengonidien*, he abandoned this opinion and propounded the theory which has since gone by his name, that Lichens are really a compound plant, the Gonidia being Algæ, and the Hyphæ and Apothecia Fungi, the Hyphæ as parasites drawing their nourishment from the Gonidia. To quote his picturesque language: "All these plants are not individuals in the common sense of the term; they are rather colonies, consisting of hundreds and thousands of Individuals, of which one holds the mastership, while the others in eternal captivity prepare the nourishment for themselves and their masters. The Master is a Fungus of the class of Ascomycetæ, a parasite which lives on the labor of others; its slaves are green Algæ, which it seeks or lays hold of and forces into its service. It encloses them, as a spider its prey, with a network of delicate tissue, which is gradually transformed into an impervious integument. But while the spider sucks the life out of its prey, the Fungus stimulates the Algæ in its grasp to greater activity, to a more vigorous increase, and thereby renders possible a luxuriant growth, and promotes the welfare of the whole Colony." This theory has been accepted by many leading Botanists, but not by one of the great Lichenists, by whom it has been opposed with many arguments. It is not our purpose to enter into the discussion

here. The main statement on which it reposes is that there is no genetic connection between the Gonidia and the Hyphæ, a statement which is not admitted by the Lichenists.

While this controversy was going on, Dr. Minks, a young botanist of Stettin, came forward with the results of long continued and close observation, which if substantiated put an entirely new face on the matter, and must profoundly affect the whole future of Lichenology. Of his doctrine, contained chiefly in two elaborate works, *Das Microgonidium* and *Symbolæ Lichenologicæ*, we can only give a short summary. He asserts firstly the existence of a very delicate tissue called the Hyphema, which permeates all parts of Lichen-structure, and is its primal basis; secondly, that the Hyphæ themselves contain Gonidia (Microgonidia), and that these occur also in the so-called spermatia, in the Hypothallus, in the spore; in short, that the Microgonidia occur in every part of the Lichen, and are the test and evidence of its autonomous existence. In the second of the works above mentioned, he has claimed that a large number of plants mentioned by him, heretofore placed among Fungi, are really to be considered as Lichens, because they exhibit Microgonidia in their tissues. He has discovered new organs, the Gonangium, the Gonocystium, and the Hormospore, and has invented a new terminology of most parts of Lichen structure, and has other doctrines, such as the alternation of species, or something analogous to it, which he has not yet fully developed. In view of his studies, it is certainly too soon to say that the question is decided against the autonomy of Lichens. It is, at least as yet, *sub litem*, and to be decided by further investigation, which belongs to the experienced botanist and not to the beginner. For the present and for practical purposes the Lichen remains a Lichen. The gonidial or algoïd part has been classified by Schwendener and Th. M. Fries, but no one has as yet undertaken to classify the Fungoid parasites on a Fungoid basis except under the general designation of *Ascomycetæ*.

CHAPTER III.

ON THE DISTRIBUTION OF NORTH AMERICAN LICHENS.

The Lichen flora of North America, extending, as it does, from the Arctic to the tropical regions, from the Atlantic to the Pacific coast, including ranges of lofty mountains, and every variety of

climate and soil, contains representatives of the Lichen-flora of the world at large. It presents peculiar difficulties on that account, because the Lichens of the warm are different from those of the cold regions, and require a special knowledge possessed only by a few, for their determination. While the lichens of our Arctic and temperate regions are in general similar to those of northern and temperate Europe, which have been so fully explored and described, they have many species peculiar to this continent, and new ones are at any time likely to be discovered. Hardly any portion of the whole continent has been thoroughly explored, while in Europe almost every yard has been gone over, by scores of explorers, especially for the last hundred years, and they have recorded the results of their labors in hundreds of works. Here there has been but one authoritative exponent of Lichenology, and the collectors have been few and far between, and our Lichenological writings, aside from mere enumerations, can almost be counted on the fingers of one hand.

Our Lichen Flora may be divided into six districts: (1) The Arctic; (2) the Alpine; (3) the Atlantic; (4) the Southern; (5) the Western, west of the Mississippi to the Rocky Mountains; (6) the Pacific. The Lichens of the Arctic district are in general like those of the same regions in Europe and Asia. The same may be said of those of the Alpine district, which includes the higher summits of the mountains of New England, the Alleghanies, and the Rocky Mountains, and of the Atlantic district, comprising the temperate region east of the Mississippi. The Western extends beyond that river to the Rocky mountains. The Southern district embraces the states along the lower Atlantic and the Gulf of Mexico, Mexico, and the more southern parts of California, and may be called subtropical and considered a part of the tropical flora. The Pacific district, comprising that portion of the country west of the Rocky Mountains, presents many distinct and peculiar forms, to which large additions may be expected when it is fully explored; and the same may be said of the Southern district, some of the species of which extend along the Atlantic coast as far even as New England. Each of these districts at its extremes merges into the adjoining ones. It was suggested by Fornander in an Essay on the Geography of Lichens in 1831, that many species of northern Europe may have had their origin in America, and some species which were first

discovered in this country have since been found there. In the Western district Lichens have been found similar to those of Africa and South America ; and a number of European Lichens occur there which have not been seen on the Eastern coast. One peculiar feature of that region is the tendency of many of the lower Lichens to assume fruticulose forms, and to be prolonged downward into the earth, exhibiting the finally ascendant tendency of the horizontal thallus.

The stimulants of the growth of Lichens are moisture, heat and light. But an excess of the first two is injurious, and tends to produce morbid and degenerate conditions. As they derive their subsistence solely from the air, the nature of the soil is of minor importance, but still not without its influence, especially on calcareous and alkaline soils. Lichens are more abundant on the moist shores of the continents than in the dryer interior. The perennial moisture of portions of the Pacific coast is very favorable to their growth, while the combined moisture and light of the tropics produces a similar effect there. The Arctic region is poor in genera and species, but rich in individuals, which afford food to animals, and in times of scarcity even to man. The *tripe de roche*, on which Arctic voyagers have supported life in time of need, is an Umbilicaria ; but it is not a wholesome food, on account of the bitter principle it contains, which may be partly removed by soaking in water. In recent times the manufacture of alcohol from *Cladonia rangiferina* in northern Europe has become quite an industry. Under proper treatment Lichens yield a variety of colors, and they were formerly much used in dyeing ; but modern chemistry has caused this use of them to be almost entirely abandoned. They were also once supposed to possess considerable medical virtues. *Peltigera canina* was so called because it was supposed to be a remedy for hydrophobia. *Sticta pulmonaria*, from its resemblance to the tissues of the lungs, was imagined to be a cure for consumption. But little or no importance is now attached to Lichens as remedies.

The Lichens of calcareous rocks are usually different from those of the granitic rocks. Some species are cosmopolitan, like *Lecanora subfusca* and *Usnea barbata*, while others have a very restricted range. Some species are exclusively corticoline, others saxicolous, and others show no preference ; but lichens of either habitat may often be found upon the other. Even Umbilicaria sometimes attaches itself to wood or bark. *Verrucaria* is exclusively saxicolous, and

the Verrucariæ of limestone rocks are generally different from those of the granitic. A single fossil lichen, *Opegrapha antiqua*, Lesq., has been found in Tertiary formations at the west, while eight species have been observed in Europe. But ours is the only species of which the characters were sufficiently recognizable to enable its genus to be determined.

As to the number of species on our continent it is impossible to speak with exactness. It is as yet too imperfectly explored; and there is besides a great difference of opinion as to what constitutes a species. An estimate made by the writer several years ago gave a little over 800 species, distributed among 75 Genera, within our limits. Of the described species 75 were Arctic, 112 Alpine, 171 sub-tropical, and 103 Western. The number of species in New England was 399. But a good many species have since been added in all these regions, and it is likely that more than 1000 species may ultimately be found within our limits.

CHAPTER IV.

THE HISTORY OF LICHENS.

Krempelhuber, in his exhaustive work *Geschichte der Lichenologie*, divides the History of the Science into six Periods: (1) from the earliest times to Tournefort at the close of the 16th century; (2) from Tournefort to Micheli, in 1728; (3) from Micheli to Weber, in 1779; (4) from Weber to Acharius, in 1802; (5) from Acharius to De Notaris, in 1845; (6) from De Notaris to the present time, (which when his work was published was 1867.)

The first four periods may be passed over briefly. Theophrastus mentions two plants supposed to be *Usnea barbata* and *Roccella tinctoria*. *Evernia furfuracea* has been found and identified in Egyptian coffins, having been well adapted from its softness to fill up the vacant places. But the ancients had no conception of Lichens as a distinct class. The lost work of Solomon, in which were described all plants from the cedar of Lebanon to the hyssop on the wall, perhaps did not include the *Cryptogamia*. Several Middle Age writers mention Lichens as "fucus," "muscus," or "pulmonaria." About 28 species and forms of Lichens were known in the 16th century. Tournefort first distinguished them from the musci and applied to them the distinctive term *Lichen*, under which all

Lichens were mentioned and described down to and including Linnæus. Tournefort mentions 44 species, although up to the end of his period about 125 species were known. Micheli made a special study of cryptogams, and divided Lichens into 38 orders, and figured them in his "Nova Plantarum Genera." Dillenius of Oxford figured and described Lichens in his *Historia Muscorum*, 1741. Linnæus describes *Cladonia rangiferina* according to the method of his time, as "Lichen (rangiferinus) fruticulosus, perforatus ramosissimus ramulis nutantibus." Over 300 species were known at this time, and some of the natural groups of Lichens had been discriminated, and names given to genera and species which they still retain.

Weber distributed the Lichens among 8 genera, and with him began a more systematic study of them, especially with regard to the fructification. Hoffman's *Descriptio et Adumbratio Lichenum*, 1790, contains many fine drawings of Lichens. The chemistry and uses of Lichens began to be studied, and Lichens were collected in various parts of the world. All these labors prepared the way for Acharius, who has been styled the Father of Lichenography. He published in 1803 his *Methodus Lichenum*, of which the basis is the structure of the fructification. His nomenclature, however, is now obsolete. In 1810 he published his *Lichenographia Universalis*, followed in 1814 by the *Synopsis Lichenum*, which remain the only complete accounts of all then known Lichens. He recognized the existence of the thekes and spores, but made no systematic use of them. In the *Synopsis* he describes 904 species. In 1831 Elias Fries, a great botanist, published his *Lichenographia Europæa Reformata*, the introduction to which is a philosophical treatise on Lichens which may still be read with profit, and whose descriptive portions are models of clearness and exactness. He established the divisions into *Gymnocarpi* and *Angiocarpi*, and separated Lichens into eight tribes: (1) *Parmeliaceæ*, (2) *Lecidinæ*, (3) *Graphideæ*, (4) *Calicieæ*, (5) *Sphærophoreæ*, (6) *Endocarpeæ*, (7) *Verrucariæ*, (8) *Limboriæ*, of which the fourth and fifth are now considered as one, and also the sixth and seventh, while the eighth is not now recognized. He also distinguished Lichens as *Myco-Lichenes* and *Phyco-Lichenes*, the latter being the gelatinous or Algæ-like Lichens. These were named by later writers *Lichenes Heteromericæ* and *Lichenes Homœomericæ*. Tuckerman was, so far as we know, the first to combine both these series into one. Among other noted Lichenists

of these last two periods may be mentioned Eschweiler, Fée, Wallroth, Flørke, Montagne and Schærer. Tuckerman began his studies under the influence of Acharius and Fries, and with Oakes and Russell explored the White Mountains, and enumerated the New England Lichens in the Boston Journal of Natural History. Muhlberg, Eaton, Torrey, Halsey and Hitchcock collected and published lists of Lichens.

The microscope had up to this time been used to some extent in the examination of Lichens, but with imperfect instruments, and leading to no important results. Fée had however figured the spores of many Lichens in the supplement to his *Essai sur les Cryptogames des Ecorces Exotiques officinales*, but he considered the theke as the spore, and called the spores Sporidia. With the present period and with better instruments began a closer microscopic study both of the Thallus and of the Spores. De Notaris observed that the spores of many genera were of a uniform type, and drew the conclusion that existing genera which included species having different types of spores must be divided, and he established many new genera based on spore characters. Massalongo devoted a great deal of labor to their study, and his system in its subordinate parts is largely based on spore differences. Koerber, although his system was based on the Thallus distinguished as horizontal, fruticulose, and foliaceous, followed the Italian school in regard to the spores. Hepp figured the spores of all the European lichens. New systems or modifications of existing ones were proposed as knowledge advanced. Norman, Theodore Fries, Montagne, Müller, Stitzenberger, Nylander and others contributed their arrangements to the large number of preceding ones. Each prominent Lichenist has a system of his own.

Nylander, whose knowledge of Lichens, at least of individuals, exceeds that of any other living Lichenist, has contributed more largely than any other to the description of them. His system is developed in his *Synopsis Lichenum*, which was intended to be to the science of the present day what the *Synopsis* of Acharius was to that of his time, but has not been continued since the first volume, published in 1860. The system is eclectic, now giving the preference to one, now to another part of the Lichen. He divides Lichens into three families, the Collemaceæ, the Myriangiaceæ, and the Lichenaceæ. The claim of the second family to belong at all to the Li-

chens is very doubtful. The Collemaceæ include the Lichenes Homœomerici or Gelatinosi of previous authors, and the Lichenaceæ all the rest. The first tribe is divided into two series, the Lichinei (fruticulose) and the Collemei (subcrustaceous, scaly and frondose); the third into six series, Epiconiodei (Calicieï), Cladonieï, Ramalodeï, Phyllodeï, Placodieï and Pyrenodieï, and these into nineteen tribes. Minor importance is attached to spore characters in establishing Genera, so far as color and the internal divisions are concerned. Thus *Lecanora* and *Rinodina* constitute but one genus, and *Verrucaria* includes *Pyrenula* and many other genera of various authors. So great has been the accumulation of material and the advance of knowledge since that time, that perhaps this classification does not represent his present views. His knowledge of the world lichens exceeds that of any other person. Next to him in this respect stands Dr. J. Müller of Geneva. But their views are very conflicting. Both seem disposed to multiply species to excess, Nylander relying largely on chemical reactions and Müller on spore differences. Each has contributed largely to the knowledge of exotic Lichens. The Lichens of Acharius and the other earlier Lichenists have been studied in the light of modern science, and a knowledge of the results thus obtained is necessary in regard to their work, especially with the lower Lichens, in which so much depends on the characters of the spores and the gonidia.

In this very brief sketch we have necessarily omitted many distinguished names and works. We have already referred to the earlier labors of Tuckerman. Becoming a zealous student of the microscopical characters of Lichens, he afterwards followed Nylander in his descriptions of Cuban and North American Lichens in the Proceedings of the American Academy of Sciences, but gradually came to systematic conclusions of his own, which were first hinted at in his Lichens of California, (1866,) and were fully developed in his *Genera Lichenum*, (1872,) and applied in the first part of his *Synopsis*, (1882;) in the introduction to which last he indicated that he had at least partly accepted the views of Dr. Minks. The completion of his *Synopsis* was prevented by his death in 1866, and there is no one left to take his place. He had not paid much attention to the physiology of Lichens, his rank being that of a philosophical Systematist, and his leading aim being to give expression to a larger and better conception of species than prevailed with the

European authors; and this conception is admirably expressed in the Synopsis, where the species are grouped so as to show their natural relations, and their multiplication is avoided as much as possible. It would be an omission not to mention the names of his collaborators in the collection of material for his work, Russell, Oakes and Frost in New England, Hayden, Hall, Macoun and Bolander for the Western region, Peters, Ravenel, Curtis and Austin for the Southern States, and Charles Wright for Cuban and exotic Lichens. All Lichens collected in this country went to him for final determination, and without consulting his herbarium no one can hope to become fully acquainted with our Lichens. A "Sylloge" of all his scattered observations and descriptions would be a boon to our Lichenists and a fitting monument to his fame.

The present decade will perhaps come to be considered as closing the sixth of Krempelhuber's Periods, and as inaugurating, with Schwendener and Minks, a new and revolutionary one. Whether the views of either of these prevail or not, it is time the discordance that has prevailed for so long a time, the difference between leading authorities as to the foundations of the system, and the basis of genera and species should come to an end, and that harmony instead of discord and confusion should prevail. Tuckerman's labors were directed to that end; and the American student can for the present do no better than to accept him as a leader and guide.

CHAPTER IV.

HELPS TO THE STUDY OF LICHENS.

To the American student the Study of Lichens presents peculiar difficulties. Some of these are (1) the want of any work containing the descriptions of all known Lichens; (2) the difficulty of procuring the works upon Lichens, and the fact that they are mostly in foreign languages, Latin, German, French, &c., and that many useful works are published in the proceedings of learned societies, and are not to be consulted here; (3) the embarrassment arising from the multiplicity of systems, and the differences of opinion as to the limits of Genera and Species; (4) the vast synonymy, which renders it often difficult to decide as to the proper name of a plant; (5) the extent and variety of our own Lichen Flora, and the incompleteness of the work of our great authority, Tuckerman. Such helps as

the student can obtain are (1) the possession of a compound microscope with powers of from 40 to 400 diameters, and with an eye-piece micrometer ; (2) the possession of a set of authentic specimens, without which it is often difficult to determine Lichens even with the aid of published descriptions. The only set of Exsiccati of our Lichens was that published by Tuckerman many years ago of New England Lichens, which is now out of print. (3) Books, the most useful of which to the American student are the works of Tuckerman, especially the Genera and the Synopsis, both of which should be in the hands of every student. To these should be added, if attainable, his Observations in the Proceedings of the American Academy, his Lichens of California, and his occasional descriptions of new Lichens in the Torrey Bulletin. Of foreign books, the most valuable to the beginner will be Nylander's Synopsis. The Cuban lichens collected by Charles Wright have been described by Tuckerman, Nylander, and Müller ; but the Graphideæ yet remain to be described. Many Lichens of this Flora are likely to be found in Florida. If the student is desirous of extending his knowledge to European authors, he can obtain some of the Exsiccati of that country, of which the most beautiful is Norrlin and Nylander's collection of Finnish Lichens, elegantly put up, and containing about 250 numbers. This Flora is much like that of the northern part of this country. Of books we will mention a few of the more important.

For the earlier periods Acharius, *Lichenographia Universalis* and *Synopsis* ; Fries, *Lichenographia Europæa Reformata* ; Eschweiler, *Systema Lichenum* ; Fée, *Essai* and *Supplement*. Of more recent authors, all the writings of Nylander are valuable, especially the *Lichenographia Scandinavica* and *Supp.*, *Expositio Pyrenocarpeonum*, *Lichens of New Granada*, and *Recognitio Ramalinorum*. For many years he has contributed descriptions of new European Lichens to the Regensburg Flora, and these have recently been collected into a volume published in Paris. Müller has described many European and exotic Lichens in the same journal. Of Theodore M. Fries may be mentioned *Lichenographia Scandinavica*, of which only one volume is published, and *Genera Heterolichenum Europæ*. Wainio's *Adjutamenta*, in connection with the works of Nylander and Th. Fries, furnishes valuable but often discordant observations on the Acharian Lichens. We have already given the titles of the works of Schwendener and Minks. Many other contributions to

this portion of the subject are contained in various botanical publications. Leighton has published a Lichen Flora of Great Britain, but it cannot be said that it is likely to be of much use to the American student. Koerber, *Systema* and *Parerga* is the fullest German work. Montagne's *Sylloge* contains descriptions of many exotic Lichens. Hepp's *Abbildungen* gives valuable drawings of spores; and finally, Krempelhuber's *Geschichte der Lichenologie* gives an encyclopædic view of the entire History and Literature of the subject. The fullest lists of works on Lichens for sale are contained in the catalogues of Freidlander of Berlin, which are furnished by B. Westermann & Co. of New York.

There are collections of Lichens at Harvard College, the Boston Society of Natural History, Columbia College, the University of Pennsylvania, the National Museum at Washington, and perhaps at other institutions. But I cannot give any detailed information about them.

CHAPTER V.

THE ARRANGEMENT OF NORTH AMERICAN LICHENS.

We conclude our work with a summary of the arrangement of North American Lichens according to Tuckerman's System. Our Lichens are divided into two series and five Tribes, based on the characters of the Apothecia. Families are based on characters of the thallus or apothecia. Spore colors are made the basis of Genera only as they are considered as typically colored or colorless. Other differences are regarded as only gradal, and serve for subordinate divisions. The Collemacei, a separate class with previous writers, are here included in the first Tribe. A peculiar notation is used in the arrangement of closely related plants, and in what follows, those following the leading species are mentioned as subspecies, although that term is not strictly appropriate. Much importance is attached to Habit, but little or none to the Spermatia and to chemical reactions.

Series I. GYMNOCARPI, with normally open apothecia, and including the first four Tribes.

Tribe I. PARMELIACEI. Apothecia with a thalline exciple (scutellæform), with now an included proper exciple (zeorine.)

Fam. 1. USNEEI. Thallus fruticulose, rarely foliaceous.

Genus 1. *ROCCELLA*. Disk of apoth. black, with a white bloom; spores 4 loc., colorless. Gonidia, according to Schwendener, of the Sclerolichens. An easily recognized genus of few species, of warm regions, of which we have 4 spp. on the lower coast of California.

Genus 2. *RAMALINA*. Disk and thallus pale. Spores 2 loc., colorless. A large genus, occurring throughout, but not abundant in the Arctic region, of which we have about 16 spp.

Genus 3. *CETRARIA*. Disk colored differently from the thallus, which is either fruticulose or dilated. (Spermatia usually marginal, and the apothecia obliquely attached to the margin of the frond.) Spores simple, colorless, small. A large, mostly northern and western genus. 22 spp.

Genus 4. *EVERNIA*. Disk concave, colored differently from the thallus. Spores simple, colorless, small. A small genus mostly of temperate regions. 5 spp.

Genus 5. *USNEA*. Disk and thallus pale, the latter with a woody core. Spores simple, colorless. A genus of few spp. occurring throughout. 5 spp. *U. barbata* is cosmopolitan.

Genus 6. *ALECTORIA*. Disk differently colored from the thallus, which is cottony within. Spores either simple and colorless, or now muriform and brown or decolorate. A mostly northern genus of few spp. 5 spp., one peculiar to the western coast, but which has also been found in northern Europe.

Genus 7. *SCHIZOPELTE*. Apothecia terminal, flabelliform, the disk colored differently from the th. Spores plurilocular, brown. A singular plant, of which only one sp. is known, from California.

Fam. 2. *PARMELIÆ*. Thallus horizontal, foliaceous, rarely ascendant; beneath usually fibrillose.

Genus 8. *SPEERSCHNEIDERA*. Spores 2-4 loc., colorless. Th. orbicular depressed, fruticulose many cleft, cartilaginous-coriaceous. Fibrils deficient. A genus of a single sp. found in Texas and Kansas.

Genus 9. *THELOSCHISTES*. Disk of apoth. yellow. Spores polar-bilocular, or in one instance simply bilocular, colorless. Th. foliaceous, or reduced and squamulose, and now ascendant. A small genus, occurring throughout. 3 spp. and 3 subsp.

Genus 10. *PARMELIA*. Spores simple, colorless, now large. Th. imbricate-foliaceous, now ascendant, mostly fibrillose beneath. A large, mostly northern genus. The th. is either glaucous, brown or

straw-colored. 19 spp., 10 subspp. What seems to be *P. molliscula* fertile, was collected by Mr. Brandegee in the Rocky Mountains.

Genus 11. *PHYSICIA*. Spores 2, rarely 4 locular, brown. Th. foliaceous, ramose-lacinate, or now ascendant, mostly fibrillose. A rather large genus, throughout. 10 spp. and 10 subspp.

Genus 12. *PYXINE*. Hypothecium black, and in one section the exciple blackening. Spores 2, rarely 4 loc., brown. Th. adnate, semi-crustaceous and now foliaceous. A small genus of the Atlantic coast north and south. 2 spp. and 2 subspp.

Fam. 3. *UMBILICARIEI*. Thallus horizontal, foliaceous, submophyllous, coriaceous, dark-colored, more or less fibrillose, attached to the substrate by a single point.

Genus 13. *UMBILICARIA*. Apoth. subcutellæform, variously difform, black, without gonidia, mostly at length lirellæform-proliferous. Spores from simple at length granulose, or more rarely muriform, becoming brown. A large genus of Arctic, Alpine and temperate regions, growing upon rocks. 17 spp.

Genus 14. *OMPHALODIUM*. Apoth. much as in *Parmelia*. Spores simple, colorless. A small genus, of which one sp. has been found in Arizona. The other spp. occur in South America and Africa.

Fam. 4. *PELTIGEREI*. Thallus plano-ascendant, foliaceous, more or less villous beneath, and veiny, and now cyphellate. Gonimous stratum of either gonidia or gonimia.

Genus 15. *STICTA*. Apoth. submarginal, elevated, now blackening. Spores fusiform-acicular, 2-4-plurilocular, fuscous or colorless. Th. foliaceous, wide lobed, rounded or elongated, beneath villous and cyphellate or now marked with bare spots. Gonimous stratum of both kinds. A large genus of temperate and tropical regions, in the former often sterile. 17 spp. and 2 subspp.

Genus 16. *NEPHROMA*. Apoth. reniform, innate on the under sides of the lobules of the circumference. Spores subfusiform, 4 loc., fuscous. Thallus frondose, more or less villous beneath, not veiny. Gonimous stratum of both kinds. A small genus of temperate regions. 6 spp.

Genus 17. *PETTIGERA*. Apoth. peltæform, adnate to the upper side of the extended lobes. Spores fusiform or acicular, 4-plurilocular, at length colorless. Thallus veiny and villous beneath,

where the cortical layer is wanting. Gonimous stratum of both kinds. A small genus occurring throughout. 9 spp.

Genus 18. *ERIODERMA*. Apoth. scutellæform, marginal on the now extended lobes. Spores simple, at length colorless. Thallus villous and now veiny beneath, with a pannose hypothallus; the cortical layer there wanting. Gonimous stratum of gonimia. A small tropical genus, of which 1 sp. occurs in Mexico.

Genus 19. *SOLORINA*. Apoth. innate on the upper side of the thallus, the margin obsolete. Spores 2 loc., brown. Th. frondose, villous beneath. Gonimous stratum of both kinds. A small genus of temperate regions. 2 spp.

Fam. 5. *PANNARIEI*. Thallus horizontal, frondose-foliaceous, or, most commonly, squamulose; mostly more or less lead-colored; imposed upon a conspicuous but now obsolete hypothallus. Gonimous stratum almost universally of gonimia.

Genus 20. *ENDOCARPISCUM*. Apoth. mostly indicated only by an ostiole, but finally emergent and scutellæform. Spores minute, colorless, very numerous in the thekes. Thallus foliaceous, peltate, the hypothallus deficient. Gonimous stratum of gonimia. A small genus, of which we have 2 spp.

Genus 21. *HEPPIA*. Apoth. orbicular, immarginate, more or less sunken in the minute, frondose-squamulose thallus. Hypothallus obsolete. Spores simple, colorless. Gonimous stratum of gonimia. A small genus, of which we have 3 spp., one of them undescribed.

Genus 22. *PHYSMA*. Apoth. scutellæform. Spores simple, colorless. Th. foliaceous, with a nap-like hypothallus. Gonimous layer of gonimia much like those of *Collema*. A small genus, of which we have 3 spp., two of them tropical.

Genus 23. *PANNARIA*. Apoth. now scutellæform and *Lecanorine*, now *zeorine*, and now *bjatorine*. Spores simple, or 2-4 loc., or rarely muriform, fuscous or decolorate. Th. monophyllous, or multifid, or most often squamulose, becoming subcrustaceous. A large and difficult genus, throughout. 24 spp.

Fam. 6. *COLLEMEI*. Thallus frondose-foliaceous, more or less gelatinous when wet; becoming squamulose or crustaceous; lead-colored or blackish-green; the hypothallus almost always obsolete. Gonimous layer of gonimia.

Subfam. 1. *LICHINEI*. Thallus fruticulose, the gonimia consti-

tuting an axis, which finally breaks up, or crowded into a more regular layer between the cortical and at length parenchymatous medullary layer. Apoth. globose or variously irregular.

Genus 24. EPHEBE. Apoth. globose. Spores simple, colorless. Th. filiform, much branched, blackish-green, the gonimia not concatenate, finally somewhat stratified. A small genus of the Atlantic coast. 3 spp., only one of which occurs with fruit.

Genus 25. LICHINA. Apoth. terminal, globose. Spores simple, colorless. Th. fruticulose, brownish-black; gonimia concatenate, distinctly stratified. A small genus of maritime rocks. A form of one sp. occurs in N. E., the peculiarities of which were first pointed out by the writer to Prof. Tuckerman in 1868. It was described and figured as "*Thamnidium Willeyi* Tuck.," by Schwendener in 1869, but without any material addition to the facts previously noted.

Subfam. 2. EUCOLIEMEI. Thallus foliaceous or squamulose, or crustaceous; rarely fruticulose; the gonimia either concatenate and dispersed in a gelatinous pulp among branching medullary filaments, or clustered. Apoth. normally scutellæform, but sometimes in the lower groups persistently globose.

Genus 26. PYRENOPSIS. Apoth. depressed-globose, urceolate, or now at length open. Spores simple or 2 loc., decolorate. Th. granulose. Gonimia concatenate or clustered, (and accompanied in some spp. by gonidia.) A numerous genus of rock Lichens, (rarely of earth,) of which 7 spp. are described with us, and more doubtless occur. It includes here spp. of *Synalissa*, Nyl. Syn., and *Psorotichia*, Mass., and *Porocyphus* Kbr.

Genus 27. OMPHALARIA. Apoth. small, subglobose, more or less immersed, or finally superficial and explicate. Spores simple, colorless. Thallus fruticulose, or more commonly foliaceous, attached by a single point. Gonimia clustered, or rarely concatenate. A genus of numerous spp., of which we have 9, one of which is undescribed. It includes here *Synalissa* and *Phylliscum*, Nyl. Syn.

Genus 28. COLLEMA. Apoth. scutellæform. Spores either simple or becoming fusiform and 2-plurilocular; or commonly muriform, scarcely colored. Th. foliaceous, rarely fruticulose, mostly dark-green, the cortical layer mostly indistinct. Gonimia almost always concatenate; medullary filaments conspicuous. A large genus. 18 spp. and 9 subspp.

Genus 29. LEPTOGIUM. Apoth. scutellæform, zeorine or biato-

rine. Spores and Th. as in *Collema*, except that the cortical layer is distinctly parenchymatous. A large genus. 21 spp. and 4 sub-spp.

Genus 30. *HYDROTHYRIA*. Apoth. biatorine. Spores 4 loc., colorless. Th. foliaceous, veiny beneath. Cortical layer parenchymatous; gonimia concatenate. A genus of one sp. occurring in cold streams of N. E. and California.

Fam. 7. *LECANOREI*. Thallus crustaceous; now lobulate or even branched, but mostly uniform; adnate; hypothallus indistinct.

Subfam. 1. *EULECANOREI*. Apoth. scutellæform.

Genus 31. *PLACODIUM*. Apoth. now zeorine; or biatorine. Spores rarely simple, or bilocular, commonly polar-bilocular, colorless. Th. now lobulate, or rarely fruticulose, mostly uniform and oftener yellowish. A large genus. 27 spp. and 1 subsp.

Genus 32. *LECANORA*. Apoth. now zeorine. Spores simple, or 2-4 loc., or long-fusiform and pluriloc., colorless. Th. now lobulate, rarely fruticulose, mostly uniform. A very large genus. 45 spp. and 10 subsp.

Genus 33. *RINODINA*. Apoth. scutellæform, more often zeorine; now lecideine. Hypothecium mostly colorless. Spores 2, rarely 4 loc., brown. Th. crustaceous; in a few spp. lobed at the circumference, but mostly uniform. A large genus. 16 spp.

Subfam. 2. *PERTUSARIEI*. Apoth. typically compound and difform, but reverting to the scutellæform type.

Genus 34. *PERTUSARIA*. Apoth. globular-difform, opening by pores, and including one to several nucleiform hymenia; but now explanate and Lecanorine. Spores simple or 2 loc., colorless, mostly very large. A large genus. 15 spp.

Genus 35. *PHLYCTIS*. Apoth. erumpent, rounded-difform, at length somewhat dilated, the blackening disk veiled by the thallus. Spores muriform, brown or decolorate. Th. uniform. A small genus, of which one sp. occurs, according to Krempelhuber, in Texas, and another has been found in Oregon.

Subfam. 3. *URCEOLARIEI*. Apoth. more or less urceolate.

Genus 36. *CONOTREMA*. Apoth. urceolate, truncate-conoid; a black proper exciple, veiled by an evanescent thalline one. Spores cylindraceous, very long, multilocular, colorless. Thallus uniform. A genus of one sp. on the Atlantic coast.

Genus 37. *GYALECTA*. Apoth. urceolate-biatorine, with a some-

what crenulate margin; a colored, rarely black, connivent proper exciple, which is now explanate, veiled by an often evanescent thalline one. Paraphyses laxly coherent. Spores 2-4-plurilocular, or muriform, uncolored. Thallus uniform. A small difficult genus. 9 spp.

Genus 38. *THELOTREMA*. Apoth. urceolate, or now verrucæform, or endocarpeine, but at length largely scutellate; the disk veiled by an inner exciple (often obsolete), the proper exciple variously colored, somewhat torn-margined, concrete with the thallus. Spores 2-plurilocular, or muriform, brown or decolorate. Thallus uniform. A large and difficult, mostly tropical genus. 12 spp. and 1 subspp. Two spp. occur in N. E.

Genus 39. *GYROSTOMUM*. Apoth. from urceolate finally explanate, orbicular, or often elongated-diform; a black proper exciple with entire margin, clothed at first by an evanescent thalline one. Spores muriform, brown. Th. uniform. A genus of one tropical sp.

[*MYRIANGIUM* has Lecanoroid apoth., which are multilocular, each locule containing a single theke, with muriform colorless spores, and innate in a rounded, plaited or lobed thallus, which is without gonidia. Hence its claim to be considered a Lichen is doubtful. The single sp. occurs on the Atlantic coast.]

Tribe II. *LECIDEACEI*. Apoth. rounded, marginal (normally) only by the proper exciple (patellæform.)

Fam. 1. *CLADONIEI*. Thallus twofold, (1) vertical, (a *Podetium*) ascending from, (2) a horizontal squamulose or crustaceous one; the latter now obsolete.

Genus 40. *STEREOCAULON*. Apoth. patellæform, brown, at length convex, and the margin excluded, (cephaloid), solid. Spores fusiform or acicular, 4-plurilocular, colorless. Th. fruticulose, erect, solid, more or less clothed with granules, passing now into fibrils; horizontal thallus granulose or obsolete. A large genus, throughout. 10 spp.

Genus 41. *PILOPHORUS*. Apoth. cephaloid, solid, black. Spores simple, colorless. Podetia simple or little branched, originally solid, clothed with wart-like granules (phyllocladia), which are also collected into a crust at the base. A small genus of Alpine and Arctic regions. 1 collective sp.

Genus 42. *CLADONIA*. Apoth. mostly cephaloid, empty within, variously colored but not black. Spores simple, colorless. Pede-

tia fistulous, cup or funnel-shaped, (*Scyphiferæ*), or much branched, or rarely club-shaped; horizontal thallus squamulose, crustaceous, or obsolete. A large genus of earth Lichens. 31 spp. and 5 subspp.

Genus 43. *THAMNOLIA*. Apoth. subglobose-patellæform; many together immersed in cephalodium-like thalline receptacles opening by cribose perforations; not black. Spores simple, colorless. Podetia cylindrical, subulate, fistulous; horizontal th. deficient. A genus of a single Alpine and Arctic sp., with us sterile.

Fam. 2. *CÆNOGONII*. Thallus horizontal, conferva-like.

Genus 44. *CÆNOGONIUM*. Apoth. patellæform. Spores simple or 2 loc., colorless. Th. of jointed filaments, densely intertangled. A small tropical genus. 3 or 4 spp.

Genus 45. *CYSTOCOLEUS*. A sterile, confervoid, dark-colored plant, erectish, the cells surrounding the central one coalescing into a sheath. Fruit unknown. The single sp. occurs on the Atlantic coast.

Fam. 3. *LECIDEI*. Thallus crustaceous, now lobulate, or rarely caulescent, mostly uniform; adnate.

Subfam. 1. *BÆOMYCEI*. Apoth. prolonged downward into a stipe.

Genus 46. *BÆOMYCES* Fée. Apoth. patellæform or cephaloid, the stipe now disappearing. Spores simple or 2-4 locular, colorless. Th. horizontal, lobulate or uniform. A small genus of earth lichens.

Subfam. 2. *BIATOREI*. Apoth. sessile, the exciple paler than the disk.

Genus 47. *BIATORA*, Fr. Apoth. patellæform or oftener cephaloid, (now blackening, but not carbonaceous); spores simple, or from fusiform becoming acicular, and 2-4-plurilocular, colorless. Th. now lobulate; mostly uniform. A very large genus. The forms with squamose thallus constitute the § *Psora*; those with uniform th. and simple spores § *Eubiatora*; with two locular spores § *Biatorina*; with fusiform 4-plurilocular spores § *Bilimbia*; with acicular spores § *Bacidia*; and with very numerous spores in the thekes § *Biatorella*. Many of our spp. remain to be determined.

Genus 48. *HETEROTHECIUM* (Fl.) Tuck. Apoth. patellæform, the exciple often thickened and lecanoroid. Spores simple, or 2-plurilocular, or muriform, brown or decolorate. Th. uniform. A rather small, and mostly tropical genus, which here includes *Lopium*, *Megalospora*, *Bombyliospora*, &c., of authors.

Subfam. 3. *EULECIDEI*. Apoth. sessile; exciple coal-black.

Genus 49. *LECIDEA* (Ach., Fr.) Apoth. patellæform, or now cephaloid, (very rarely lecanoroid.) Spores simple, becoming fusiform and acicular and 2-4-pluriloc., colorless. Th. now lobulate or caulescent, mostly uniform. The forms with lobulate Th. constitute the § *Thalloedema*; those with simple spores § *Eulecidea*; with 2-4-plurilocular spores § *Toninia*; with numerous spores § *Sporastatia*. A very large and difficult genus, with a complicated synonymy. Many of our spp. are undetermined.

Genus 50. *BUELLIA* (DN.) Tuck. Differs from *Lecidea* in having brown spores, either 2-4 loc., or muriform. The forms with lobulate Th. are § *Catolechia*; with 2-4 loc. spores § *Eubuellia*; with muriform spores § *Rhizocarpon*. A large genus.

Tribe III. *GRAPHIDACEI*. Apoth. difform, oftener elongated, (lirellæform,) margined normally only by the proper exciple, which is now indistinct.

Fam. 1. *LECANACTIDEI*. Apoth. more or less rounded, or less commonly elongated, margined.

Genus 51. *LECANACTIS* (Eschw., Kbr.) Tuck. Apoth. rounded, or more rarely oblong, black. Spores from dactyloid at length fusiform-oblong, 4-plurilocular, colorless. Th. uniform. A small genus.

Genus 52. *PLATYGRAPHA* Nyl. Apoth. rounded or oblong; the proper exciple more or less obscure, bordered by an accessory thal-line or thalloid one. Spores 4-plurilocular, colorless. Th. uniform. A small genus, mostly of southern regions. One sp. occurs in N. E.

Genus 53. *MELASPILEA* Nyl. Apoth. rounded or oblong, black. Spores 2 loc., brown, or decolorate. Th. uniform. A small genus.

Fam. 2. *OPEGRAPHEI*. Apoth. normally lirellæform.

Genus 54. *OPEGRAPHA* (Humb.) Ach, Nyl. Apoth. lirellæform, rarely rounded-difform, oftener simple, mostly superficial, the exciple almost always black throughout. Spores dactyloid or fusiform, 2-4-pluriloc., brown, or oftener decolorate. Th. uniform. A genus of numerous spp.

Genus 55. *XYLOGRAPHA* Fr., Nyl. Apoth. now angulate-patellæform, oftener lirellæform; the exciple softish, originally pale, at length black. Spores simple, colorless, (in a foreign sp. muriform.) Th. uniform, or almost obsolete. A small genus, of which we have 4 spp., two of which are undescribed.

Genus 56. *GRAPHIS* Ach., Nyl. Apoth. lirellæform, mostly

branched, seldom rounded-diform, mostly innate; the exciple colored or black, and more often colorless below, almost always bordered by an accessory thalline or thalloid one. Spores 4-pluriloc., or muriform, brown or decolorate. Th. uniform or almost obsolete. A large and difficult, mostly southern genus. Several of our spp. are undescribed, and new ones may be expected to occur. Only 3 or 4 spp. occur in our temperate region.

Fam. 3. GLYPHIDEI. Many apoth. collected in a common, cushion-like, thalloid receptacle (stroma.)

Genus 57. CHIODECTON Ach. Apoth. rounded-diform or oblong, plano-convex, immarginate, immersed in a white stroma. Spores 4-pluriloc., or rarely muriform, almost always uncolored. Th. uniform. A small tropical genus.—*Thelotrema Californicum* Tuck., Obs. 1877, p. 177, is a *Chiodecton*.

Genus 58. GLYPHIS Ach., Mont., Nyl. Apoth. rounded or oblong, concave, in a white stroma. Spores 4-pluriloc., brown or decolorate. Th. uniform. A small, tropical genus, of which we have one collective sp.

Fam. 4. ARTHONIÆ. Apoth. difform, without proper margin, commonly confluent, and now evidently compound.

Genus 57. ARTHONIA Ach., Nyl. Apoth. rounded or oblong, now with an accessory thalloid margin, the proper margin deficient, more or less aggregated, or confluent in an irregular pseudo-stroma. (Paraphyses mostly obsolete.) Spores, in pyriform or globose, rarely clavate thekes, oblong-ovoid, or oblong, or very rarely fusiform, 2-4-pluriloc., or muriform, brown or decolorate. Thallus uniform, or scanty and subcortical. A large and difficult genus, of which we have many new spp., and others doubtless are to be discovered.

Genus 58. AGYRIUM Fr. Apoth. rounded or oblong, waxy, immarginate. Spores in clavate thekes, simple, hardly colored. Thallus scarcely visible. A very small genus, of which we have 1 sp. of the Atlantic coast.

Genus 59. MYCOPORUM (Fl.) Nyl. Apoth. rounded or oblong, black, finally compound; a difform pseudo-stroma including 1 to 6 hymenia. Spores 2-4 loc., or muriform, brown or decolorate. Th. uniform or almost obsolete. A small genus, of which we may have six or seven spp., mostly undetermined. It includes *Melanotheca* of authors, and some of the spp. are referred by Minks to his genus

Cyrtidula. By most authors it is placed with the Verrucariæ. (Paraphyses deficient.)

Tribe IV. CALICIACEI. Apoth. turbinate-lentiform (crateriform), or globose; a proper exciple, either naked and oftener stipitate, or bordered by an accessory thalline one, margining or supporting a hymenium the disk of which consists of naked spores.

Fam. 1. SPHÆROPHOREI. Thallus vertical, fruticulose.

Genus 60. SIPHULA Fr. Apoth. unknown. Th. erect, sparingly branched or almost simple, passing below into root-like branchlets, by which it is attached to the substrate, densely cottony within. A small genus of Arctic lichens.

Genus 61. SPHÆROPHORUS Pers. Apoth. globose; the proper exciple reduced to a hypothecium included in a thalline receptacle formed by the swollen tips of the branches. Spores spherical, simple, violet-black. Thallus fruticulose, erect, densely cottony within. A small genus of Alpine and Arctic regions.

Genus 62. ACROSCYPHUS Lev., Mont. Apoth. crateriform; a black proper exciple included in a clavate thalline receptacle formed by the swollen tips of the branches. Spores 2-loc., brown. Th. fruticulose, erect, solid, the medullary layer at length more or less compacted into cartilaginous cords. A small tropical genus.

Fam. 2. CALICIEI. Thallus crustaceous, lobulate, or mostly uniform.

Genus 63. ACOLIUM (Fée) DN. Apoth. crateriform, or now urn-shaped, sessile; a black proper exciple, which is either naked, or margined by an accessory thalline one. Spores spherical and simple, or 2-rarely 4 loc., or even muriform, brown. Th. crustaceous, rarely lobulate, mostly uniform. A genus of numerous, mostly tropical spp., of which one or two from the Western coast are undescribed.

Genus 64. CALICIUM Pers., Ach., Fr. Apoth. crateriform, stipitate; a naked, black, proper exciple. Spores simple or 2-rarely 4 loc., brown. Th. crustaceous or almost obsolete, or in parasitic spp., none. A numerous genus, mostly of temperate regions. The spp. with simple spores constitute the § Cyphelium, in which the spores are lighter colored than in the other §§; those with 2 loc. spores § Calicium, and the parasitic spp. § Sphinctrina.

Genus 65. CONIOCYBE Ach. Apoth. globose, stipitate, the margin of the colored proper exciple obscure. Spores spherical, glo-

bose, hardly colored. Th. crustaceous or almost obsolete. A genus of few spp. of temperate regions.

Series II. ANGIOCARPI. Apoth. globular, opening only by a pore at the summit.

Tribe V. VERRUCARIACEI. Apoth. globular; a proper exciple (perithecium), covering a similarly shaped hymenium, (nucleus), which is included in a more or less distinguishable inner envelope, (amphithecium.)

Fam. 1. THAMNOPIRENEL. Thallus fruticulose.

Genus 66. PYRENOTHAMNIA Tuck., Torr. Bulletin, 1883, p. 22. "Apoth. immersed in the th.; perithecium fuscescent, amphithecium colorless, paraphyses diffuent and obsolete. Spores 1-2 or 4 in the thekes, muriform, brown, .036-56 mm. long, by .016-24 mm. wide. Hymenial gonidia oblong, guttated, .010-24 mm. long, by .003-4 mm. wide. Th. fruticulose, cæspitose, about half an inch high, fragile, from a teretish base dilated above, and dichotomously much-branched, the obtuse tips crenate-dentate, the color from cinerascens fuscescent. Hyphæ forming a confused layer." An earth lichen of the Rocky Mountains.

Fam. 2. ENDOCARPEI. Thallus foliaceous, becoming squamulose.

Genus 67. ENDOCARPON Hedw., Fr. Apoth. immersed in the thallus; perithecium much reduced; amphithecium pale or blackening; paraphyses obsolete. Spores simple, or 2-4 loc., or rarely muriform, brown or decolorate. Thallus foliaceous, one-leaved, or squamulose, passing also into subcrustaceous states. A small genus of rock and earth Lichens.

Genus 68. NORMANDINA Nyl. Apoth. immersed in thalline warts; perithecium indistinct; amphithecium black; paraphyses obsolete. Spores 8 loc., colorless. Th. squamæform, one-leaved. A small genus of 2 spp. of temperate regions.

Fam. 3. VERRUCARIEI. Thallus crustaceous.

Subfam. 1. SEGESTRIEI. Apoth. solitary; perithecium colored.

Genus 69. SEGESTRIA Fr. Apoth. immersed in thalline warts; perithecium colored; amphithecium pale or finally blackening; paraphyses filiform. Spores simple or 2-4-plurilocular, or muriform, without color. Th. now lobulate, mostly uniform. Includes here, with other genera of authors, Thelocarpon, Nyl., in which the spores

are numerous in the thekes. A small genus of temperate and southern regions.

Genus 70. *STAUROTHELE* Norm. Apoth. immersed in thalline warts; perithecium blackening; amphithecium pale; paraphyses obsolete. Spores muriform, brown or decolorate. Th. somewhat lobulate, or uniform. A small genus of rock lichens.

Subfam. 2. *TRYPETHELIEI*. Many apoth. collected in a verrucæform stroma.

Genus 71. *TRYPETHELIUM* Spreng., Ach., Nyl. Apoth. one to several, immersed in a stroma; perithecium reduced, blackening; amphithecium black; paraphyses distinct. Spores 4-pluriloc., or muriform, brown or decolorate. Thallus uniform, mostly obscure. A rather small genus of mostly tropical lichens. One sp. occurs in N. E.

Subfam. 3. *PYRENULEI*. Apoth. solitary, or now confluent; perithecium black. The spp. of this subfam., except *Strigula*, are included by Nyl. under *Verrucaria*.

Genus 72. *SAGEDIA* (Mass., Kbr.) Tuck. Apoth. innate-superficial; perithecium black; amphithecium pale or blackening; paraphyses distinct or now obsolete. Spores from cymbiform (boat-shaped), fusiform, at length acicular, 4-plurilocular, colorless. Th. uniform, or disappearing. A small genus of bark and rock lichens.

Genus 73. *VERRUCARIA* Pers., Tuck. Apoth. innate; perithecium black; amphithecium pale or blackening; paraphyses slender, and mostly indistinct or obsolete. Spores simple, or 2-4 loc., or muriform, decolorate. Th. uniform, somewhat tartareous, rarely areolate-squamaceous. A large genus of rock lichens. The limestone formations of Europe yield many peculiar spp., but those of this country have been very imperfectly explored. The spp. with simple spores constitute § *Euverrucaria*; with 2-4 loc. spores § *Thelidium*; with muriform spores § *Polyblastia*, &c.

Genus 74. *PYRENULA* (Ach., Næg. & Hepp) Tuck. Apoth. somewhat prominent; perithecium black; amphithecium pale or blackening; paraphyses distinct or now obsolete. Spores 2-4-plurilocular, or muriform, brown or decolorate. Thallus mostly obscure. A large genus of bark lichens, in the tropics often on leaves, or now parasitic. The gonidia are often those of the *Sclerolichens*.

Genus 75. *PYRENASTRUM* Eschw. Apoth. rather prominent, turbinate, several oftener confluent above into a common ostiole; peri-

thecium conical, oblique, black; amphithecium blackening; paraphyses distinct. Spores muriform, brown. Thallus indistinct. A small genus of tropical lichens on bark.

Genus 76. STRIGULA Fr. Apoth. prominent, depressed-globose; perithecium black; amphithecium pale or blackening; paraphyses distinct. Spores simple, or 2-4 loc., colorless. Thallus epiphyllous, passing finally into a lobulate crust. A small genus of tropical lichens, growing upon leaves.

NOTE.—The first fascicle of Vol. II. of Nylander's *Synopsis Lichenum*, including the *Pyxinei*, *Gyrophorei*, *Psoromei*, and *Pannariei*, is to be added to the list of his works on p. 29.

As the plates were not prepared until a portion of the forms had been printed, they could not be referred to in the text. It is hoped that the accompanying letter-press will be sufficient for their explanation.

SUPPLEMENT.

This Supplement is intended to give the names of published Lichens following Part I. of Tuckerman's Synopsis, so far as known to me. There are of course many unpublished species. I have not included inedited spp. of Tuckerman, but have ventured to name a few Arthonias, having had the advantage of studying Tuckerman's collection of the Genus. There are, however, several species on which I have not cared to venture an opinion. The authors of the species named are responsible for them. Most of the Arctic spp. not in a previous list, are given on the authority of Nylander and Theodore M. Fries.

The distribution given is according to the Districts of the previous pages, but is very general. G. stands for a more or less general distribution; Atl. for the Atlantic district; Alp. for the Alpine; Arc. for the Arctic; W. for the Western; Pac. for the Pacific; and S. for the Southern.

Tribe 2. LECIDEACEI.

Fam. 3. LECIDEEL.

Subfam. 1. Bæomycei Fée.

BÆOMYCES Fée.

- roseus Pers. G.
- fungoides (Sw.) Ach. S.
- byssoides (L.) Fr. G.
- æruiginosus (Scop.) Nyl. Alp.
- absolutus Tuck. S.
- placophyllus Fr. Alp.

Subfam. 2. Biatorei Fr.

BIATORA Fr.

A. Thallus squamulose. PSORA.

- decipiens Fr. W.
- crenata Tayl. W.
- icterica Mont. W.
- Russellii Tuck. G.
- globifera (Ach.) Fr. G.
- luridella Tuck. Pac.

rufo-nigra Tuck. G.
 scotopholis Tuck. Pac.
 ostreata (Hoffm.) Atl.
 Friesii (Ach.) Atl.
 Petri Tuck. S.
 caulophylla Tuck. Pac.

B. *Thallus uniform.*

1. *Spores simple.* EUBIATORA.

coarctata (Ach.) Th. Fr. G.
 glebulosa Fr. Pac.
 granulosa (Ehrh.) Hoffm. Atl.
 flexuosa Fr. Atl.
 viridescens (Schrad.) Fr. Atl.
 internectans (Nyl.) Arc.
 vernalis (L.) Fr. G.
 parvifolia (Pers.) S.
 russula (Ach.) Mont. G.
 cinnabarina (Smf.) Th. Fr. Pac.
 sanguineo-atra Fr. G.
 cuprea (Smf.) Fr. Arc.
 atro-rufa Fr. Alp.
 rufo-fusca Anzi. Arc.
 Tornoensis (Nyl.) Th. Fr. G.
 fuscescens (Smf.) Fr. Alp., Arc.
 exigua (Chaub.) Fr. G.
 Nylanderi Anz. Atl.
 uliginosa (Schrad.) Fr. Atl.
 rivulosa (Ach.) Fr. Atl.
 querneæ (Dicks.) Th. Fr. G.
 lucida Fr. Atl.
 mutabilis Fée. S.
 aurigera Fée. S.
 furfuracea Kremph. S.
 ementiens (Nyl.) Arc.
 apochrœiza (Nyl.) Arc.
 insperabilis (Nyl.) Arc.
 Konyamensis (Nyl.) Arc.
 Diapensia Th. Fr. Alp.
 rubidula (Nyl.) Arc.
 rufofuscella (Nyl.) Arc.
 subdeusta (Nyl.) Arc.
 leucophæa (Flk.) Th. Fr. Arc.
 denotata (Nyl.) Arc.
 ænea (Duf.) Arc.
 circumflexa (Nyl.) Arc.
 carnulenta Tuck. Atl.
 peliaspis Tuck. S., Atl.
 peliaspistes Tuck. Atl.
 furfurosa (Nyl.) S.
 hypomela (Nyl.) S.
 myriocarpoides (Nyl.) Atl.
 speirococca (Nyl.) Arc.
 turgidula Fr. G.
 pycnotheliza (Nyl.) Arc.
 oxyspora (Tul.) Atl.

2. *Spores 2-ocular.* BIATORINA.

erysibe Fr. Pac.
 cyrtella Ach. Atl.
 cumulata (Smf.) Arc.
 globulosa Flk. Atl.
 denigrata Fr. Atl.
 mixta Fr. G.
 atro-purpurea Mass. G.
 gyalizella (Nyl.) Atl.
 expallescens (Nyl.) Arc.
 Heerii Hepp. Atl.
 micrococca Kbr. Atl.
 prasina Fr. Atl.
 glauconigrans Tuck. Atl.

3. *Spores fusiform, 4-plurilocular.* BILIMBIA.

trachona (Fl.) Atl.
 leucoblephara (Nyl.) S.
 tricholoma Mont. S.
 artyta Ach. Arc.
 sphæroides Smf. G.
 obscurata Smf. Arc.
 hypnophila Turn. G.
 milliaria Fr. Atl.
 cupreo-rosella (Nyl.) Tuck. Atl.
 Friesiana Linds. Arc.
 pallidella (Nyl.) Arc.
 Naegelii Hepp. Atl.
 melæna (Nyl.) Atl.
 trisepta (Naeg.) Atl.
 allinita (Nyl.) Arc.
 suballinita (Nyl.) Arc.
 verecunda Th. Fr. Arc.
 subfuscula (Nyl.) Arc.
 parasitula (Nyl.) Arc.
 declinis Tuck. Atl.
 hyaliniza (Nyl.) Arc.

4. *Spores acicular, plurilocular.* BACIDIA.

rubella (Ehrh.) Rab. G.
 fuscobrubella (Hoffm.) G.
 Schweinitzii Tuck. Atl.
 medialis Tuck. S.
 inundata Fr. Atl.
 stigmatella Tuck. S.
 atrogrisea Hepp. S.
 atrosanguinea (Schaer.) Hepp. Atl.
 millegrana (Nyl.) S.
 alborussula (Nyl.) Arc.
 effusa (Sm.) Atl.
 effusa var. arceutina (Ach.) Atl.
 Beckhausii (Kbr.) G.
 subabbrevians (Nyl.) Arc.
 umbrina Ach. Atl.
 chlorosticta Tuck. Atl.
 chlorantha Tuck. Atl.

microphyllina Tuck. S.
rufescens Müll. S.

ε 4. *Thekes polysporous*. BIATORELLA.

campestris Fr. Atl.
fossarum (Duf.) Mont. G.
cyphalea Tuck. Atl.
ilicis Willey. Atl.
geophana Nyl. Atl.
resinæ Fr. Atl.
moriformis (Ach.) Pac.

6 HETEROTHECIUM (Fl.) Tuck.

sanguinarium (L., Fl.) Tuck. Alp.
grossum (Pers.) Tuck. Atl.
tuberculosis (Fée) Fl., varr. porphyrites Tuck., pachycheilum Tuck.,
pachycarpum (Fr.) Tuck., chlorites Tuck. Atl., S.
pezizoideum (Ach.) Fl. Atl.
endochroma (Fée.) S.
Domingense (Pers.) Fl. S.
leucoxanthum (Spreng.) S.
versicolor (Fée.) S.
leptocheilum Tuck. S.
conspersum (Fée) Fl. S.
nannarium Tuck. S.
vulpinum Tuck. S.

Subfam. 3. Eulecideei.

LECIDEA (Ach., Fr.)

A. *Th. effigurate*. THALLŒDEMA.

Brandegeei Tuck. Pac.
Pringlei Tuck. Pac.
candida (Web.) Ach. Arc.
mamillana Tuck. S.
cœruleonigricans (Lightf.) Ach. G.

B. *Th. crustaceous*.

1. Spores simple. EULECIDEA.

albo-cœrulescens Fr. Atl.
contigua Fr., Nyl. G.
Laurentiana Nyl. Arc.
lapidica Ach. Alp., Pac.
tessellata Flk. G.
tessellina Tuck. Atl.
auriculata Th. Fr. Arc.
auriculata v. diducens Nyl. Arc.
amylacea (Ach.) Nyl. Arc.
aglæa Smf. Alp.
aglæida Nyl. Arc.
Armeniaca (DC.) Fr. Arc., Alp.
atro-brunnea (DC.) Schær. Arc., Alp.
confluens Schær. Atl.
fusco-atra (L.) Fr. Alp.

insularis Nyl. Pac.
 tenebrosa Fl. Arc.
 lugubris (Smf.) Nyl. Arc.
 panœola (Ach.) Fr. Arc.
 Rhætica Hepp. Arc.
 elata Schær. Arc.
 epiiodiza Nyl. Arc.
 subtristisiuscula. Nyl. Arc.
 lugubrior Nyl. Arc.
 pycnocarpa Kbr. Atl.
 vorticosa (Flk.) Kbr. Arc.
 conferenda Nyl. Arc.
 borealis Kbr. Arc.
 pallida Th. Fr. Arc.
 sublimosa Nyl. Arc.
 brachyspora Th. Fr. Arc.
 scrobiculata Th. Fr. Arc.
 ultima Th. Fr. Arc.
 despecta Th. Fr. Arc.
 melapsepha Nyl. Arc.
 dendroclinis Nyl. Arc.
 lygotropa Nyl. Arc.
 cyrtidia Tuck. Atl.
 crassipes Th. Fr. Arc.
 paraphana Nyl. Arc.
 vitellinaria Nyl. Pac.
 enteroleuca Fr. G.
 melancheima Tuck. G.
 parasitica Flk. Arc.

2. *Spores 2-plurilocular.* TONINIA.

acclinis Fl. Atl.
 caudata Nyl. Alp.
 granosa Tuck. Atl., S.
 massata Tuck. Pac.
 squalida (Schleich.) Ach. Pac., Arc.
 ruginosa Tuck. Pac.
 flavo-virescens (Dicks.) Borr. Alp.

3. *Thekes polysporous.* SPORASTATIA.

morio (DC.) Schær. Alp.

BUELLIA (DN.) Tuck.

A. *Thallus lobulate.* CATOLECHIA.

epigæa (Pers.) Tuck. Pac.
 badia (Fr.) Kbr. Pac.
 pulchella (Schrad.) Tuck. Alp., Arc.
 scabrosa (Ach.) Kbr. Alp., Arc.

Catawbensis n. sp. Thallus thickish, squamulose, peltate, orbicular, (about $\frac{1}{2}$ inch in diam.) sub-entire, white, beneath black and naked. Apoth. innate-superficial, the disk even with the thallus, black, at length crowded and confluent in the centre of the th., hypothecium black, the proper exciple deficient; paraphyses distinct, agglutinate; Spores oblong-ellipsoid, 2 loc., brown, .015-18 mm. by .007-8 mm. On rocks along Catawba River, Landsford, S. C., Prof. H. A. Green, 1886. A singular plant without near affinity.

B. Thallus uniform.

1. *Spores 2-4 locular.* EUBUELLIA.

lactea Mass. Atl.
 lepidastra Tuck. Atl.
 stellulata Tayl. Atl., Pac.
 pullata Tuck. Pac.
 coracina (Moug.) Th. Fr. Alp.
 halonia Ach. Pac.
 papillata Smf. Arc.
 parasema (Ach.) Kbr. G.
 dialyta Nyl. Atl., Pac.
 myriocarpa (DC.) Mudd. G.
 Schæreri DN. Atl.
 turgescens (Nyl.) Tuck. Atl.
 Elizæ Tuck. Atl.
 vernicoma Tuck. Atl.
 spuria (Schær.) Kbr. Arc.
 leptocline (Fr.) Kbr. Alp.
 badio-atra (Flk.) Kbr. Atl.
 colludens (Nyl.) G.
 præbadia (Nyl.) Arc.
 atroalbescens (Nyl.) Arc.
 semotula (Nyl.) Arc.
 vilis Th. Fr. Arc.
 infernula (Nyl.) Arc.
 ochrodela (Nyl.) Arc.
 decinerascens (Nyl.) Arc.
 ignobile Th. Fr. Arc.
 calcarea (Weiss.) Arc.
 alboatra (Hoffm.) G.
 leucopsepha (Nyl.) Arc.
 pullata Tuck. Pac.
 Alpicola (Nyl.) Anz. Alp.
 destitula (Nyl.) Atl.
 meiosperma (Nyl.) Arc.
 saxatilis (Schær.) Kbr. Atl.
 inquilina Tuck. Atl.
 parasitica (Flk.) Th. Fr. Arc.
 parasitula (Nyl.) Arc.
 urceolata Th. Fr. Arc.
 Smithii (Tul.) Atl.

3. *Spores muriform.* RHIZOCARPON.

Bolanderi Tuck. Pac.
 oidalea Tuck. Pac.
 penichra Tuck. Pac.
 petræa (Fl.) Tuck. G.
 *Montagnei Fl. G.
 *Oederi Kbr. Alp.
 apopetræa (Nyl.) Arc.
 detinens (Nyl.) Arc.
 Geographica (L.) Th. Fr. Alp.

Tribe III. GRAPHIDACEI Eschw., Nyl.

Fam. 1. LECANACTIDEI Stitz.

LECANACTIS (Eschw., Kbr.) Tuck.

- abietina (Ach.) Kbr. Pac.
 premnea Ach. Atl., Pac.
 var. chloroconia Tuck. Atl.

PLATYGRAPHA Nyl.

- periclea Nyl. Atl.
 Californica Tuck. Pac.
 ocellata Nyl. S.
 Ravenelii Tuck. S.
 phlyctella Nyl. S.

MELASPILEA Nyl.

- arthonioides (Fée) Nyl. S.
 angulosa Nyl. Atl.

Fam. 2. OPEGRAPHEI Stitz.

OPEGRAPHA (Humb.) Ach., Nyl.

- tribulodes Tuck. S.
 demissa Tuck. Atl.
 levidensis Willey. Apoth. minute, rounded or oblong, black, the thin
 margin connivent. Spores 2 loc., colorless, .012-16 mm. long, .004-5
 wide. Thallus deficient. On rails, New Bedford, very rare.
 oulocheila Tuck. S.
 microcycelia Tuck. Atl.
 varia (Pers.) Fr. Atl.
 atra (Pers.) Nyl. Atl.
 var. hapalea Ach. Atl.
 vulgata (Ach.) Nyl. Atl.
 var. lithyrge (Ach.) Atl.
 rimalis Pers. Pac.
 Bonplandi Fée. S.
 viridis Pers. G.
 astræa Tuck. S.
 quaternella Nyl. Atl.

XYLOGRAPHA Fr., Nyl.

- opegraphella Nyl. Atl.
 parallela Nyl. Atl.

GRAPHIS Ach., Nyl.

- scripta (L.) Ach. G.
 sophistica Nyl. S.
 assimilis Nyl. S.
 eulectra Tuck. Atl.
 elegans (Sm.) Ach. S.
 var. striatula (Ach.) S.
 substriatula Nyl. S.
 rigida (Fée) Nyl. S.
 Pavoniana Fée. S.
 dendritica Ach. Atl., S.

varr. *inusta* (Ach.); *medusula* Nyl. Atl.
sculpturata Ach. S.
triosa Ach. S.
erumpens Nyl. S.
hololeucoides Nyl. S.
patellula (Meissn.) Nyl. S.
scolecites Tuck. S.
Afzelii Ach. S.
leprocarpa Nyl. S.
Babingtonii (Mont.) Tuck. S.
nitida (Eschw.) Nyl. S.
punctiformis Eschw. S.
hæmatites Fée. S.
cometia Fée. S.
nitidella Nyl. S.
hypoleptella Nyl. S.
leiogrammodes Kph. S.
intricans Nyl. S.
glaucoderma Nyl. S.

Fam. 3. GLYPHIDEI (Fr.) Mont.

CHIODECTON Ach.

rubro-cinctum Nyl. S.
Montagnæi Tuck. S.
Californicum Tuck. Pac.

GLYPHIS Ach., Mont., Nyl.

Achariana Tuck. S.
labyrinthica Ach. S.

ARTHONIA Ach., Nyl.

A. Fruit colored.

1. *Spores 2 locular.*

carneo-rufa n. sp. Apoth. small, rounded, convex, reddish-flesh-colored.
 Spores 2 loc., colorless, .008-10 mm. long, by .004-5 mm. wide. Th.
 inconspicuous. On dead wood, Oregon.

incarnata (Th. Fr.) Hellb. Alp.
lurida Ach. Atl.

Floridana n. sp. Apoth. small, rounded-diform, dark brown and black-
 ening. Spores oblong, narrowed below, 2 loc., colorless, .016-22 mm.
 by .006-8 mm. Th. inconspicuous. S.

2. *Spores 4-plurilocular.*

lurido-alba Nyl. Atl.
albofuscenscens Tuck. Atl.
cupressina Tuck. Atl.
lecidella Nyl. Atl.
cinnabarina Wallr. G.
 varr. *anerythræa* Nyl., *ochrocincta* Nyl. G.
pryrrhula Nyl. S.
subrubella Nyl. S.
atrata Fée. S.
rubella Fée. S.
varia Ach. S.

- erubescens n. sp. Apoth. minute, plane, angular-diform, brownish-red.
Spores 4 loc., colorless, .013-18 mm. by .005-6 mm. Th. inconspicuous. S.
- pyrrhuliza Nyl. (has been distributed as pyrrhula.) Atl.
- impallens Nyl. Atl.
- ochrolutea Nyl. S.
- conturbata Nyl. S.
- platyspeilea Nyl. S.
- fissurinea Nyl. S.
- vernans n. sp. Apoth. innate-depressed, angular-diform, plane, pale flesh-colored. Spores 10-16 loc., colorless, .040-44 mm. by .010-15 mm.
Th. powdery, green. S.
- chiodectella Nyl. S.
- erupta Nyl. S.
- leucastræa Tuck. S.
- Ravenelii Tuck. hb. Apoth. rounded-diform, convex, reddish-brown and blackening. Thekes clavate. Spores 4-8 loc., the upper locule larger, .015-23 mm. by .006-7 mm. Th. inconspicuous. S.
- impolita (Ehrh.) Borr. Pac.
- impolita var. chiodectoides Tuck. hb. Pac.
- velata Nyl. f. develata ib. Atl.
- glaucescens Nyl. Atl., S.

3. *Spores muriform.*

- sanguinea Willey. Pac.
- gregarina n. sp. Apoth. macular-diform, crimson. Spores muriform, colorless, .028-40 mm. by .013-16 mm. Th. inconspicuous. S.

B. Fruit black.

1. *Spores 2 locular.*

- glebosa Tuck. Pac.
- patellulata Nyl. Atl.
var. subpallidiuscula Nyl. Atl.
- exilis Mass. Atl.
- lapidicola Tayl. Atl.
- dispersa (Schrad.) Nyl. Atl.
- subminutula Nyl. Atl.
- subminutissima Nyl. Atl.
- Hibernica Nyl. Atl., S.
- tædescens Nyl. S.
- terrigena Willey. Atl.

2. *Spores 4-plurilocular.*

- mediella Nyl. Arc.
- astroidea Ach. G.
- astroidea v. Swartzoidea Nyl. Atl.
- hamamelidis Nyl. Atl.
- quintaria Nyl. Atl., S.
- subastroidella Nyl. Atl.
- xylographica Nyl. Atl.
- reniformis (Pers.) Atl.
- punctiformis Ach. G.
- epipastoides Nyl. Atl.
- pinastri Anz. Atl.
- oxytera Nyl. S.
- ramulosa Nyl. "N. Am."
- polymorpha Ach. S.

- diffusa Nyl. Atl.
 excedens Nyl. Pac.
 platygraphidea Nyl. S.
 melaspora Tuck. hb. Apoth. innate-depressed, linear or variously dif-
 form, black. Spores 4 loc., becoming blackish-brown, .025-36 mm. by
 .009-14 mm. Th. powdery, white. On dead wood. S.
 caudata n. sp. Apoth. minute, rounded-diform, depressed, black. Spores
 fusiform, attenuate below, 6-8 loc., colorless, .025-36 mm. by .004-5
 mm. Th. inconspicuous. On white pine, New Bedford.
 varians Nyl. Atl.

3. *Spores muriform.* ARTHOTHELIUM.

- interveniens Nyl. S.
 tædiosa Nyl. S., Atl.
 spectabilis Fl. S., Atl.
 macrotheca Fée. S.
 mesoleuca Nyl. S.
 paralia Nyl. Atl.
 subcyrtodes n. sp. Apoth. rounded, convex, black. Spores 4-8, muri-
 form, brown, .022-27 mm. by .008-10 mm. Th. uneven, whitish. S.

AGYRIUM Fr.

- rufum (Pers.) Fr. Atl.

MYCOPORUM (Fl.) Nyl.

- pycnocarpum Nyl. Atl., S.
 sparsellum Nyl. G.

Several spp. of this genus are undetermined.

Tribe IV. CALICIACEI.

Fam. 1. SPHÆROPHOREI.

SIPHULA Fr.

- ceratites (Wahl.) Fr. Arc.
 simplex (Gayl.) Nyl. Arc.
 dactyliza Nyl. Arc.

SPHÆROPHORUS Pers.

- compressus Ach. Alp., Arc.
 globiferus (L.) DC. Alp., Arc.
 fragilis (L.) Pers. Alp., Arc.

ACROSCYPHUS Lev., Mont.

- sphærophoroides Lev. S.

Fam. 2. CALICIEI.

ACOLIUM (Fée) DN.

- Bolanderi Tuck. Pac.
 Californicum Tuck. Pac.
 Carolinianum Tuck. S.
 tympanellum (Ach.) DN. Pac.
 chloroconium Tuck. Pac.
 viridulum (Schær.) DN. Atl.
 tigillare (Ach.) DN. G.
 Javanicum (M. & V. d. B.) Stitz. S.
 S'ti Jacobi Tuck. Pac.

CALICIUM Pers., Ach., Fr.

1. *Spores simple, globose.* CYPHELIUM.

- trichiale Ach. Atl.
 brunneolum Ach. Atl.
 stemoneum Ach. Atl.
 phæocephalum (Turn.) Turn. & Borr. Atl. .
 var. aciculare (Fr.) Nyl. Atl.
 chrysocephalum (Turn.) Ach. Atl.
 albidum Kbr. Atl.

2. *Spores 2 locular.* CALICIUM.

- curtum Turn. & Borr. Atl.
 subtile Fr. Atl.
 *albo-nigrum Nyl. Atl.
 lenticulare (Hoffm.) Ach. Atl.
 fuscipes Tuck. Atl.
 trachelinum Ach. Atl.
 hyperellum Ach., Wahl. Pac.
 roscidum (Flk.) Nyl., var. trabinellum Nyl. Atl.
 faculatum Nyl. Pac.
 disseminatum Fr. Atl.
 citrinum (Leight.) Nyl. Atl.
 Ravenelii Tuck. S.
 Curtisii Tuck. Atl.
 byssaceum Fr. Atl.
 præcedens Nyl. Atl.
 eusporum Nyl. Atl.
 polyporæum Nyl. Atl.

3. *Parasitic.* SPHINCTRINA.

- microcephalum (Sm.) Turn. & Borr. Atl.
 tubiforme Mass. Atl.
 leucopodium Nyl. Atl.
 turbinatum Pers. Atl.

CONIOCYBE Ach.

- furfuracea (L.) Ach. Atl.
 pallida (Pers.) Fr. Atl.
 albella Schwein. Atl.

Series II. ANGIOCARPI.

Tribe V. VERRUCARIACEI (Fr., Fée) Stitz.

Fam. 1. THAMNOPYRENEI.

PYRENOTHAMNIA Tuck.

- Spraguei Tuck. Pac.

Fam. 2. ENDOCARPEI Th. Fr.

ENDOCARPON Hedw., Fr.

- miniatum (L.) Schær. G.
 varr. complicatum Schær., fulvo-fuscum Tuck., Manitense ib., aqua-
 ticum Schær., Muhlenbergii (Ach.)
 Moulinsii Mont. S.

arborescens Schwein. G.
 rufescens Ach. S., W.
 hepaticum Ach. G.
 cinereum (Pers.) var. cartilagineum Nyl. G.
 ochroleucum Tuck. Pac.
 Texanum Tuck. S.
 pusillum Tuck. G.

NORMANDINA Nyl.

Jungermaniæ Delis. G.
 læte-virens Turn. Atl.

Fam. 3. VERRUCARIEI.

Subfam. 1. Segestrii.

SEGESTRIA Fr.

1. *Eusegestria*.

lectissima Fr. Atl.
 nucula Fr. S.

2. *Thelocarpon* Nyl.

majusculum Nyl. Atl.
 intermediellum Nyl. Atl.
 prasinellum Nyl. Atl.

STAUROTHELE Norm.

Drummondii Tuck. Atl.
 circinata Tuck. Atl.
 diffractella (Nyl.) Tuck. Atl.
 umbrina (Wahl.) Tuck. G.
 var. clopima (Nyl.)
 Brandegeei Tuck. Pac.
 Petersii Tuck. S.
 discedens (Nyl.) Arc.
 diffusilis (Nyl.) Arc.

Subfam. 2. Trypetheliei.

TRYPETHELIUM Spreng., Ach.

uberinoides Nyl. S.
 cruentum Mont. S.
 pallescens (Fée) Nyl.
 catervarium (Fée) Tuck. S.
 scorites (Tuck.) Nyl. S.
 exocanthum Tuck. S.
 virens Tuck. S., Atl.
 mastoideum Ach. S.
 Kunzei Fée. S.
 Eleuteriæ Spreng. S.
 megaspermum Nyl. S.
 madrepiforme Eschw. S.
 pyrenuloides Mont. S.

Subfam. 3. Pyrenulei.

SAGEDIA (Mass., Kbr.) Tuck.

chlorotica (Ach.) Mass. Atl.
 heteropsis (Nyl.) S.
 Cestrensis Tuck. Atl.

lactea Kbr. Atl.
 oxyspora (Nyl.) Tuck. Atl.
 semiintegra Müll. S.
 carpinea (Pers.) Mass. S., Atl.
 kentrospora (Branth.) Arc.

VERRUCARIA (Pers.) Tuck.

1. *Spores simple.* EUVERRUCARIA.

epigæa (Pers.) Ach. Atl.
 maura (Wahl.) Th. Fr. Atl.
 ceuthocarpa Wahl. Atl.
 mucosa (Wahl.) Th. Fr. Atl.
 striatula Wahl. Atl.
 pinguicola Mass. Atl.
 papillosa (Ach.) Kbr. Atl.
 margacea (Wahl.) Nyl. Atl.
 nigrescens Pers. Atl.
 viridula (Ach.) Atl.
 fuscella Fr. Atl.
 virens Nyl. Atl.
 rupestris Schrad. G.
 var. purpurascens Schær. S.
 muralis Ach. Atl.
 tartaricola Linds. Arc.

2. *Spores 2-4-plurilocular.* THELIDIUM.

Nylanderi Hepp, var. Hudsonana ib. Atl.
 pyrenophora Ach., Nyl. G.
 microbola Tuck. Atl.
 pertusura Nyl. Arc.
 punctellata Nyl. Arc.

3. *Spores muriform.* POLYBLASTIA.

terrestris Th. Fr. Arc.
 interversa Nyl. Arc.
 obtenta Nyl. Arc.
 subareolata Nyl. Arc.
 sordidula Th. Fr. Arc.
 bryophila Lonur. Arc.
 perniigrata Nyl. Arc.
 intercedens Nyl. Arc.
 intermedia Th. Fr. Arc.
 verrucoso-areolata Schær. Atl.

PYRENULA (Ach., Næg. & Hepp) Tuck.

1. *Spores decolorate.*

punctiformis (Ach.) Næg. G.
 quinque-septata (Nyl.) Tuck. S.
 subcinerea (Nyl.) Tuck. S.
 cinchonæ (Ach.) Tuck. S.
 subprostans (Nyl.) Tuck. S.
 gemmata (Ach.) Næg. Atl.
 tropica (Ach.) Tuck. S.

hyalospora (Nyl.) Tuck. Atl.
 leucochlora Müll. Atl.
 rhypona (Ach.) Atl., S.

2. *Spores colored.*

thelæna (Ach.) Tuck. Atl.
 oblongata Müll. Atl.
 Willeyana Müll. Atl.
 aggregata Fée. S.
 ochraceo-flava (Nyl.) S.
 leucoplaca (Wallr.) Kbr. G.
 glabrata (Ach.) Mass. G.
 mamillana (Ach.) var. Santensis (Nyl.) S.
 nitida Ach. G.
 / pachycheila Tuck. Pac.
 / thelomorpha Tuck. Pac.
 lactea (Mass.) Tuck. Atl.
 fallaciosa Stitz. G.
 geminella (Ach.) S.
 aurantiaca (Fée.) S.
 fetivica Kph. S.

3. *Parasitic. ENDOCOCCUS.*

pygmæa (Kbr.) Tuck. Arc.
 gemmifera (Tayl.) Atl.
 ventosicola Mudd. Alp.
 perpusilla (Nyl.) Arc.
 triphracta (Nyl.) Arc.

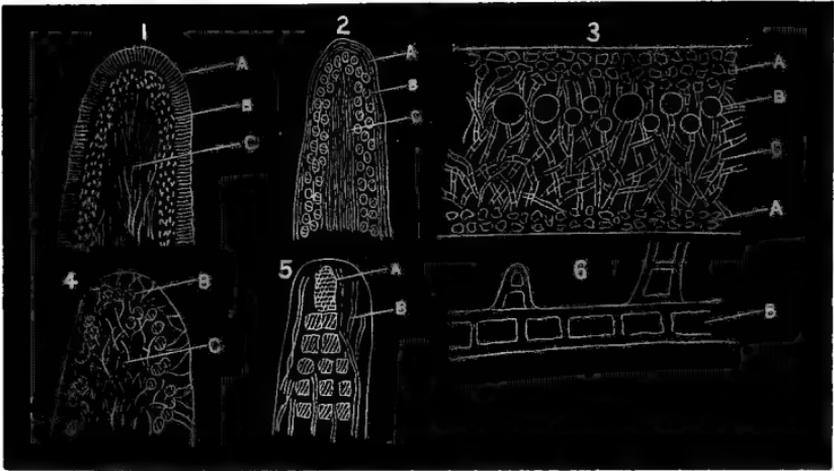
PYRENASTRUM Eschw.

astroideum (Fée) Eschw. S.
 Ravenelii Tuck. S.
 intrusum Nyl. S.

STRIGULA Ff.

complanata (Fée, Mont.) Nyl. S.
 actinoplaca Nyl. S.

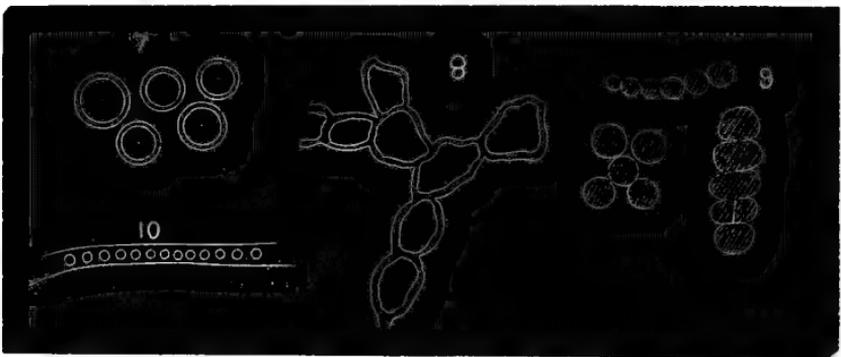
PLATE 1. THALLUS.



1. ROCELLA. 2. USNEA. 3. THELOSCHISTES. 4. COLLEMA.
5. EPHEBE. 6. CÆNOGONIUM.

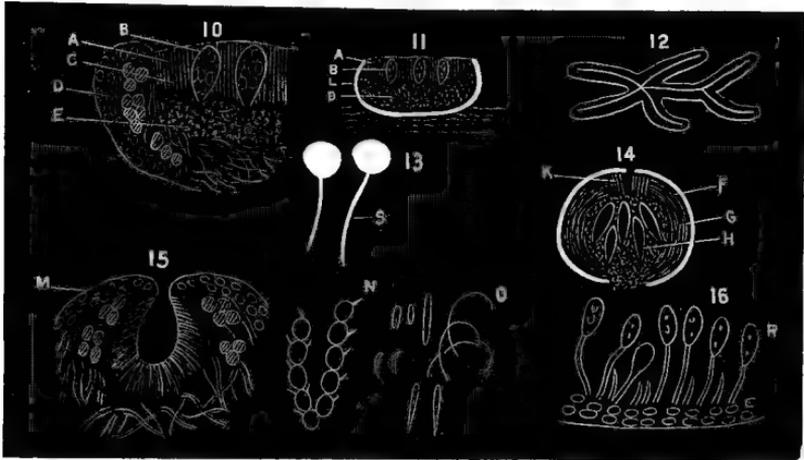
A. *Cortical layer.* B. *Gonidial do.* C. *Medullary do.*

PLATE 2. GONIDIA.



7. OF ARCHILICHENS. 8. OF SCLEROLICHENS. 9. GONIMIA.
10. MICROGONIDIA.

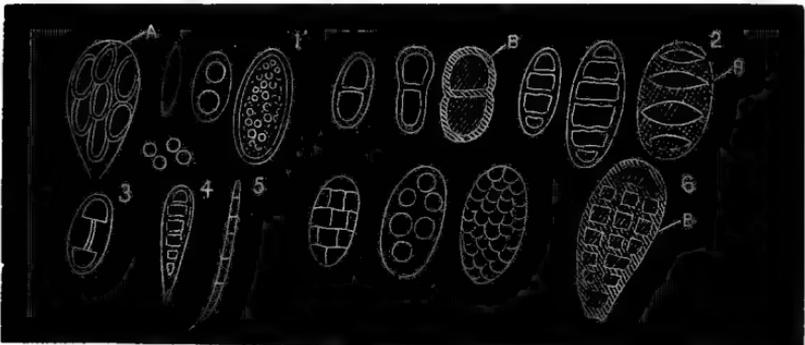
PLATE 3. APOTHECIA, SPERMOGONES, AND
PYCNIDES.



10. TRIBE 1. 11. TRIBE 2. 12. TRIBE 3. 13. TRIBE 4.
14. TRIBE 5. 15. SPERMOGONE, STERIGMAS, and SPERMATIA.
16. STYLOSPORES.

A. *Hymenium*. B. *Thekes*. C. *Paraphyses*. D. *Thalline Margin*. L. *Proper do*. E. *Hypothecium*. S. *Stipe*. F. *Perithecium*. G. *Amphithecium*. H. *Nucleus*. K. *Anaphyses*. M. *Spermatia*. N. *Sterigmas*. O. *Spermatia*.

PLATE 4. SPORES.



1. SIMPLE. 2. TWO-4 PLURILOCULAR. 3. POLAR-BILOCLULAR.
4. FUSIFORM. 5. ACICULAR. 6. MURIFORM.

A. *Theke*. B. *Colored spores*.

PLATE 5.

1. Roccella.
2. Ramalina.
3. Cetraria.
4. Evernia.
5. Usnea.
6. Alectoria.
7. Schizopelte.
8. Speerschneidera.
9. Theloschistes.
10. Parmelia.
11. Physcia.
12. Pyxine.
13. Omphalodium.
14. Umbilicaria.
15. Sticta.

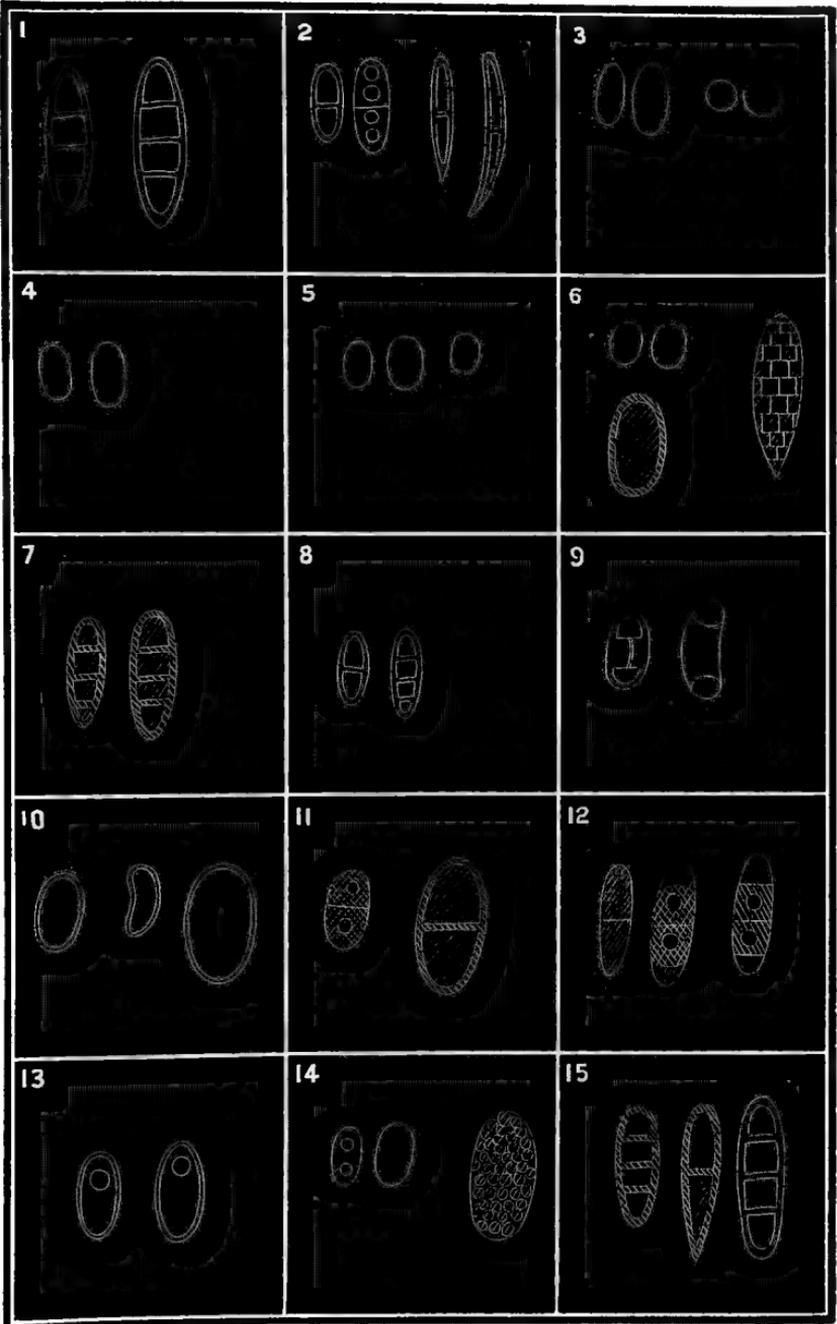


PLATE 6.

16. Nephroma.
17. Peltigera.
18. Erioderma.
19. Solorina.
20. Endocarpiscum.
21. Heppia.
22. Physma.
23. Pannaria.
24. Ephebe.
25. Lichina.
26. Pyrenopsis.
27. Omphalaria.
28. Collema.
29. Leptogium.

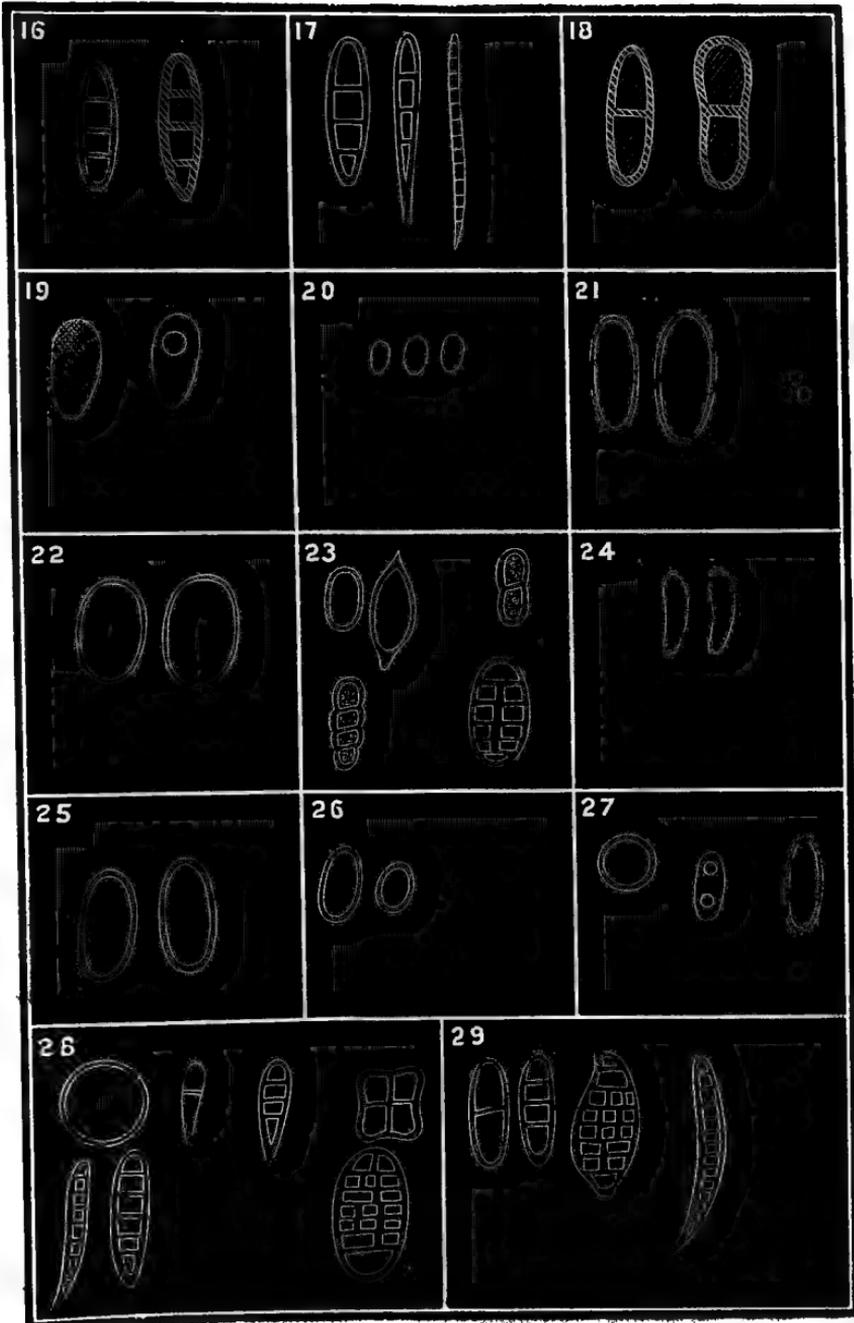


PLATE 7.

- 30. Hydrothyria.
- 31. Placodium.
- 32, 33. Lecanora.
- 34. Rinodina.
- 35. Pertusaria.
- 36. Phlyctis.
- 37. Conotrema.
- 38. Gyalecta.
- 39. Urceolaria.
- 40. Thelotrema.
- 41. Gyrostomum.
- 42. Stereocaulon.
- 43. Pilophorus.
- 44. Cladonia.

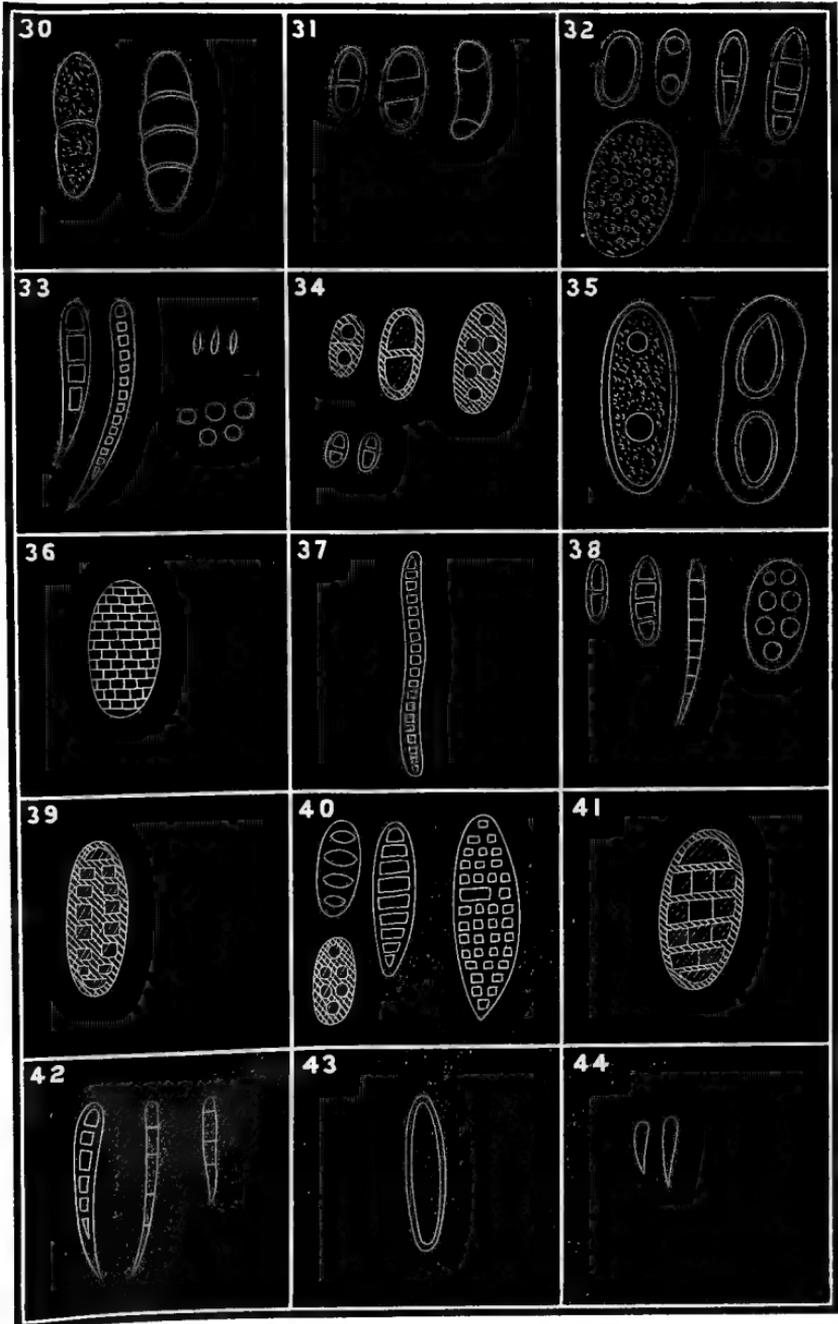


PLATE 8.

- 45. *Thamnolia*.
- 46. *Bæomyces*.
- 47. *Cœnogonium*.
- 48. *Biatora*.
- 49. *Heterothecium*.
- 50, 51. *Lecidea*.
- 52. *Buellia*.
- 53. *Lecanactis*.
- 54. *Platygrapha*.
- 55. *Melaspilea*.
- 56. *Opegrapha*.

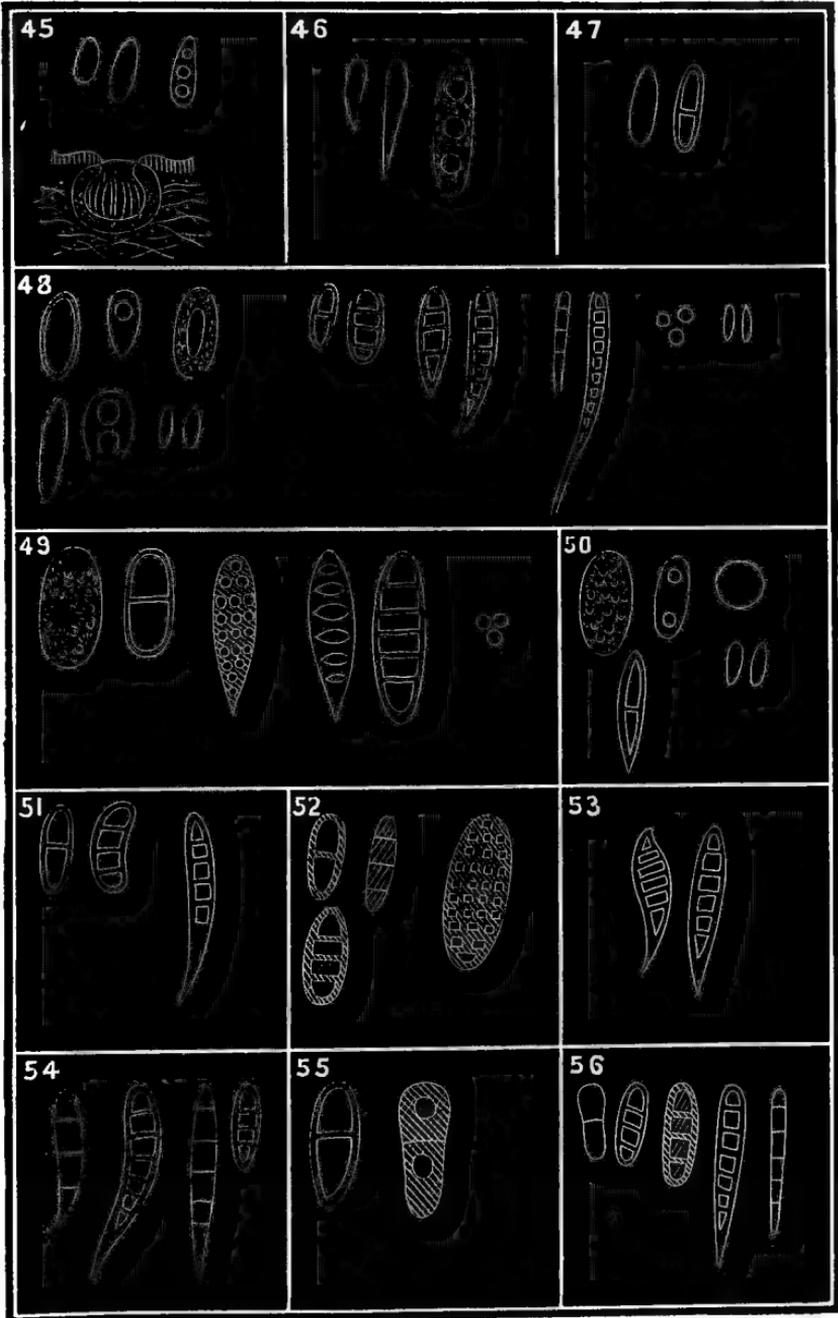
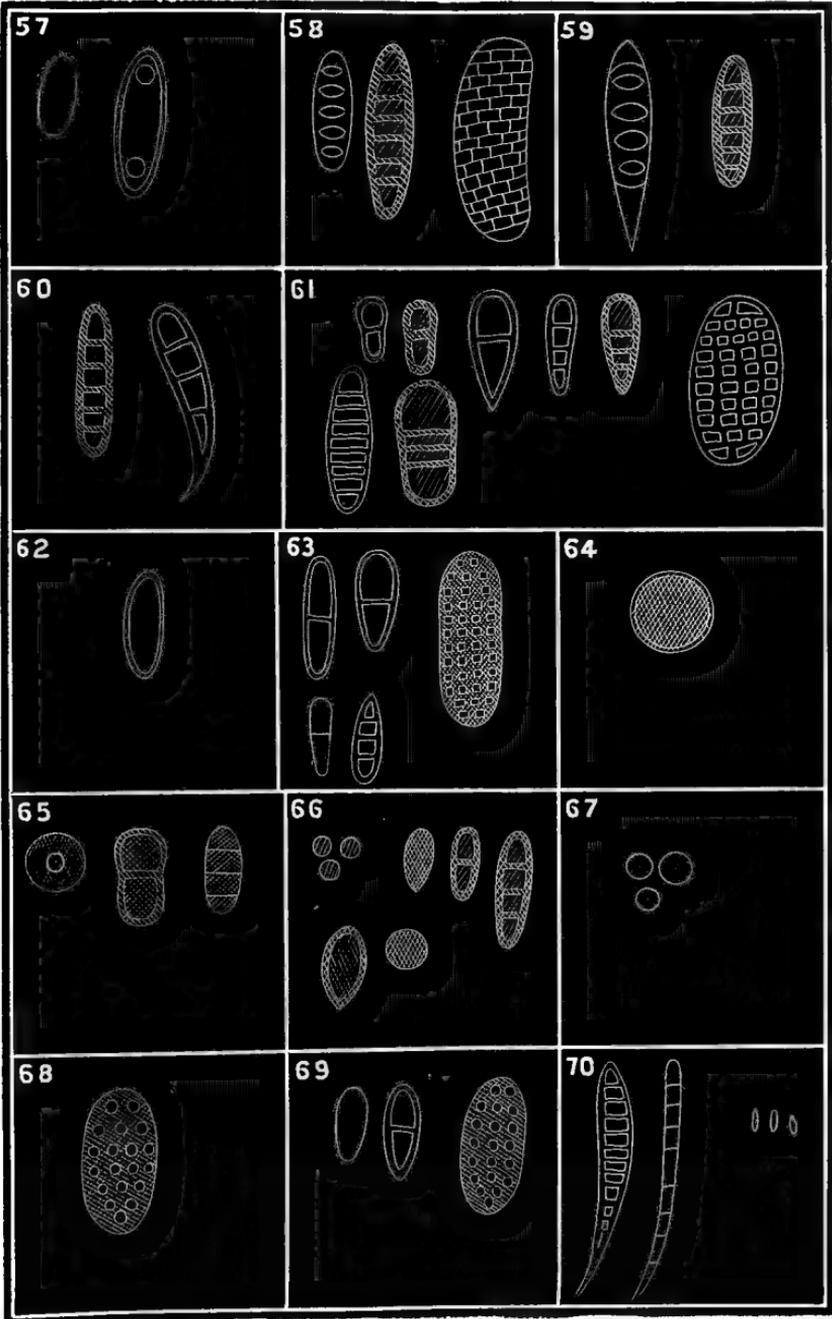


PLATE 9.

57. Xylographa.
58. Graphis.
59. Glyphis.
60. Chiodecton.
61. Arthonia.
62. Agyrium.
63. Mycoporum.
64. Sphærophorus.
65. Acolium.
66. Calicium.
67. Coniocybe.
68. Pyrenothamnia.
69. Endocarpon.
70. Segestria.



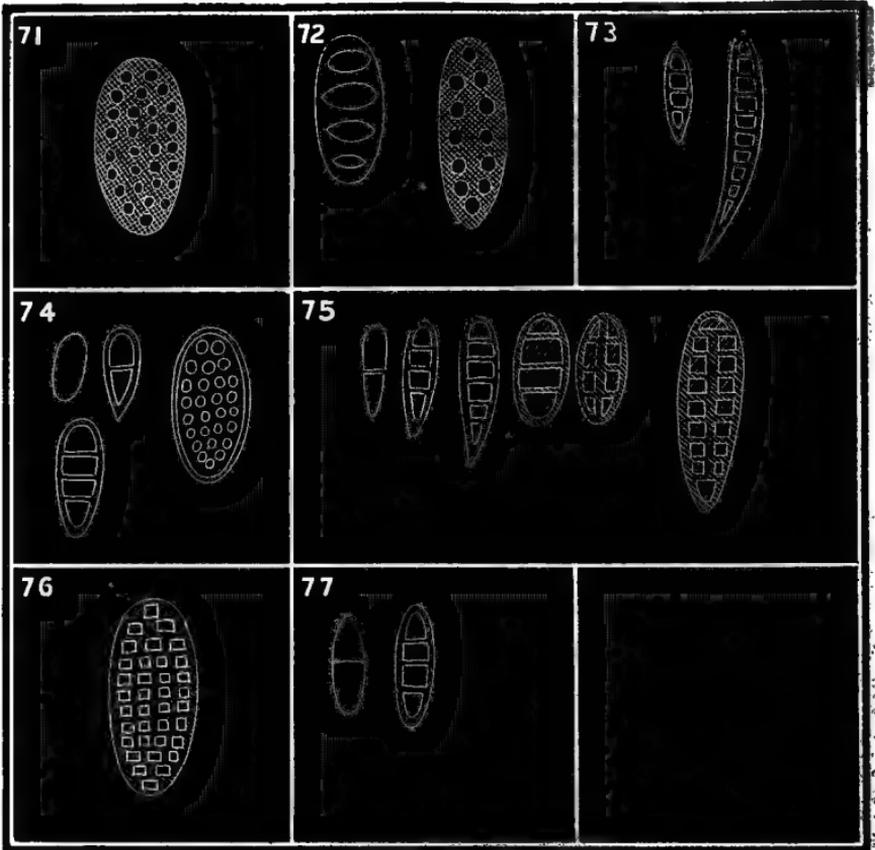


PLATE 10.

- 71. *Staurothele*.
- 72. *Trypethelium*.
- 73. *Sagedia*.
- 74. *Verrucaria*.
- 75. *Pyrenula*.
- 76. *Pyrenastrum*.
- 77. *Strigula*.

