A SURVEY OF THE CORTICOLOUS PYRENOCARPOUS LICHENS OF THE GREAT LAKES REGION

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ABSTRACT

A SURVEY OF THE CORTICOLOUS PYRENOCARPOUS LICHENS OF THE GREAT LAKES REGION

by Richard Clinton Harris

This survey of the corticolous pyrenocarpous lichens in the Great Lakes region treats nine genera and 23 species. The study is based on field work and examination of material from the Farlow Herbarium, Michigan State University, Smithsonian Institution, University of Michigan, University of Wisconsin and the personal herbarium of J. W. Thomson.

The morphology and ecology of these lichens is discussed briefly. Spores are illustrated for all species treated. *Molestia* and *Plagiocarpa* are described as genera new to science. *Arthopyrenia quisquiliae*, *A. thomsonii*, *A. willeyana*, *Pyrenula agawae* and *P. neglecta* are described as species new to science. *Arthopyrenia myricae* (Nyl.) Zahlbr., *Leptorhaphis atomaria* (Ach.) Szatala, *L. parameca* (Massal.) Koerb., and *Polyblastiopsis meridionalis* Zahlbr. are reported as new to North America. *Microthelia wallrothii* (Hepp) Rehm is reported as new to the Great Lakes Region. *Pyrenula nitida* (Weig.) Ach. and *Arthopyrenia alba* (Schrad.) Zahlbr. are excluded from the flora.

A SURVEY OF THE CORTICOLOUS PYRENOCARPOUS LICHENS OF THE GREAT LAKES REGION

BY

Richard Clinton Harris

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INTRODUCTION

This study was designed primarily as a taxonomic survey of the corticolous pyrenocarpous lichens in the Great Lakes region. Very little work has been done in this group in North America. There have been no previous systematic collections made of these lichens made in the Great Lakes region which centers on Michigan including the area adjacent to the Great Lakes as shown in Pl. 1. Bruce Fink collected on the western edge of the area in Iowa and Minnesota, but he apparently had reached no final treatment of this group at the time of his death. Specimens were tentatively named pending a final decision and the same species was often found under more than one name. Thus in order to clarify Fink's species concepts and because of their historical importance many of his collections have been included in this study although they were not collected in the Great Lakes region proper. Several new species have been included in order to place them on record since they probably will be collected in this region eventually. Specimens seen from outside of the Great Lakes region are cited only for taxa of special interest.

The pyrenocarpous lichens seem to be on the boundaries of lichenization and are worthy of study for this reason alone. In view of the difficulty of determining lichenization it was decided to collect all pyrenocarpous fungi in the field and then after preliminary examination in the laboratory to treat further only such material as could be determined to belong to a genus or species which traditionally was considered to be a lichen whether or not an obvious algae containing thallus was present.

A secondary purpose of this study was to become acquainted with the problems of morphology and morphological terminology in the pyrenocarpous lichens preparatory to monographic work in the group. For this reason the discussion of morphology is somewhat more extensive than it otherwise might be.

The lack of knowledge concerning the pyrenocarpous lichens is especially great in regard to their ecology. On account of this the field work also included a brief ecological study designed to provide some basic ecological data about their abundance and relations with the substrate.

I would like to thank the curators of the following herbaria for generous loans of material for this study: Farlow Herbarium, Harvard Univ. (FH), Michigan State Univ. (MSC), Smithsonian Institution (US), Univ. of Michigan (MICH), Univ. of Wisconsin (WIS), and the personal herbarium of J. W. Thomson (Thomson). I would especially like to thank H. A. Imshaug for his advice and guidance during the course of the study.

MORPHOLOGY

Methods

External morphology was studied under a dissecting microscope. Measurements were made with an eyepiece micrometer. For microscopic studies the material was moistened with water and freehand sections were cut with a sharp razorblade. Freezing microtome sections were made for some collections during the earlier stages of the study. Although microtome sections are generally superior, especially for details of ascocarp structure, the large amount of time and difficulty involved precluded their routine use.

Thallus sections were mounted in 10-20% potassium hydroxide (KOH) and examined for the presence of algae. If algae were not immediately obvious, additional sections were mounted in lactophenol-cotton blue, warmed briefly and examined for algae. The cotton blue stains the cytoplasm of the algae but not the bark cells of the substrate making the presence and abundance of the algae easily observable.

Ascocarp sections were routinely mounted in Lugol's iodine (IKI, iodine 1gm, potassium iodide 1gm, water 100gm). Occasionally there are color reactions with the gelatinous material in the ascocarp nucleus. In general, however, the contents of the asci are colored bright orange-red, making them easier to locate. The cytoplasm of the paraphyses or paraphysoids is often colored pale yellow. After it was observed that dilute KOH changed the appearance of the asci, 20% KOH was run in under the edge of the coverslip of the IKI mount and its effects on the ascus were observed.

Several biological stains were tried in an attempt to investigate ascus structure. None were particularly successful. Congo red, recommended by Richardson & Morgan-Jones (1964) is a good cytoplasmic stain but does not seem sufficiently superior to the more easily handled IKI to warrant its routine use. Janus green shows promise for differential staining of parts of the ascus wall but I have not been able as yet to devise a consistently satisfactory procedure for its use. R. A. Shoemaker (1964) has suggested that blue writing ink is very good for staining certain ascus structures. I have not as yet tried it.

Paraphyses and paraphysoids were examined in 10-20% KOH. This dissolves most of the gelatinous material around them and allows their septation and branching to be studied. Potassium hydroxide often causes considerable swelling and if measurements were made in KOH, this fact should be indicated.

Ascus and spore measurements were made in both IKI and KOH. There is little, if any, difference in overall ascus or spore size in the two reagents.

Critical morphological features were recorded for the majority of the specimens by drawing them with the aid of a Wild drawing tube.

Thallus

The thallus in all of the pyrenocarpous lichens examined so far is of the endophloeodal type. The fungus hyphae and algae, if present, occur beneath the upper layers of the bark, penetrating into the bark to varying depths. The alga, in all cases where there is a clear algal layer, is *Trentepohlia*. The amount of algae and hyphae in the thallus varies considerably from species to species. In many cases what appears to be a thallus is in reality an area of roughened, loosened and modified bark cells with relatively few hyphae and often no algae. At the opposite extreme the external layer of the thallus is an almost cortex-like layer of bark cells consolidated with very abundant hyphae. The bark and the hyphae may almost lose their identity. In this type a well-developed algal layer is always present. There seems to be at least a partial series connecting these two end-points. The loose bark, no algal layer type is found in Polyblastiopsis, Leptorhaphis and some species of Arthopyrenia. Dermatina pyrenocarpa has a thallus in which there are scattered clumps of algae in the loose bark-hyphal layer. This species seems to be the only one intermediate in amount of algae. In all other cases there is either a clearly defined algal layer, at least when young, or no algae at all. Many Arthopyrenia species, Plagiocarpa and Molestia have a good algal layer underneath a roughened bark exterior. The most advanced type, in which the thallus appears shiny and smooth due to the cortex-like upper layer, occurs in Pyrenula neglecta and Trypethelium virens. Both of which, it may be noted, are ascohymenial.

Almost half of the species in the Great Lakes region lack an obvious algal layer. Algae are apparently entirely lacking or only a few scattered cells are present on the surface of the bark. These scattered cells never seem to be Trentepohlia. I do not know whether these algae are bark epiphytes or are associated with the fungus. If these species are indeed lichens, it is clear that they are on the borderline of lichenization. Lichenologists and mycologists, on the whole, have paid very little attention to genera which have been considered traditionally to belong in the others domain. Genera and families have been circumscribed to include only fungi or only lichens on the basis that they are two fundamentally different types of organisms. Lichens are now generally considered to be fungi which

which differ from other fungi only in the source of their nutrition. Gradually less and less emphasis is being placed on the source of nutrition, i.e., saprophytic or parasitic and if parasitic whether on higher plants or algae. Distinctions on this basis are being replaced by ones based on ascocarp, ascus and spore morphology. Lichenologists, in general I think, have realized the relative unimportance of nutrition in taxonomy earlier than mycologists. Bruce Fink (1913, pp. 106-107) over fifty years ago stated what he considered the ideal solution to this problem.

> "If we are ever to know the relationships of algicolous to non-algicolous Ascomycetes, lines of cleavage in study must cease to be determined by the food habits of these plants. Forms that appear to be closely related must be studied together, whether all are algicolous, all non-algicolous, or part of them one and part the other."

However, it is only quite recently that mycologists have begun to reconsider some of the genera traditionally passed over as lichens. Butler (1940) suggested that the genus Buellia should include lichenized fungi, lichen parasites and saprophytes. The first comprehensive work to take up this suggestion is that of Mueller and von Arx (1962). H. Riedl (1963, p. 264), a mycologist experimenting with the application of modern mycological taxonomic principles to a group of pyrenocarpous lichens, says in a discussion of Arthopyrenia,

> "Vom Standpunkt der Flechtenorganization aus, ist Arthopyrenia besonders primitiv zu werten, es finden sich bei ihr saemtliche Uebergaenge von nicht lichenisierten ueber seitweilig lichenisierte zu obligat lichenisierten Arten. Aber auch in letzterem Fall handelt es sich wohl nur um eine Form von obligatem Parasitismus."

Riedl also points out that if parasitism on algae is a generic or even a specific criterion, then facultative lichen fungi would have to recieve different names depending on whether algae were present or absent when collected. This is, of course, nomenclaturally absurd.

Even if some of the pyrenocarpous genera can be shown to be completely non-lichenized, they probably will continue to be treated primarily by lichenologists due to the inertia of tradition. These are the reasons why many species which are described as not having associated algae are treated here in a work on lichens.

Ascocarp

Within the class Ascomycetes two fundamentally different types of ascocarp development have been distinguished. Nannfeldt (1932) introduced the terms Ascoloculares and Ascohymeniales for the two types and although they have never formally been given taxonomic rank, they make euphonious descriptive adjectives. The two basic types will be referred to as ascolocular and ascohymenial.

The ascocarp in the ascohymenial type possesses a wall derived from the basal cells of the archicarp, which is the name given to the ascogonium and the cells immediately surrounding it resulting from the stimulus of sexual fusion. A pyrenomycete ascocarp with such a wall around it is properly called a perithecium. The perithecial wall is probably best called the exciple or excipulum. Exciple has been used for both apothecial and perithecial walls by lichenologists, although it is often restricted to apothecia by mycologists. In view of the presumed phylogenetic relationship of ascohymenial discomycetes and pyrenomycetes and in view of the identical origin and function of this tissue in both, exciple seems to be the best term for the perithecial wall. The sterile elements of the hymenium arise from the basal ascogenous layer before the asci and grow upwards. These paraphyses are usually unbranched, not anastamosed and free at their upper ends. The perithecium opens by an ostiole which is schizogenous in origin, resulting from differential growth of the exciple. The terms perithecium, paraphyses and ostiole are usually restricted to ascohymenial ascomycetes by contemporary mycologists.

The ascolocular ascocarp begins as a small patch of vegetative cells which multiply and become carbonized to form an area of stromatic tissue. There is apparently no sexual fusion stimulus involved in the formation of this tissue. Sexual fusion, if it occurs, takes place within this tissue after it has developed. In the simplest types the asci which develop within the stroma are randomly scattered and each dissolves its own chamber in the stroma as it expands. The probable next stage has the asci aggregated into a group or several groups in the stroma. The asci may again dissolve chambers or they may be surrounded by the compressed remains of the original stroma tissue. This tissue has been called either paraphysoid threads (Singer 1963) or interthecial tissue (Luttrell 1965). The most advanced type has a distinct paraphysis-like tissue which grows downward from the top of the stroma before the asci develop. This type of tissue has been called paraphyseid hyphae (Singer) or pseudoparaphyses (Luttrell). They are attached at the top, branched and anastamosed. The ascolocular type of ascocarp with a single chamber is a pseudothecium. Its opening is simply called a pore. Singer (1963) suggests that if the origin of the sterile elements is not definitely known the general term paraphysoid should be used. Since I have made no developmental studies, I will use the term paraphysoid.

The major feature of the ascolocular type is that the ascocarp is a modified stroma in which the asci develop without any seperating wall derived from the archicarp. If a perithecium is embedded in a stroma, the fertile tissue is separated from the stromatic tissue by a distinct wall derived from the archicarp.

Stromata occur in ascohymenial pyrenolichens as well as forming the basis of the ascocarp in the ascolocular pyrenolichens. A stroma may be defined generally as a cushion-like mass of fungus cells and host tissue, in or on which fructifications develop. Some workers, including Johnson (1940) prefer to call a stromatic tissue containing numerous cells from the substrate a pseudostroma. In the ascohymenial species the stroma is an accessory structure surrounding a perithecium or group of perithecia. It tends to contain bark cells and is therefore in most cases a pseudostroma in the sense of Johnson. In _Tryphethelium virens_ the raised area around groups of perithecia is almost all bark mixed with relatively few hyphae. It may or may not be carbonized. In _Pyrenula_ and _Plagiocarpa_ the stroma is reduced to a fairly thin carbonaceous wall-like layer surrounding a single perithecium with various degrees of completeness or forming a shield at the tip of the perithecium. A general term for this stromatic layer is involucrellum (Swinscow 1962). The exciple often separates from the involucrellum. The involucrellum may contain crystals of unknown composition. The involucrellum in some cases is restricted to a shield around the ostiole and should be referred to by the mycological term, clypeus. If the involucrellum is lacking at the base of the perithecium, it may be called a dimidiate involucrellum.

The majority of the ascolocular species have only a single chamber in the stroma which does not usually contain bark cells. Such pseudothecia are found in _Arthopyrenia_, _Leptorhaphis_, _Polyblastiopsis_, _Molestia_ and _Microthelia_. The ascolocular stroma in _Dermatina_ and related genera usually contain c. 2-10 distinct chambers separated from each other by thin layers of stromatic tissue. Each chamber has its own exit pore.

Since the pseudothecium is a modified stroma, the nomenclature used for the wall and accessory structures of an ascohymenial ascocarp cannot be used. It also seems inadvisable to create terms for ascolocular structures by adding -oid to ascohymenial terms. The layer of carbonized stromatic tissue surrounding the fertile tissue is not a wall in the sense that the perithecial wall is, but since there is no other satisfactory term, I will use pseudothecial wall. The term excipuloid layer has been used, but it seems to me that when, as is often the case, the outer part of the stroma is darker than the inner, there is too much temptation to use the term involucrelloid layer also. This is contrary to the fact that there is, in reality, only a single tissue involved. Also the stromatic origin of the involucrellum as opposed to the archicarpal origin of the exciple might tend to be forgoten.

My own studies of the ascocarp, especially in ascolocular species, have been somewhat superficial. In monographic work more use would have to be made of pseudothecial wall characters. Mycologists have based species and even genera on its cellular characteristics (Scheinpflug 1958). Virtually the only character which has been used by lichenologists is whether the "wall" is entire or lacking below (dimidiate). In both ascolocular and ascohymenial types this can only apply to stromatic tissues. This character must be used with great care. There seems to be variation between dimidiate and entire forms within a single species. Therefore the character is probably best treated as a quantitative rather than a qualitative character.

The pseudothecia of several genera may be surrounded by a dark circular or elliptical stain. Keissler (1938) calls this the "hof". It is composed of dark brown hyphae extending outward from the pseudothecial wall and may possibly serve to anchor the pseudothecium to the substrate. It is most highly developed on Betula whose bark flakes off very readily. This structure is not found in any species possessing a well-developed algal layer.

The fertile tissue of the ascocarp taken as a unit is often termed the nucleus, especially when being considered on a more-or-less macroscopic level. The term is very useful in discussing color reactions since the reacting substance has not been definitely localized, although it seems to me to be in the gelatinous material surrounding the paraphyses or paraphysoids. It may be a polysaccharide in view of the blue-green or red-orange reaction with iodine. Iodine reactions are found in both ascolocular and ascohymenial species. These reactions are often used to distinguish species or occasionally varieties. Iodine reactions must be interpreted with great care since the concentration of iodine in the IKI solution used to test the ascocarp section affects the color produced. Also the IKI solution tends to deteriorate fairly rapidly with age and should be freshly made for any critical work. For example, in Plagiocarpa hyalospora too low an iodine concentration results in no reaction. A moderate concentration [redacted] gives a strong blue-green color in the nucleus which may be changed to red-orange by increasing the concentration of iodine. By raising and lowering the concentration the cycle of colors can be run thru several times before it remains permanently red-orange. It is apparently a general rule that a high enough concentration of iodine will finally shift a blue-green color to red-orange, indicating perhaps that there is only a single substance reacting. In Leptorhaphis atomaria the orange color appears at such low iodine concentrations that the blue-green color is not seen or is visible only fleetingly. If the IKI solution is not allowed to become too old these reactions seem quite reliable and are usually correlated with morphological characters.

The nucleus may contain oily substances in large or small amounts and appear as droplets in a KOH mount. The presence or absence of oil in the nucleus seems to be a consistent character at the species level.

Paraphyses and Paraphysoids

As mentioned in the discussion of the ascocarp the sterile elements among the asci have different origins and characteristics. The ascolocular type, paraphysoids, are attached at top and bottom without any free tips. They are usually clearly branched and much anastamosed. They are always septate. The amount of septation and branching varies greatly. At one extreme, found in Leptorhaphis and Polyblastiopsis especially, the paraphysoids are more septate with short cells so that they appear almost parenchymatous. The other extreme is represented by some species of Arthopyrenia where septation and branching are almost non-existent, so that these paraphysoids are difficult to distinguish from true paraphyses. In such cases the ascus type may become the sole criterion of the ascolocular nature of these species.

In our species of the ascohymenial genus Pyrenula the paraphyses are unbranched, apparently non-septate and free at the tips. Plagiocarpa has slightly branched and septate paraphyses. In Trypethelium the paraphyses pose some difficulty since they are anastamosed into a broad meshed net. However, they are not much if at all septate. This broad paraphysis reticulum has not been found in any genera known to have ascolocular development or bitunicate asci. This paraphysis type seems to be an independent development in ascohymenial pyrenomycete evolution. I have also observed anastamosed paraphyses in discomycete lichens, such as _Pertusaria_, but no one has ever suggested that their development is ascolocular.

Asci

As far as I am aware no studies have been made to definitely establish ascolocular or ascohymenial development in any of the pyrenocarpous lichens. This information is merely inferred from the presence of characters which have been shown in other well studied cases to be associated with one type or the other. One is the presence of paraphyses as opposed to paraphysoids. The other major characteristic is that the structure of the ascus can be divided into two types which generally correlate with the type of ascocarp development. The walls of the asci in both types consist of two layers, exoascus and endoascus. In the ascohymenial type the two layers are permanently fused together. The spores are liberated, in most cases, by means of a complicated pore mechanism at the ascus tip. This type is called the unitunicate ascus. In the ascolocular type the two wall layers are not fused. The exoascus is thin and relatively inelastic. The endoascus is usually thick and elastic. When the spores are to be liberated the exoascus splits or an apical exoascus cap is pushed off and then the exoascus expands becoming greatly elongated. The spores are then expelled from the stretched and extended endoascus.

The pore mechanism at the tip of the ascus is less complex. This type is called the bitunicate ascus.

The bitunicate ascus has been demonstrated and illustrated for at least one species in most of the genera treated in this paper as ascolocular (Richardson & Morgan-Jones 1964). I have also observed bitunicate asci in many of the Great Lakes species, especially Arthopyrenia and Polyblastiopsis.

A second phenomenon has been noted which is apparently mainly a feature of bitunicate asci. Unfortunately, it was noticed only recently so that consistent detailed studies have not been made for very many species. When an ascus is treated with dilute KOH the wall at the tip increases considerably in thickness. Sometimes an ascus tip may become 4-5 times thicker. This thickening has not been observed in all species studied but it may occur so slowly that I simply have not watched long enough. This phenomenon seems associated with another common characteristic of bitunicate asci, the dimple of Richardson and Morgan-Jones (1964) or the chambre sous-apicale of Magne (1946). This structure is a narrowing of the ascus cavity just below the tip to form what looks like an indentation in the ascus tip. The dimple may be almost unnoticable, broad and shallow, or small and thimble-shaped, or larger and subglobose. The shape and size of the dimple as seen in asci mounted in IKI or Congo red is a useful character. The shape in KOH is also useful but needs more care in interpretation, since the shape is often changed in KOH. Also in KOH dimples become evident which were not evident or only indistinctly so in IKI. The dimple in KOH is usually a short thimble-shaped tube projecting somewhat into the ascus cavity. It should be noted that the exoascus is apparently unchanged by KOH. The changes in the ascus tip are due to an expansion of the exoascus tip downward into the ascus cavity. This expansion, occurring a short distance back from the tip, could narrow the ascus cavity and emphasize or even create a dimple. Occasionally the endoascus swells for a considerable distance back from the tip and a long narrow canal is formed. It is possible that this expanding layer is responsible for the mechanical splitting of the exoascus or pushing off an exoascus cap in the process of spore liberation. Its reactions in KOH are almost certainly abnormal.

Spores

The classification of the pyrenocarpous lichens is based primarily on differences in spore septation and color. No non-septate spores are known in the temperate-boreal corticolous pyrenolichens. The ascolocular genera have a wide variety of shape and septation but all lack any endospore thickening. The spore lumina are, therefore, cylindrical. They are transversally septate or muriform, colorless or brown. A few species posses a colorless outer layer which expands in KOH and eventually dissolves. It may be gelatinous in nature. Its presence or absence seems to be a reliable character at the species level.

The ascohymenial genera in the Great Lakes region possess a thickened endospore. It is not well-developed in Plagiocarpa but it is highly developed in Pyrenula and Trypethelium. Thickening of the endospore results in the lumina becoming lenticular, ellipsoidal or globose instead of cylindrical. The position of the lumina in relation to the outer spore wall is important. All three of the genera mentioned have transversally septate spores. Pyrenula spores are 3-septate and brown, Plagiocarpa 3-septate and colorless, Trypethelium 7-9-septate and colorless.

Pycnidia

The structures which I am treating as the imperfect states of the pyrenolichens are considered by some to be spermatia. The fusion of the spores produced with a trichogyne has never been demonstrated and until such information is available it seems best to treat them as asexual reproductive imperfect states.

The type of perfect state recognized for the pyrenolichens is the pycnidial type. Pycnidia are quite common scattered among the ascocarps. They are generally similar in appearance to the ascocarps but usually much smaller, c. 1mm in diameter. The pycnidia known for all the ascolocular species and for Pyrenula are simple one-chambered pycnidia. In Trypethelium virens the pycnidia are labyrinthiform.

The conidia produced in these pycnidia are normally borne on relatively short unbranched conidiophores. Conidia in the pyrenolichens have been divided into two kinds on the basis of size: macroconidia and microconidia. The macroconidia are often pigmented and septate while microconidia are usually hyaline and simple. The conidia in ascolocular species tend to be short rods, while in the ascohymenial species they tend to be longer, often filiform and curved. More attention should be paid to conidia since they may reveal fundamental groupings in the pyrenolichens.

ECOLOGY

In view of having only a short time available in the field and in view of the taxonomic difficulties in attempting any detailed ecological studies of corticolous lichens, it was decided to keep the ecological study as simple as possible, especially since not even the most basic data have been collected previously for any corticolous pyrenocarpous lichens. In this study ten different forest stands were chosen for their interest or convenience. A tree was picked in what seemed on inspection to be a fairly homogeneous area. The next hundred trees over 10 cm in diameter at breast height away from the starting point were sampled moving in a single direction to avoid repetition. The species and diameter were recorded for each tree. All pyrenocarpous lichens were collected. The height above ground, the side of the tree and a rough approximation of the area covered were recorded for each collection. The data are in no way rigorous and provide only general indications of the abundance, relations to the substrate and distribution of this little known group of lichens. Summations of the basic data for each stand are to be found in Appendix I. The stands have been roughly characterized according to the system of Curtis (1959). The location of the sample stands is shown in Pl. 1.

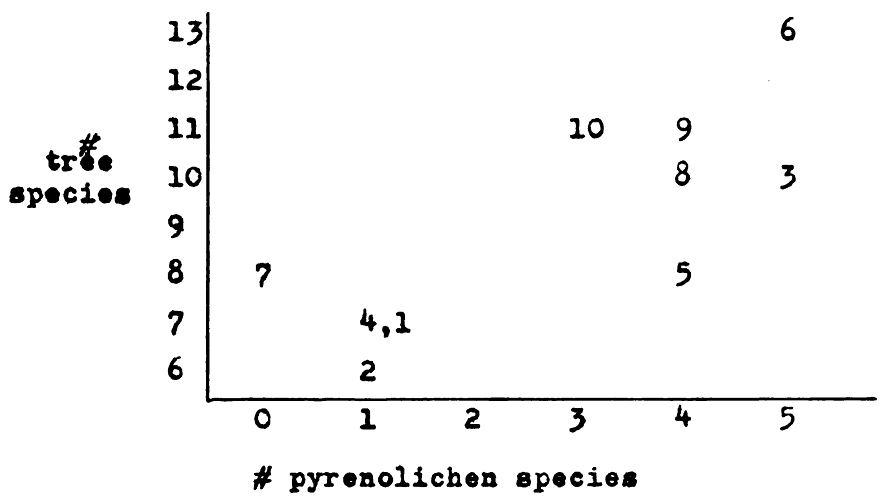
The percentage of trees with pyrenolichens (Table 1) normally seems to range from 4 to 23. The Newaygo stand (7) which was extremely dry (Opuntia nearby) had no pyrenolichens at all. The Pine Grove stand (5) had a very high pyrenolichen cover but it was almost all a single species, Polyblastiopsis fallaciosa, which coated all of

the young maples dominating the stand. The number of pyrenolichen species ranged from 0 to 5; the number of tree species from 6 to 13.

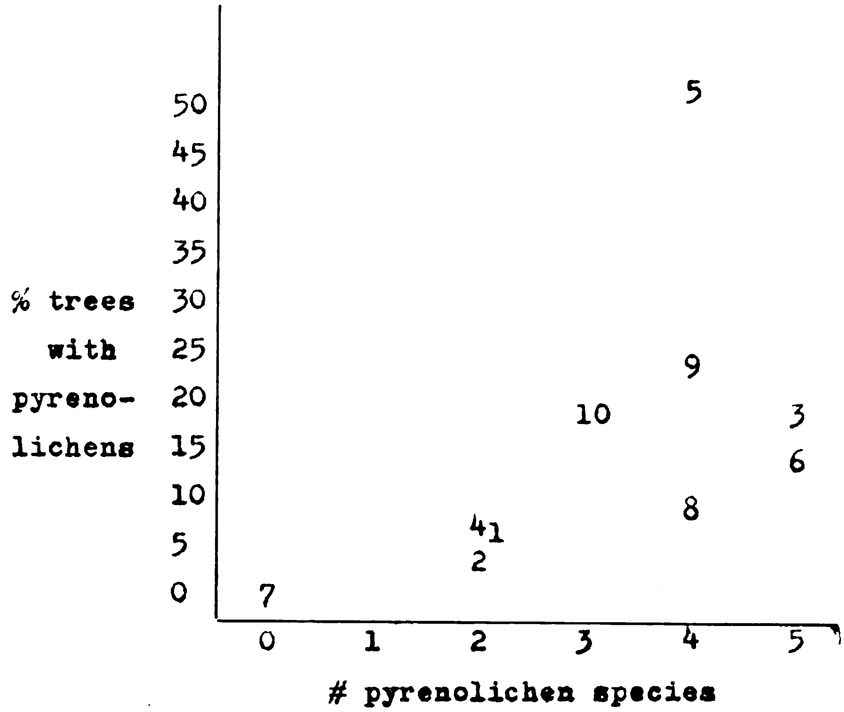
Table 1. Summation of the number of pyrenolichen and tree species and the percentage of the trees with pyrenolichens.

Stand	# lichen species	# tree species	% trees with lichens
1	2	7	6
2	2	6	4
3	5	10	17
4	2	7	7
5	4	8	53
6	5	13	13
7	0	8	0
8	4	10	9
9	4	11	23
10	3	11	16

If the number of tree species is graphed against the number of lichen species for each stand, there seems to be a tendency for both to increase together.



Likewise the percentage of trees with pyrenolichens increases with an increase in the number of pyrenolichen species.

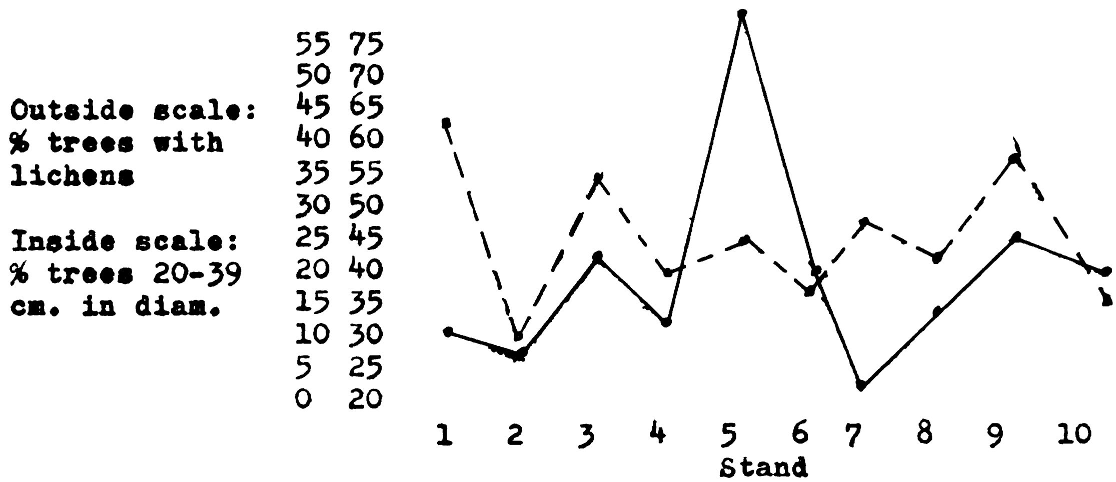


If the stands are arranged in a north to south order and the percent occurrence of each species is listed for the stands, it seems evident that there are two groups; one occurring south of Clare, Michigan and the other north of Clare. Of the three species which occur on both sides of the line, it is interesting to note that Microthelia micula represents a species group and I have suspicions that there may be more than one species included in Polyblastiopsis fallaciosa.

Table 2.

Species	South				Stand				North	
	9	10	8	7	6	5	4	2	3	1
Arthopyrenia sphaeroides	1									
A. finkii	1									
A. willeyana	17	11	5							
Tryphethelium virens			2			2				
Polyblastiopsis fallaciosa	13	3	1		2	49	1		2	
Microthelia micula		5			1	1		33	4	5
Pyrenula neglecta					1					
Molestia leucoplaca					1	1	6		4	
Leptorhaphis epidermidis									6	
L. atomaria									1	
Pyrenula agawae										1

There are faint indications that the occurrence of the pyrenolichens is related to the age of the tree which it grows on. In general it can be seen that the percentage of trees with pyrenolichens increases with the percentage of trees in the 20-39 cm. diameter class and decreases with the increase of trees under 20cm. or over 40cm.



There are two exceptions to the tendency for correlation of tree diameter and occurrence of pyrenolichens as shown in the graph above. The very dry Newaygo stand (7) had no lichens at all. The Pine Grove stand (5) was dominated by Polyblastiopsis fallaciosa which seems to have a preference for the conditions on young Acer saccharum but older Quercus alba as shown in Table 3.

Table 3.

Diameter in cm.	10-19	20-29	30-39	40-
% Acer saccharum available	46	32	10	11
% Acer saccharum with Polyblastiopsis	66	32	2	0
% Quercus alba available	20	26	24	30
% Quercus alba with Polyblastiopsis	0	0	44	66

The only other species with enough collections to show any trend in preferring substrate trees with a certain diameter is Arthopyrenia willeyana which apparently has a preference for older trees. Since there were not enough collections from any one tree species, all the species which A. willeyana occurred on have been combined in a single table (Table 4).

Table 4

Diameter in cm.	10-19	20-29	30-39	40-
% trees available	24.5	22	20	33.5
% trees with A. willeyana	0	24	22	54

The final ecological factor which may be worthy of comment is the tendency for species with well-developed algal layers to be able to live on a greater variety of sustrates (Table 5). The data are compiled from herbarium material and my own collections.

Table 5

Species	Algae	# substrate trees
Arthopyrenia willeyana	good layer	9, on lignum also
Plagiocarpa hyalospora	" "	5, on lignum also
Pyrenula neglecta	" "	4
Molestia leucoplaca	" "	4
Arthopyrenia sphaeroides	layer	3
Dermatina pyrenocarpa	scattered	3
Arthopyrenia finkii	good layer	2
A. quinqueseptata	layer	2
A. quisquiliae	"	2
Trypethelium virens	good layer	2, on 5 outside G.L.
Pyrenula agawae	layer	1
Average		3.4
Polyblastiopsis fallaciosa	absent	5
Arthopyrenia punctiformis	"	4
Polyblastiopsis meridionalis	"	2
Leptorhaphis parameca	"	2
L. atomaria	"	1
L. contorta	"	1
L. epidermidis	"	1

Polyblastiopsis lactea	absent	1
Melanomma sp.	"	1
Microthelia wallrothii	"	1
Arthopyrenia myricae	"	1
Average		1.8

It would appear that on the average those pyrenolichens with a good algal layer occur on twice as many tree species as those without algae.

A table of the species of tree which the various pyrenolichens occur on will be found in Appendix II.

TAXONOMY

Family Classification

The delimitation of families in the pyrenocarpous lichens is at present in a state of chaos due to the relatively recent upheaval caused by the discovery of the two fundamental types of ascocarp development.

According to Zahlbruckner (1926) the genera occurring in the Great Lakes would be placed in three families. *Trypethelium* is our only representative of the Trypetheliaceae Zahlbr. It can be characterized as possessing perithecia embedded in a pseudostroma. Mycoporaceae Zahlbr., having more than one chamber in the ascocarp, is also known from the Great Lakes by a single genus, *Dermatina*. All of the remaining genera were included in the Pyrenulaceae Zahlbr. Of these *Arthopyrenia*, *Leptorhaphis*, *Polyblastiopsis* and *Microthelia* have been shown to possess bitunicate asci (Richardson & Morgan-Jones 1964) and are, therefore, presumably ascolocular. *Pyrenula*, however, is ascohymenial. Since it is the type genus of the Pyrenulaceae, the ascolocular genera must be excluded from the family. *Pyrenula* and *Plagiocarpa* are the two genera of the Pyrenulaceae occurring in the Great Lakes region. Riedl (1962) has united the Mycoporaceae, which is clearly ascolocular, with the other ascolocular genera removed from the Pyrenulaceae. This seems to me to be taxonomically correct but there is a nomenclatural problem as to what the correct name for this family is. This group seems to be closely related to genera in the traditionally non-lichen family Pleosporaceae Lindau. Many of the species treated in this paper are at best facultative lichens. Thus it seems best not to make any family distinction based on lichenization. The Pleosporaceae, dating from 1897, is clearly the oldest available name for the family. It should be noted here that I am not reccomending that all lichen families should be united with non-lichen families. It is clearly not warranted in most cases, but in this case where the relationships are clear and where the boundaries of lichenization are tenuous, uniting the two groups seems justifiable. If one wishes to maintain a separate lichen family, the correct name would seem to be the Xanthopyreniaceae Zahlbr. (Engler & Prantl, Nat. Pflfam. ed. 2. 8: 91. 1926). Riedl (1962) uses as the oldest name Mycoporaceae Zahlbr. (1903) but the generic name Mycoporum Flotow in Koerb. (Grundriss der Cryptogam. 199. 1848) is a later homonym of Mycoporum Meyer (Nebenstudien 327. 1825) and is therefore illegitimate. The family name is also illegitimate unless conserved (Int. Bot. Code. 1961ed. Art. 64, Art. 17 note 1). Article 17 was modified in the 1961 edition of the Code so that Riedl's choice of names was possible at the time he made it. Xanthopyrenia Bachmann is distinguished from Arthopyrenia only in possessing Xanthocapsa rather than Trentepohlia as the phycobiont. The general trend as indicated in the discussion of thallus morphology is to regard the phycobiont as unimportant and not worthy of generic recognition (Riedl 1963, Morgan-Jones & Swinscow 1965). Thus if Mycoporaceae is unavailable and Xanthopyrenia is included in Arthopyrenia, the next available name is Xanthopyreniaceae. If one does not consider Xanthopyrenia to be closely related to Arthopyrenia and maintains them in separate families the next available name is Arthopyreniaceae Watson (New Phytol. 28: 107. 1929). The Arthopyreniaceae, as circumscribed by Watson, is actually the best fit for the present grouping and would require very little modification. However, since I do not believe lichenization to be imporatant in this group, I will include the ascolocular pyrenocarpous lichens in the Pleosporaceae Lindau.

Key to the species of Great Lakes pyrenocarpous lichens

1. Ascocarp containing more than one chamber, chambers separated by thin uncarbonized sterile layers------------------------------ 2

1. Ascocarp containing only a single chamber (if more than one are joined then each with an entire carbonaceous wall)-------------3

 2. Spores muriform, brown---------------Dermatina pyrenocarpa

 2. Spores transversally 1-septate--------------(Mycoporellum)

3. Walls of spore thickened, lumina of spores therefore lenticular or spherical, never muriform-----------------------------------4

3. Walls of spore not thickened, lumina of spores therefore cylindrical, sometimes muriform-------------------------------------6

 4. Spores hyaline, 7-9-septate, perithecia in groups embedded in a pseudostroma-------------------Tryphethelium virens

 4. Spores brown, 3-septate, perithecia not in a pseudostroma---5

5. Thallus well-developed, hymenium with abundant oil droplets, IKI+ blue-green, terminal lumina of spores directly against the outer spore wall-------------------------Pyrenula neglecta

5. Thallus poorly developed, hymenium without much oil, IKI-, terminal lumina of spores seperated from the outer spore wall by a layer of endospore-----------------------Pyrenula agawae

 6. Spores brown---7

 6. Spores colorless (occ. becoming tinted in old age but if so almost always shrunken and obviously defunct)-----------10

7. Spores 1-septate---8

7. Spores more than 1-septate----------------------------------9

 8. Hyphae at base of pseudothecium, not nucleus, IKI+ violet, occurring on Betula papyrifera-----Microthelia wallrothii

8. Hyphae at base of pseudothecium IKI-, on a wide variety of trees other than Betula papyrifera ---Microthelia micula group

9. Spores constantly 3-septate with a thick gelatinous outer layer, always on Populus tremuloides, algae lacking---Melanomma sp.

9. Spores more than 3-septate, usually 5-6-septate, without gelatinous outer layer, on a variety of trees, algal layer well-developed-----------------------------------Molestia leucoplaca

10. Spores muriform---11

10. Spores transversally septate----------------------------13

11. Asci initially with four spores, spores 35-45 x 12-13μ-------- Polyblastiopsis lactea

11. Asci initially with eight spores, spores up to 25 x 10μ-----12

12. Pseudothecial wall green or greenish-brown-------------- Polyblastiopsis meridionalis

12. Pseudothecial wall brown------Polyblastiopsis fallaciosa

13. Spores cylindrical-fusiform to acicular, in one or two bundles in the ascus, which is little longer than the spores--------14

13. Spores oval to fusiform, strung out in the ascus, which is several to many times longer than the spores----------------17

14. Spores under 30μ in length-------------------------------15

14. Spores over 30μ in length--------------------------------16

15. Nucleus IKI-, spores often with pointed ends, on Betula papyrifera--------------------------Leptorhaphis epidermidis

15. Nucleus IKI+ orange (occ. initially pale bluish), spores with rounded ends, on Populus----------------Leptorhaphis atomaria

16. Nucleus IKI-, on Populus tremuloides-------------------- Leptorhaphis contorta

16. Nucleus IKI+ bluish, on Prunus and Betula papyrifera---- Leptorhaphis parameca

17. Spores in a single row in the ascus, ellipsoid with rounded ends and two equal cells-------------------------------------18

17. Spores in more than one row in the ascus, or if in a single row not ellipsoid and equal two-celled---------------------19

18. Spores 35-60 x 15-23μ, pseudothecia 0.5-1.0mm in diameter
Arthopyrenia finkii

18. Spores 21-27 x 10-12μ, pseudothecia 0.5-0.8mm in diameter
(Arthopyrenia alba)

18. Spores 11-15 x 6-8μ, pseudothecia 0.3-0.5mm in diameter
Arthopyrenia sphaeroides

19. Spores more than 1-septate------------------------------------20

19. Spores 1-septate (very rarely becoming 3-septate)-----------22

20. Mature spores 5-7-septate, nucleus IKI-, ---------------
Arthopyrenia quinqueseptata

20. Mature spores 3- rarely 4-septate---------------------21

21. Nucleus IKI+ greenish-blue becoming orange, pseudothecial wall brown---------------------------------Plagiocarpa hyalospora

21. Nucleus IKI-, pseudothecial wall green---Arthopyrenia myricae

22. Spores narrow, 2-4μ, in a single row in the ascus-------
(Arthopyrenia quisquiliae)

22. Spores broader than 4μ, in more than one row in the ascus
---23

23. Pseudothecium hemispherical and shiny, not much immersed, asci clavate or cylindrical-clavate, spores coming to a slightly rounded point at both ends-------------Arthopyrenia willeyana

23. Pseudothecium not hemispherical and shiny, often immersed, spores truncate at least at one end-------------------------24

24. Pseudothecium c. 0.1mm in diameter, flattened, often with a dark hyphal ring, asci obclavate, 2-4 times as long as broad--------------------------Arthopyrenia punctiformis

24. Pseudothecium 0.3-0.5mm in diameter, hemispherical, asci long cylindrical or cylindrical-clavate, (4)5-7 times as long as broad---------------------Arthopyrenia thomsonii

PLEOSPORACEAE Lindau

Engler & Prantl, Natuer. Pflanzenfam. I. Teil, Abt. 1. 428. 1897.

ARTHOPYRENIA Massal.

Ricerch. Auton. Lich. 165. 1852.

Verrucaria*Leiophloea Ach. Method. Lich. suppl. 24. 1803.

Leiophloea (Ach.) S. Gray, Natur. Arrang. Brit. Plants I: 495. 1821.

Pyrenillium Clem. Gen. Fungi 41. 1909.

Ascocarp a pseudothecium, spores hyaline, transversally septate with cylindrical lumina.

The oldest name for this genus is Leiophloea (Ach.) S. Gray. Arthopyrenia Massal. will have to be conserved unless one wishes to split the genus as Riedl (1962) has done and use Leiophloea for those species with 1-septate spores and Arthopyrenia for those with more than 1-septate spores. Riedl fails to discuss Clements' (1909) treatment which also separated the 1-septate spored species from the multiseptate spored species. Arthopyrenia was retained by Clements as the multiseptate genus and typified it with A. pyrenuloides (Fee) Muell. Arg. The typification is incorrect since this species was not included in the original publication of the genus. A genus, Pyrenillium, was erected for the 1-septate species which is, therefore, a synonym of Leiophloea. From the few observations I have made in this genus it seems that the trend toward spores with more than a single septum occurs in several natural groups within the genus which are not closely related. The division suggested by Clements and Riedl seems unnatural and can be justified only on grounds of convenience in pigeon-holing species. Until relationships within the genus can be more carefully assessed it seems best to maintain a single genus and to conserve Arthopyrenia Massal against Leiophloea (Ach.) S. Gray.

Arthopyrenia is often cited as having been emended by Mueller Arg. (Mem. Soc. Phys. Hist. Nat. Geneve, 16: 428. 1862.). Mueller actually emended Arthopyrenia Massal. 1854(not 1852). Massalongo (1854) erected the genus Acrocordia for some species removed from Arthopyrenia. Mueller's emendation consists of placing Acrocordia back in Arthopyrenia as a section and adding two other sections. One of these, Pseudosagedia, has had all of its species transferred to Porina. The other, Leptorhaphis, is generally recognized as a distinct genus. Massalongo's (1852) original genus included a species, A. gemmata which he later included in Acrocordia so that Mueller's emendation was unecessary in this respect. Therefore, unless one wishes to include Porina or Leptorhaphis, Arthopyrenia cannot be cited as having been emended by Mueller Arg.

Arthopyrenia finkii Zahlbr.

Cat. Lich. Univ. I: 306. 1921.

Pyrenula gemmata var. macrocarpa Willey, Enumer. Lich. New Bedford 38. 1892.

Pyrenula megalospora Fink, Minn. Bot. Stud. 2: 329. 1899.

Arthopyrenia macrospora Fink, Contr. U.S. Nat. Herb. 14: 237. 1910. (non J. Stein. 1909).

Thallus endophloeodal, pale gray to whitish, smooth, with a hyaline cortex-like layer 10-20(35)µ thick. Trentepohlia abundant. Pseudothecia scattered, dark brown to blackish, matt, subspherical, 0.5-1.0mm in diameter, one third to almost completely immersed. Pore often at the end of a short neck, ocassionally displaced from the vertical. Pseudothecial wall entire, brown above and below, or hyaline below appearing dimidiate, 30-70µ thick, thinner below. Nucleus IKI-. Paraphysoids c. 1µ thick, not obviously septate, branched and anastamosed, persistent. Asci long cylindrical, usually with a distinct subglobose dimple, unchanged in KOH, 170-250 x 15-25µ. Spores initially eight in the ascus but 1-4 spores often aborting, hyaline, ellipsoid with blunt or somewhat pointed ends, 1-septate with equal cells, slightly constricted at the septum especially in age, wall uniformly c. 2µ thick, 33-48 x 15-23µ.

Arthopyrenia finkii has the largest spores and pseudothecia of an apparent series within the genus *Arthopyrenia*, sometimes recognized as a separate genus *Acrocordia* Massal., which have a similar sopre, ascus and parphysoid type differing primarily in size of spores and pseudothecia. *Arthopyrenia sphaeroides* is the smallest member; *A. alba* (Schrad.) Zahlbr. is intermediate. *Arthopyrenia alba* apparently does not occur in North America. All specimens in herbaria so far seen under the name *A. alba* or *A. gemmata* have been incorrectly identified.

This species occurs from southern Minnesota to western Pennsylvania and on the East Coast in Massachusetts and Maryland.

Specimens seen.

UNITED STATES

IOWA: Jones County, Wapsipinicon, south of Anamosa, Imshaug 28092 (MSC).

MARYLAND: Baltimore County, ravine at Catonsville, Plitt 402, 14 Jan. 1911 (US), Union Dam, Plitt 208, 12 Sept. 1907 (US).

MASSACHUSETTS: Bristol County, New Bedford, Willey (US).

MICHIGAN: Kalamazoo County, Kellog Forest north of Augusta, Harris 141 (MSC); Washtenaw County, Crooked Lake, Harris 870 (MSC).

MINNESOTA: Blue Earth County, Mankato, Fink 209, 1 July 1899 (MICH, TYPE); Yellow Medicine County, Granite Falls, Fink 576, 11 July 1899 (MICH).

PENNSYLVANIA: Huntingdon County, Penn State College Nature Camp, Thomson 1789 (Thomson).

WISCONSIN: Green Lake County, T16N, R13E, sect. 18, Hale 1251 (WIS); Vernon County, T12N, R4W, sect. 26/35, Hale 1223 (WIS), Wild Cat Mtn. State Park, Thomson 12818 (WIS).

Arthopyrenia myricae (Nyl.) Zahlbr.

Annal. Naturh. Hofmus. Wien. 18: 365. 1903. Verrucaria myricae Nyl. Flora 52: 297. 1869.

Verrucaria epidermidis var. aeruginella Nyl. Notiser ur Sällsk. Faun. Fl. Fenn. Forhandl. 8: 173. 1866. Verrucaria aeruginella Nyl. Flora 55: 365. 1872.

In 1872 Nylander combined V. myricae with V. epidermidis var. aeruginella, raising the variety to species level as the name for the combined taxon, treating V. myricae as a synonym. However, according to the International Code of Botanical Nomenclature the correct epithet is myricae since it is the first one used at the species level.

Description modified from Keissler (1938). "Thallus" effuse, indicated by a paler grayish or brownish area on the bark. No algae seen. Pseudothecia scattered, black to greenish-black, elliptical, 0.2-0.4mm long by 0.1-0.2mm wide, flattened. Pseudothecial wall lacking below, including bark cell, green to greenish-brown or greenish-black, changing to reddish-purple in nitric acid, 25-35µ thick.

Nucleus IKI-. Paraphysoids c. 1μ thick, septate, much branched and anastamosed. Asci cylindrical, tip 2-5μ thick, without dimple; expanding in KOH to 6-10μ thick, inner ascus tip protruding 2-3μ into the ascus cavity, without any visible canal in the tip; 50-70 x 10-15μ. Spores eight in the ascus, roughly biseriate, fusiform with slightly pointed ends, 3-(4)-septate, cells approximately equal, constricted at the septa; 18-22 x 6-8μ.

This European species has not been reported from North America before. It is easily recognized by the greenish pseudothecial wall and the three-septate spores. Only a single collection from Isle Royale on Abies can be definitely referred to this species. Several collections from Iowa and Illinois on Quercus also have a greenish pseudothecial wall and three-septate spores but the asci are longer, up to 120u, and the spores are somewhat larger and not at all pointed at the ends.

Exsiccati examined. Krypt. Vind. 861 (FH) and 3477 (US); Magn. 127 (FH).

Specimens seen.

UNITED STATES

MICHIGAN: Keweenaw County, Isle Royale National Park, Rock Harbor, Lowe 567 (MICH).

Arthopyrenia punctiformis Massal.

Ricerch. Auton. Lich. 168. 1852.

Massalongo in his publication of this species clearly is not transferring a species as conceived by any earlier author and does not cite any basionym except Verrucaria punctiformis auct. Thus the priority of this name must date from 1852 and not from Persoon 1794 or Schrank 1789, whose species Massalongo is often cited as having transferred into Arthopyrenia. Vainio (1921) credits Arthopyrenia punctiformis to Arnold (1871), specifically excluding Massalongo's species. He does not give any reasons for this treatment and if the Massalongo type should prove to be a different species, a new epithet will be needed since A. punctiformis Arnold is a later homonym.

Description. Thallus endophloeodal or apparently absent, indicated only by a lighter area on the bark. No algae seen. Pseudothecia scattered or rarely clustered and fused, dark brown or black, circular to elliptical in outline, hemispherical to flattened, c. 0.1mm in diameter; occasionally surrounded by a ring of dark hyphae; initially covered by a thin layer of bark but soon entirely uncovered. Pseudothecial wall lacking below, 20-30µ thick. Nucleus IKI-. Paraphysoids thick, 2-3µ, septate and much branched with an almost parenchymatous appearance, often appearing moniliform in KOH. Asci obclavate, clearly broadest below the middle, wall thickest at the tip, expanding strongly in KOH; (30)-40-60 x 12-20µ. Spores eight in the ascus, irregularly arranged, hyaline, 1-septate, cells somewhat unequal with the lower one longer and narrower than the upper, usually not constricted at the septum; occasionally with a gelatinous outer layer; 16-22 x 5-6µ.

There is variation in the collections which I have included in this species in regard to the size of the spores, reactions of the asci in KOH and the nature of the paraphysoids. However, they all have short squat asci enlarged in the lower part and much thickened at the tip in KOH. Until these variations can be interpreted thru study of more material than is now available, they are best left together under A. punctiformis.

This species occurs on smooth, young bark of Acer, Quercus, Populus and Betula throughout the Northeastern United States. A single specimen has been seen from Arizona.

Specimens seen.

UNITED STATES

MICHIGAN: Alger County, Kingston Lake, Harris 661 (MSC), Laughing Fish Point, Deerton, Lowe 1929 (MICH); Charlevoix County, Fox Lake, Beaver Island, Imshaug 27485 (MSC); Keweenaw County, Isle Royale Nat. Park, Angleworm Lake, McFarlin & Bronn 580a (MICH, US).

MINNESOTA: County unknown, Minneapolis, Fink 35, 1896 (MICH); Ottertail County, Battle Lake, Fink 18, 18 June 1900 (MICH).

OHIO: Franklin County, Georgesville, Bogue, 1895 (MICH, US).

Arthopyrenia quinqueseptata (Nyl.) Muell. Arg.

Flora 68: 326. 1885. Verrucaria quinqueseptata Nyl. Mem Soc. Acad. Maine-et-Loire 4: 58. 1858. (Expos. Syn. Pyrenocarp.).

Thallus endophloeodal, light gray to whitish, smooth. Trentepohlia abundant. Pseudothecia scattered to clustered and partially fused, black, occasionally slightly shiny, hemispherical, mostly only about one third immersed but rarely almost entirely immersed. Pseudothecial wall dimidiate or entire but very thin below, brown above, hyaline below if entire and appearing dimidiate, 24-30µ thick. Nucleus IKI-. Paraphysoids c. 1µ thick, septate but not much branched or anastamosed. Asci cylindrical-clavate, somewhat thickened at the tip, with a small apical dimple, expanding very slightly in KOH; 60-65 x 10-15µ. Spores eight in the ascus, biseriate or triseriate, hyaline, fusiform, often slightly narrower at one end, 5-(7)-septate transversally, often with 1-2 cells longitudinally septate, not or only slightly constricted at the septa; 19-25 x 5-7µ.

Pycnidia often present, black, c. 0.1mm in diameter. Macroconidia hyaline, cylindrical fusiform with rounded ends, mostly 7-septate, 22 x 5µ.

This is a very interesting species in several respects. The tendency for the spores to become longitudinally septate would lead one to think that it might be intermediate between *Arthopyrenia* and *Polyblastiopsis*. However, the extremely paraphysis-like paraphysoids make this unlikely since the paraphysoids in *Polyblastiopsis* are usually almost parenchymatous. The species is also difficult to separate from *Porina* since the paraphysoids are so little branched and anastamosed. A very closely related species, *Arthopyrenia faginea* (Schaer.) Swinsc., has only very recently been transferred from *Porina* (Swinscow 1965). The American species differs only slightly from that species. The spores in *A. faginea* are larger and consistently have seven transverse septa with no tendency to become submuriform. Both species, as does the also related *Porina affinis* (Massal.) Zahlbr., possess a unique type of fusiform multiseptate macroconidia. *Porina affinis* has not yet been transferred to *Arthopyrenia* but Swinscow (1965) has suggested that it should be.

I have not collected this species in the Great Lakes region. Specimens have been seen from Iowa, Minnesota and Pennsylvania so that it seems that the species should eventually be found in our area.
Exsiccati examined. Cummings I. 299 (MICH, MSC); Cummings II. 250 (MSC).
Specimens seen.

UNITED STATES

ILLINOIS: Menard County, Athens, *Hall*, 1878 (MICH).

IOWA: Fayette County, Fayette, *Fink*, June 1893 (WIS), *Fink*, June 1894 (MICH), Fink, 1895 (US), Fink, 1896 (US).

MINNESOTA: Beltrami County, Red Lake, Fink 887, 26 July 1900 (MICH); Blue Earth County, Mankato, Fink 208, 4 July 1899 (MICH).

PENNSYLVANIA: Chester County, locality unkown, collector unknown, Hb. E. Michner, 1852 (MICH), West Chester, Windle, July 1898 (MICH, MSC).

Arthopyrenia quisquiliae sp. nov.

Thallus endophloeodal, pale gray, smooth, *Trentepohlia* present, well-developed but not abundant. Pseudothecia scattered or clustered and occasionally fused, black, mostly shiny, subglobose to slightly conical, about one third immersed, 0.3-0.4mm in diameter. Pseudothecial wall entire or dimidiate, brown above, 30-60µ thick, thinner below and colorless, or lacking below. Nucleus IKI-. Paraphysoids c. 1µ thick, septate, slightly branched and anastamosed. Asci cylindrical, not thickened at the tip, without an obvious dimple; tip expanding in KOH forming a small dimple. Spores eight in the ascus, obliquely uniseriate, fusiform, 1-septate with equal or slightly unequal cells, slightly constricted at the septum, occasionally somewhat bent, 14-20 x 2-4µ.

No species has been described in the temperate or boreal floras with such narrow spores uniseriate in the ascus. Unless there is a tropical species name available, this is clearly a new species.

This species has not yet been found in the Great Lakes region but it should be expected since it occurs in Iowa and Minnesota. The only collection for which the substrate is identified is on *Ulmus*.

Specimens seen.

UNITED STATES

ILLINOIS: Fulton County, Canton, Wolf (US).

IOWA: Boone County, Fink, 27-8 July 1903 (MICH); Fayette County, Fayette, Fink, 1896 (MICH, MSC, US); Jones County, Wapsipinicon, south of Anamosa, Imshaug 28103 (MSC).

MARYLAND: Baltimore County, Beaman's Run, Plitt, 1 Dec. 1911 (US).

MINNESOTA: Beltrami County, Red Lake, Fink (MSC).

Arthopyrenia sphaeroides (Wallr.) Zahlbr.

Engler & Prantl, Natuerl. Pflanzenfam. I Teil, Abt. I*: 65. 1903.

Verrucaria sphaeroides Wallr. Flora Crypt. Germ. 3: 300. 1831.

Thallus endophloeodal, pale gray to whitish, slightly roughened to smooth. Trentepohlia abundant, well-developed, forming short chains. Pseudothecia scattered, dark brown to black, occasionally somewhat shiny, hemispherical, one third to two thirds immersed, 0.3-0.5mm in diameter. Pseudothecial wall entire, brown above but mostly hyaline below and appearing dimidiate, 60-80µ thick above, thinner below. Nucleus IKI-. Paraphysoids c. 1µ thick, not obviously septate, branched and anastamosed. Asci cylindrical, with an obvious dimple in the tip, unchanged in KOH, 80-90 x 9-10µ (80-120 x 8-14µ, Keissler 1938). Spores eight in the ascus, uniseriate, hyaline, oval with blunt ends, 1-septate with equal cells, slightly constricted at the septum, spore wall minutely roughened; 12-15 x 7-8µ (11-21 x 8-12µ, Keissler 1938).

Arthopyrenia sphaeroides has usually not been recognized in North America by American lichenologists. It is commonly found in herbaria under A. alba (A. gemmata) or A. biformis. All of the

European specimens of A. sphaeroides seen have the spore wall minutely roughened. However, in the Northeastern United States there are a large number of collections in which the spores are smooth-walled and slightly smaller. The spores are quite close in appearance to those of A. biformis (Borr.) Massal. but A. biformis has much smaller, completely superficial pseudothecia and also differs in ascus structure and spore arrangement. These collections probably represent an undescribed species. However, it is part of a very complex species-group centered around A. biformis, A. sphaeroides, and A. alba. I do not feel well-enough acquainted with this group to describe a new species in it at this time. All of the smooth spored collections come from Maine, Massachusetts and Maryland with one exception, a single collection from Michigan (Crooked Lake, Washtenaw County, Harris 869 MSC). Arthopyrenia sphaeroides proper, with the exception of collections from the Gaspe Peninsula, has been found only in Iowa and western Michigan. It occurs mainly on Quercus alba but also once on Acer and Thuja. In Europe it has been reported on Fagus, Carpinus, Fraxinus and Populus.

Exsiccati examined. Krypt. Vind. 2152 (FH, US); Malbr. 398 (MSC).

Specimens seen.

CANADA

QUEBEC: Gaspe Peninsula, Eckfeldt, 1880-1883 (MICH), Macoun 12 Aug. 1882 (US).

UNITED STATES

IOWA: Boone County, The Ledges, Fink, 27-8 July 1903 (MICH); Fayette County, Fayette, Fink, July 1894 (MICH, WIS).

MICHIGAN: Keweenaw County, Isle Royale Nat. Park, Siskowit Lake, Lowe 863 (MICH); Newaygo County, near Hesperia, Imshaug 21196 (MSC).

Arthopyrenia thomsonii sp. nov.

Thallus endophloeodal, gray, smooth to roughened. *Trentepohlia* present but very scarce. Pseudothecia mostly clustered and occasionally fused, rarely scattered, dark brown, rough, hemispherical, completely immersed when young, becoming up to three-fourths exposed in age. Exit pore mostly depressed, pale, large, up to 60µ in diameter. Pseudothecial wall dimidiate, 40-75µ thick, the outer layers consisting mostly of bark cells, only the inner 25u or so consisting entirely of fungal tissue. Nucleus white or yellowish-white, opaque not translucent as is usual in *Arthopyrenia*. Paraphysoids c. 1-2µ thick, septate, branched and anastamosed. Asci cylindrical to cylindric-clavate, without a dimple or with a very small one, tip not expanding in KOH, 80-90 x 12-15µ. Spores eight in the ascus, obliquely uniseriate to biseriate, hyaline or very pale brown in old age, fusiform to elliptic-fusiform, 1-septate becoming 3-septate in old age, cells equal or slightly unequal, 22-25 x 7-8µ.

The only material seen of this species is an exsiccat, Thomson 96 (sub *A. leucochlora*), on *Gleditsia triacanthos*.

Specimens seen.

UNITED STATES

WISCONSIN: Fond du Lac County, 2 miles north of Rosendale, *Thomson*, 16 May 1947 (MICH, MSC, WIS).

Arthopyrenia willeyana sp. nov.

Thallus endophloeodal, light gray to whitish, well-developed, often somewhat powdery appearing but mostly smooth. *Trentepohlia* very abundant and well-developed. Pseudothecia mostly scattered, black, shiny, hemispherical to subglobose, almost completely immersed when young but very soon becoming almost entirely superficial, 0.15-0.25mm in diameter. Pseudothecial wall entire, brown or occasionally somewhat greenish in KOH, hyaline below and appearing dimidiate, 20-30μ thick. Nucleus IKI-. Paraphysoids c. 1μ thick, septate, much branched and anastamosed, persistent, when dry forming a layer just within the pseudothecial wall leaving a hollow in the center of the ascocarp. Asci cylindric or clylindric-clavate, not much thickened at the tip, small dimple evident or not; expanding in KOH to 5-7μ thick at tip, the dimple becoming more pronounced; 40-90 x 10-18μ. Spores eight in the ascus, biseriate, hyaline, 1-septate, often some spores becoming 2-3-septate, cells unequal, the lower usually narrower and shorter than the upper; spore wall not constricted at the septum, thin, without gelatinous outer layer; 11-18 x 3-5μ.

Material of this species has been found in herbaria as *Arthopyrenia leucochlora* Muell. Arg. to which it is quite similar. *Arthopyrenia leucochlora* was described from material sent by Willey. Material under this name from Willey's herbarium in the Smithsonian Institutuion is mixed. Two of his collections which have a rather peculiar thallus seem to fit Mueller's description best. Unfortunately, they are not conspecific with the Great Lakes collections. However, the rest of Willey's material is. I have not seen Mueller's type but feel sure from the original description of the species that it is the species which does not occur in the Great Lakes. On this basis I have described the Great Lakes material as a new species. Thomson's Lich. Wisc. Exsic. 96, issued as *A. leucochlora*, is neither of the species involved here but another, apparently new species, described in this paper as *A. thomsonii*.

Most of the collections of A. willeyana come from either Quercus alba or Ulmus americana but it also occurs on Quercus borealis, Carya, Fraxinus, Platanus, Acer saccharum, Populus tremuloides, Betula lutea and lignum. This species is the most common and abundant pyrenolichen in southern Michigan. I have also seen specimens from Illinois, Ohio, Massachusetts and Long Island.

Specimens seen.

UNITED STATES

IOWA: Dickson County, Lake Okoboji, Thomson 10940 (WIS); Jones County, Wapsipinicon, south of Anamosa, Imshaug 28093, 28105 (MSC).

MICHIGAN: Alger County, Kingston Lake, Harris 652 (MSC); Barry County, Shaw Lake, Harris 464 (MSC); Berrien County, Warren Woods, Harris 215, 216B, 219 (MSC); Clare County, Thuja swamp west of Farwell, Harris 997, 998 (MSC); Clinton County, near Rose Lake, Harris 956 (MSC); Eaton County, near Vermontville, Imshaug 29252, 29256 (MSC); Emmet County, Harbor Springs, Mains 173, 8 Sept. 1931 (MICH); Ingham County, Sanford Woodlot, East Lansing, Harris 45A, 46, 49, 53B, 69, 85, 89, 905, 906, 908, 915 (MSC), Baker Woodlot, East Lansing, Harris 57, 72 (MSC), Holt Bog southwest of Holt, Harris 922 (MSC); Iosco County, Silver Valley State Forest campground north of Tawas, Harris 818 (MSC); Kalamazoo County, oak woods west of Richland, Harris 114, 116, 118, 122, 132 (MSC), Kellog Forest north of Augusta, Harris 274, 317, 319, 326, 415, 416, 513, 514 (MSC); Montcalm County, Coley Lake north of Sheridan, Harris 1022 (MSC); Washtenaw County, Crooked Lake, Harris 15, 19, 20, 23, 26, 855, 857, 859, 861, 864, 866, 867, 868 (MSC)

WISCONSIN: Dane County, Univ. of Wisc. Arboretum, Greene, 23 Oct. 1965 (WIS); Rock County, Thibault Point, Lake Koshkonong, Thomson 1922 (Thomson).

DERMATINA Almq.

K. Svensk. Vetensk.-Akad. Handl. 17: 8. 1880.

Mycoporum Flot. in Koerb. Grundriss der Cryptogam. 199. 1848. (non Meyer 1825).

Ascocarp with more than one distinct multiascal chamber, each with its own exit pore; spores brown and muriform.

Dermatina pyrenocarpa (Nyl.) Zahlbr.

Cat. Lich. Univ. I: 550. 1922. Mycoporum pyrenocarpum Nyl. Flora 41: 381. 1858.

Thallus endophloeodal, indicated by a lighter area on the bark. Trentepohlia present in scattered clumps, not abundant. Ascocarps scattered, dark brown to black, often slightly shiny, cushion-shaped, elliptical in outline, 0.2-1.0mm in length, usually 0.1-0.2mm less in width; containing 1-10 separate chambers, the upper part of the chambers often raised giving the ascocarp a bumpy appearance. Pores of chambers large, usually easily visible due to their lighter color. Upper layer of stroma dark, carbonaceous, c. 20-40µ thick, not penetrating very far downward into the sterile layers separating the chambers which are mostly hyaline and c. 10-20µ thick; stromatic layer at the base hyaline or somewhat carbonaceous, especially between the chambers. Nuclei IKI-. Paraphysoids not distinct, short septate, much branched and anastamosed, appearing almost parenchymatous. Asci obclavate-saccate, much thickened at the tip which expands greatly in KOH, 70-85 x 35-50µ. Spores eight in the ascus, irregularly arranged, initially hyaline but soon brown, oblong-ellipsoid, muriform with 7-9-(11) transverse septa and 1-3 longitudinal septa, constricted only at the median septum dividing the spore into two, usually unequal, halves; 30-50 x 12-15μ (33-46 x 13-19μ in Fink 1935).

This species is the only Great Lakes representative of a group of three genera which have more than one chamber in the ascocarp. Care must be taken not to confuse these genera with members of the Arthoniaceae where single asci are randomly scattered throughout an irregular or disk-like stroma. Perhaps the best distinguishing character is that under a dissecting microscope *Dermatina* and its relatives have obvious exit pores for each chamber, while such openings are never present in the Arthoniaceae. Also the multichambered nature of *Dermatina* is usually obvious and the fruit resembles a bunch of small black beads glued together. The other two genera, *Mycoporellum* and *Mycoporopsis* have not yet been found in the Great Lakes region. I have, however, seen material from Ohio (without locality) and from Iowa which seems to be an undescribed species of *Mycoporellum*. The two Ohio collections from the Fink Herbarium are apparently type material of *Dermatina ohiense* (Fink) Zahlbr. The name was originally published by Nylander (1857) as a variety of *D. pyrenocarpa* without any description. Fink (1935) validated the name at the species level. According to his description, the spores are muriform but I have found only 1-septate spores in Fink's material. Since Fink's specimens are at variance with his description and since they are without locality, *Dermatina ohiense* is best treated as a doubtful species until further studies can be made.

Dermatina pyrenocarpa has been found on the bark of *Acer rubrum*, *Carpinus caroliniana*, and *Fagus grandifolia*. Specimens verified come from the southeastern Great Lakes and the East Coast from Massachusetts to Tennessee. The species was originally described from

Mexico but I have not seen the type. Fink (1935) reports it from California but the only specimen in his herbarium under this name from California is an Arthothelium.

Exsiccati examined. Cummings I. 286 (MSC); Cummings II. 218 (MICH, MSC); Lojka 150 (MICH); Macoun II. 199 (MICH).

Specimens seen.

CANADA

ONTARIO: Hastings County, Central Ontario Junction, Macoun, 22 Oct. 1893 (MICH).

UNITED STATES

DELAWARE: New Castle County, Newark, Commons, 6 July 1891 (MICH).

DIST. OF COLUMBIA: Takoma Park, Williams & Snell, 1898 (MICH).

MASSACHUSETTS: Bristol County, New Bedford, Willey, 1885 (MICH).

MICHIGAN: Cheboygan County, gorge near Douglas Lake, Nichols, June-Aug. 1923 (MICH).

OHIO: Fairfield County, Sugar Grove, Bogue 428, 28 Jan. 1893 (MICH).

TENNESSEE: Hamilton County, Chatanooga, Calkins 247 (MICH).

LEPTORHAPHIS Koerb.

Syst. Lich. Germ. 371. 1855. conserved over Endophis Norm. Nyt. Mag. Naturv. 7: 240. 1853.

Ascocarp a pseudothecium, spores long narrow fusiform-cylindrical to acicular, in one or two bundles in the ascus which is little longer than the spores.

Leptorhaphis atomaria (Ach.) Szatala

Magy. Bot. Lap. 26: 31. 1928. *Lichen atomarius* Ach. Lich. Suec. Prodrom. 16. 1798.

Leptorhaphis tremulae Koerb. Syst. Lich. Germ. 372. 1855.

Vainio (1921) examined the Acharian material of *Lichen atomarius* and determined that it was a *Leptorhaphis* and not an *Arthopyrenia* as has often been assumed. The transfer of *Lichen atomarius* to *Leptorhaphis* has been attributed to Magnusson (1936).

"Thallus" not visible or indicated by a lighter area on the bark. No algae seen. Pseudothecia scattered, dark brown to black, subglobose to hemispherical, initially immersed but very soon almost completely exposed, 0.1-0.2mm in diameter. Pseudothecial wall dark brown, almost entire but usually lacking at the very base, 15-30µ thick. Nucleus IKI+ orange or occasionally pale bluish initially. Paraphysoids not distinct, c. 1µ thick, short celled, much branched and anastamosed. Asci short clavate, not much thickened at the tip, mostly without a dimple; tip thickening slightly in KOH and forming a dimple; 40-50 x 8-15µ. Spores eight in the ascus, in one or two bundles, cylindric-fusiform, usually with rounded ends, often curved, 1-3-septate, 20-28 x 2-4µ.

This is a European species which has not been previously reported from North America. It occurs on *Populus* on both continents. North American material is IKI+ orange which has occasionally been taken as the basis for a distinct variety in Europe. I have seen no collections of this species from outside the Great Lakes region. Exsiccati examined. Magn. 126 (FH); Rabenh. 147 (MICH).

Specimens seen.

CANADA

ONTARIO: Algoma District, Lake Superior Prov. Park, lookout 4 miles north of campground, Harris 583 (MSC); Thunder Bay District, Sibley Prov. Park, one mile east of Lake Marie Louise, Erbisch 426 (MSC).

UNITED STATES

IOWA: Allamakee County, Effigy Mounds Nat. Monument, bluffs along Mississippi River, Imshaug 27906 (MSC); Delaware County, Maquoketa River north of Dundee, Imshaug 28011 (MSC).

MICHIGAN: Emmet County, Wilderness State Park, Harris 810 (MSC); Iosco County, Silver Valley State Forest campground north of Tawas, Harris 820 (MSC); Iron County, junction USF hwy. 139 and Co. 657 south of Kenton, Harris 721 (MSC); Keweenaw County, Isle Royale Nat. Park, Hay Bay, Lowe 752 (MICH), Forbes Lake, Wetmore 4142 (MSC); Ontonagon County, Porcupine Mtns. ½ mile east of parking lot, Harris 680 (MSC).

Leptorhaphis contorta Degel.

Ark. Bot. 30A: 13. 1940.

"Thallus" not visible or indicated only by a lighter area on the bark. No algae seen. Pseudothecia scattered, black, occasionally quite shiny, subglobose to hemispherical, 0.1-0.2mm in diameter. Pseudothecial wall dimidiate, lacking below, dark brown, 15-25µ thick, Nucleus IKI-. Paraphysoids c. 1µ thick, septate with short cells, branched and anastamosed. Asci cylindrical, not much thickened at the tip; tip thickening in KOH and occasionally forming a dimple; 50-65 x 10-12µ (45-54 x 10.5-13µ in Degelius 1940). Spores eight in the ascus, in a single bundle, hyaline, acicular, 1-(3)-septate; 35-50 x 2-3µ.

Degelius (1940) described this species from Maine on *Quercus borealis* and also found it on *Prunus* in North Carolina (Degelius 1941). The Great Lakes material is all from *Populus* and differs from the type in having larger, more rounded and emergent pseudothecia. It differs from *L. parameca* in lacking any IKI reaction and may not be distinct.

Specimens seen.

CANADA

ONTARIO: Algoma District, Lake Superior Prov. Park, north of Sand River, *Imshaug* *26152* (MSC), lookout 4 miles north of campground, *Harris* *582* (MSC).

UNITED STATES

MAINE: Sagadahoc County, Prince's Point near Brunswick, *Degelius*, 3 Sept. 1939 (isotype US).

MICHIGAN: Cheboygan County, Pine Grove State Forest campground east of Wolverine, *Harris* *787* (MSC); Iron County, junction of USF hwy. 139 and Co. 657 south of Kenton, *Harris* *716*, *719* (MSC); Keweenaw County, Isle Royale Nat. Park, McCargo Cove, *Lowe* *441* (MICH); Menominee County, Big Cedar River State Forest campground north of Cedar River, *Harris* *752* (MSC); Otsego County, Grass Lake, *Harris*, 10 Oct. 1962 (MSC).

WISCONSIN: Vilas County, Trout Lake, *Culberson* *1584* (WIS).

Leptorhaphis *epidermidis* (Ach.) Th. Fries

Lich. Arctoi 273. 1860. *Lichen* *epidermidis* Ach. Lich. Suec. Prodr. 16. 1798.

Lichen *epidermidis* has been transferred to both *Arthopyrenia* and *Leptorhaphis*. The first to realize that Acharius and others had included several taxa in this species was Nylander (1852). He used the name Verrucaria epidermidis for what is now recognized as an Arthopyrenia and gave a new name to the Leptorhaphis, Verrucaria oxyspora. This treatment was followed in essence, notably by Koerber and Massalongo, until Th. Fries Lichenes Arctoi in 1860. Fries reversed the previous treatment and used epidermidis in Leptorhaphis and placed the Arthopyrenia in synonymy. From that time until the early 1900's oxyspora and epidermidis were used about equally for the Leptorhaphis. Nylander's interpretation is supported by the use of Arthopyrenia epidermidis by the describer of that genus, Massalongo, and by the fact that the type of Koerber's genus, Leptorhaphis, is L. oxyspora (Nyl.) Koerb. Th. Fries seemingly arbitrary reversal has been supported by the two modern treatments of European pyrenolichens, Vainio (1921) and Keissler (1938). If the type contained spores, the problem would be easily resolvable. Vainio (1921) has examined what he says is the Acharian type, although he does not give his reasons for his choice of a specimen. It is, according to Vainio, a mixed collection, neither part containing spores. Thus the identity of neither half can be definitely determined but Vainio suggests that one is Leptorhaphis and the other an Arthopyrenia. It is hard to believe that Acharius' material was limited to a single collection. Further research should be done in the Acharian herbarium to verify Vainio's conclusion. If there is no satisfactory way of typifying the species, the name should be dropped in both Leptorhaphis and Arthopyrenia.

Description. "Thallus" not detectable. Algae absent or perhaps a few protococcoid cells at the base of the pseudothecia. Pseudothecia scattered, black, dull to slightly shiny, hemispherical or slightly flattened, c. 0.2mm in diameter, surrounded by a dark elliptical hyphal ring, c. 0.1mm wide. Pseudothecial wall dimidiate, lacking below, dark brown, 20-30µ thick. Nucleus IKI-. Paraphysoids c. 1-2µ thick, septate with short cells, branched and anastamosed. Asci short clavate, often somewhat truncate at the tip, not much thickened at the tip, sometimes with a shallow dimple; expanding in KOH to c. 5µ thick with a pronounced cylindrical dimple; 32-45 x 10-15µ. Spores eight in the ascus, mostly in a single bundle, hyaline, cylindrical-fusiform, often with one or both ends sharp-pointed, usually curved or twisted, 1-(3)-septate, not constricted at the septum, 20-30 x 2-4µ.

This is a widespread circumboreal species rare south of the Hemlock-White Pine-Northern Hardwoods region. It occurs on Betula papyrifera and B. populifolia.

Exsiccati examined. Malbr. 100 (MSC); Norrlin 389 (MSC); Thomson 41 (MICH, MSC, Thomson, WIS).

Specimens seen.

CANADA

ONTARIO: Algoma District, Lake Superior Prov. Park, just north of Sand River, Imshaug 26214 (MSC); Simcoe County, Blue Mtns. between Singhampton and Duntroon on hwy. 24, Imshaug 26925 (MSC).

UNITED STATES

MICHIGAN: Alger County, Kingston Lake, Harris 626, 663 (MSC); Charlevoix County, Fox Lake, Beaver Island, Imshaug 27479 (MSC); Clare County, Thuja swamp north of Harrison on old US 27, Harris 924 (MSC); Keweenaw County, Isle Royale Nat. Park, Rock Harbor, Lowe 575 (MICH); Montcalm County, Coley Lake north of Sheridan, Harris 1025 (MSC); Ontonagon County, Porcupine Mtns. ½ mile east of the parking lot, Harris 673, 678, 686, 688, 689, 691 (MSC).

MINNESOTA: Beltrami County, Bemidji, Fink 671, 12 July 1900 (MICH); Blue Earth County, Mankato, Fink 140, 27 June 1899 (MICH); Lake County, Beaver Bay, Fink 697, 13 July 1897 (MICH); Otter Tail County, Henning, Fink 189, 25 June 1900 (MICH); St. Louis County, Duluth, Kimball, 1900 (US).

WISCONSIN: Douglas County, Brule River Valley, Thomson, 9 Aug. 1946 (MICH, MSC, Thomson, WIS).

Leptorhaphis parameca (Massal.) Koerb.

Parerg. Lich. 386. 1856. Sagedia parameca Massal. Symmict. Lich. 97. 1855.

Description modified from Keissler (1938). "Thallus" not visible. No algae seen or a few scattered protococcoid cells on the bark surface. Pseudothecia scattered or clustered and occasionally fused, dark brown, flattened, circular or elliptical in outline, 0.15-0.2mm in diameter, with a dark hyphal ring (poorly developed in Great Lakes material). Pseudothecial wall dimidiate, lacking below, dark brown, c. 25-30µ thick. Nucleus IKI+ blue-green. Paraphysoids septate with short cells, branched and anastamosed. Asci clavate, slightly thickened at the tip, not much changed in KOH, 30-50 x 7-10µ. Spores eight in the ascus, in a single bundle, hyaline, acicular, pointed at both ends, with several indistinct septa, 30-50 x 2.5-3µ.

This European species has not previously been reported from North America, but American material seems to agree closely with European material. Known only from three Michigan collections, one on Prunus, the others on Betula papyrifera.

Specimens seen.

UNITED STATES

MICHIGAN: Alger County, Kingston Lake, Harris 623, 624 (MSC); Clare County, Thuja swamp north of Harrison on old US 27, Harris 948 (MSC); Roscommon County, Thuja swamp, Backus Lake Flooding, Imshaug 25491 (MSC).

MICROTHELIA Koerb.

Syst. Lich. Germ. 372. 1855.

The status, both nomenclatural and biological, of the genus *Microthelia* has been and still is in a state of confusion. Mueller and von Arx (1962) have discussed these difficulties in detail. I shall comment briefly on them. *Microthelia* was erected by Koerber as a lichen genus. Later workers considered it to be synonymous with *Didymosphaeria* Fuck. (1869), a non-lichen genus. Although *Microthelia* is the older name, they refused to use it for a non-lichen genus since it was a lichen name. This cannot be done any longer since for the purposes of nomenclature the Int. Code of Botanical Nomenclature does not recognize lichens as distinct from fungi. Currently both *Microthelia* and *Didymosphaeria* are regarded as valid, distinct non-lichenized genera. Vainio (1921), however, divided *Microthelia* Koerb. into two genera, *Microthelia*, saxicolous and lichenized, and *Didymosphaeria*, corticolous and non-lichenized. The genus *Microthelia* Koerb. has been typified, both thru usage and lectotypification, by *M. micula* Koerb. (Mueller & von Arx 1962), a corticolous species. Therefore, Vainio's *Didymosphaeria* must bear the name *Microthelia* Koerb. This leaves the saxicolous lichen genus without a name. It seems to be distinct from *Microthelia* on other grounds in addition to lichenization. It is probably worthy of generic recognition. This would result in three distinct and nomenclaturally correct genera. *Microthelia* Koerb. and *Didymosphaeria* Fuck., non-lichenized, and a third unamed genus which is lichenized. In this paper the only species considered are referable to the genus *Microthelia* as traditionally treated by lichenologists as well as by modern mycologists. There is a great need for close study of this group to determine more clearly both generic and specific limits. I have no "feel" for this group and as a result have not tried to resolve the material centered around *M. micula* into definite taxonomic entities as indicated under the species.

Microthelia micula Koerb.

Syst. Lich. Germ. 373. 1855.

Mueller and von Arx (1962) use the name *M. biformis* (Leight.) Massal. This name is based on a misidentification by Leighton of *Pyrenula biformis* Borr. Leighton clearly attributes his name to Borrer. Borrer's species is an *Arthopyrenia* so that Leighton's combination cannot be used as a basionym in *Microthelia*.

"Thallus" indistinct or indicated by a gray blotch on the bark. No algae seen. Pseudothecia scattered to clustered, black, dull, hemispherical, 0.2-0.3mm in diameter. Pseudothecial wall dimidiate, occasionally almost entire, brownish-black, 50-60µ thick. Pore large. Nucleus IKI+ bluish or IKI-. Paraphysoids septate, branched and anastamosed. Asci cylindrical to slightly obclavate, tip thicker than the walls, with an indistinct dimple; expanding greatly in KOH to form a long narrow dimple. Spores eight in the ascus, biseriate or irregular, brown, ovoid, 1-septate, constricted at the septum, cells usually unequal, 12-16 x 5-8µ.

According to Scheinpflug (1958) the spores in this species are equal-celled and unequal in M. applanata (Fr.) Mueller, an otherwise very similar species. All of the collections which I have examined vary in this respect within a single pseudothecium. My main difficulty here seems to be that the characters which I have tried to use to separate collections seem to be varying entirely independently of one another. There seems to be a group with smaller spores, mostly under 22µ long and 10µ wide, but an overlap occurs with a group which has spores mostly 22-30µ long by 10-12µ wide. The majority of the collections have a minutely roughened spore wall but a few have smooth walls. Hepp's Flect. Europ. 108, cited by Mueller, has smooth spore walls. Some spores have a gelatinous outer layer, others do not. According to Vainio (1921) the nucleus is IKI-, while Keissler (1938) finds that it is IKI+ bluish. Degelius (1941) comments that he has found M. micula to be both IKI+ and IKI-. There is also a great deal of variation in the completeness of the pseudothecial wall.

Specimens seen.

CANADA

ONTARIO: Algoma District, Lake Superior Prov. Park, ½ mile north of Doc Grieg Lake, Harris 556, 561, 562, 563, 564, 565, 566, 580 (MSC).

UNITED STATES

MICHIGAN: Alger County, Kingston Lake, Harris 612, 616, 617, 650, 651, 659, 666 (MSC); Charlevoix County, old orchard, Beaver Island, Imshaug 27573 (MSC); Cheboygan County, Pine Grove campground east of Wolverine, Harris 781, 802 (MSC); Clare County, oak woods north of Harrison, Harris 941 (MSC); Emmet County, Wilderness State Park, Harris 807 (MSC); Ingham County, Baker Woodlot, East Lansing, Harris

55, 56, 63, 71 (MSC); Iosco County, Silver Valley campground north of Tawas, Harris 817, 820 (MSC); Iron County, Teepee Lake south of Kenton, Harris 695 (MSC); Isabella County, woods north of Mt. Pleasant, Imshaug 21082 (MSC); Kalamazoo County, Kellog Forest north of Augusta, Harris 273, 320, 321, 322, 323, 325, 413 (MSC); Keweenaw County, Isle Royale Nat. Park, outlet of Siskowit Lake, Lowe 643, 689 (MICH); Mackinac County, vicinity of Sugar Loaf Rock, Mackinac Island, Imshaug 27270C (MSC); Menominee County, Big Cedar River campground north of Cedar River, Harris 750 (MSC); Ontonagon County, Porcupine Mtns., ½ mile east of parking lot, Harris 679, 683, 684, 692 (MSC); Washtenaw County, Crooked Lake, Harris 2 (MSC).

MINNESOTA: Blue Earth County, Mankato, Fink 88, 24 June 1899 (MICH), Fink 129, 26 June 1899 (MICH); Pennington County, Thief River Falls, Fink 798, 18 July 1900 (MICH); Yellow Medicine County, Granite Falls, Fink 513, 14 July 1899 (MICH).

Microthelia micula var. *quadriloculata* (Fink) Zahlbr. Cat. Lich. Univ. I: 263. 1921. *Pyrenula cinerella* var *quadriloculata* Fink, Contr. U.S. Nat. Herb. 14: 239. 1910.

The type of this variety consists only of pycnidia with brown macroconidia, ellipsoid and 3-(4)-septate with an occasional longitudinal septum. These pycnidia have not been found to my knowledge to be associated with any perfect state so that the material is in essence undeterminable. However, the name should be removed from *Microthelia*.

Specimens seen.

UNITED STATES

MAINE: Knox County, Rockland, Merrill, 25 May 1910 (MICH).

MINNESOTA: Beltrami County, Bemidji, Fink 632, 11 July 1900 (MICH); Blue Earth County, Mankato (Rapidan), Fink 163a, 28 Jan. 1899 (MICH); Cook County, Grand Portage Island, Fink 85, 24 June 1897 (type, MICH, MSC).

Microthelia wallrothii (Hepp) Rehm

Hedwigia 18: 163. 1879. Pyrenula wallrothii Hepp. Flecht. Europ. 709. 1860.

Description modified from Keissler (1938). "Thallus" indistinct. No algae seen. Pseudothecia scattered, black, often slightly shiny, hemispherical, often depressed in the center, 0.18-0.3mm in diameter; surrounded by a well-developed dark elliptical hyphal ring which may be up to 0.15mm wide. Pseudothecial wall entire, brownish-black, thinner below, rarely lacking below in the center, often extending outward from the edges a little. Nucleus IKI-. Paraphysoids 1.5-2µ thick, septate, branched and anastamosed. Asci clavate, tip somewhat thickened, without a dimple, 40-50 x 14-18µ. Spores eight in the ascus, biseriate, brown, ellipsoid, 1-septate, not constricted at the septum, 10-17 x 6-7µ.

A rather peculiar type of macroconidia has been attributed to this species, but I have found them associated with two other pyrenolichens on Betula, both in this country and in Europe. Thus, specimens without ascocarps should not be assigned to this species on the basis of conidia alone. The pynidia are black, c. 0.05-0.1mm in diameter, with macroconidia brown, oval, 1-septate, appearing polarilocular, 10-12 x 5-6u.

Microthelia wallrothii is unusual in that some of the hyphae at the base of the ascocarp and, perhaps, of the hyphal ring turn pale violet in IKI. This reaction occurs sporadically in some collections of *Leptorhaphis* and *Polyblastiopsis* but appears to be constant in *M. wallrothii*. Both American and European material are variable in regard to the thickness of the pseudothecial wall below the nucleus and it is even occasionally lacking below.

Microthelia oblongata Muell. Arg., described from material collected in Massachusetts by Willey, is very similar but lacks the IKI+ violet reaction of the pseudothecial hyphae and the ascus tip reacts differently in KOH.

Microthelia wallrothii occurs only on *Betula papyrifera* in the United States. The majority of collections come from Iowa and the Black Hills. It reaches the Great Lakes only in northern Minnesota.

Specimens seen.

UNITED STATES

IOWA: Fayette County, Fayette, *Fink*, June 1894 (MICH, Thomson, WIS), *Fink*, 19 Aug. 1897 (MICH).

MINNESOTA: Cook County, Grand Portage, *Fink 56*, 21 June 1897 (MICH).

MOLESTIA gen. nov.

Ascocarp a pseudothecium, spores brown, with more than one transverse septum, lumina cylindrical.

Type species: *Verrucaria leucoplaca* Wallr.

The only species known is *M. leucoplaca*. It has previously been included in *Pyrenula*. However, on the basis of the cylindrical spore lumina and the presumably ascolocular nature of the ascocarp it must be excluded from *Pyrenula*, which has lenticular or spherical lumina and is ascohymenial. Vainio (1921) placed the species in the non-lichenized genus Leptosphaeria but stated in his discussion, "Etiam sporarum indole haec species a Pyrenulis differt, et inter lichenes, si gonidiis instructa esset, genus autonomum constitueret.". Vainio either did not find algae in his specimens or if he did, he attributed them to another lichen mixed in. However, algae are abundant in both American and European collections. M. leucoplaca could be included in Microthelia, which has been treated by lichenologists to allow inclusion of species which occasionally have more than one septum in the spores. These species are saxicolous and are never more than 3-septate. Microthelia has been taken over by mycologists and redefined on the basis of the cellular characteristics of the pseudothecial wall. I have not tried to make use of this character as yet. The distinction of Molestia from Microthelia is admittedly at present based primarily on the multiseptate spores and general "feel".

Molestia leucoplaca (Wallr.) comb. nov.

Verrucaria leucoplaca Wallr. Flora Crypt. Germ. 3: 299. 1831. Pyrenula leucoplaca (Wallr.) Koerb. Syst. Lich. Germ. 365. 1855. Leptosphaeria leucoplaca (Wallr.) Vainio, Acta Soc. Fauna Flora Fenn. 49: 143. 1921. Pyrenula leucoplaca var. pluriloculata Fink, Minn. Bot. Stud. 2: 709. 1902.

The basionym of this species is often given as Verrucaria farrea Ach. (Meth. Lich. 115. 1803.) but Vainio (1921) has examined the type of this species and states that it has nothing to do with M. leucoplaca.

Thallus endophloeodal, white to pale gray, smooth. Trentepohlia abundant, very well-developed, cells 9-12µ in diameter, forming short chains. Pseudothecia scattered, black to dark brown, shiny or appearing pruinose due to the remains of the covering bark layer, hemispherical to subglobose, c. 0.3mm in diameter, usually depressed in the center; pore in the depression, large, up to 50μ across; initially just under bark surface but finally one third to one half immersed. Pseudothecial wall entire, brown above, 60-90μ thick, colorless below, thinner below, appearing dimidiate. Nucleus IKI+ dark blue-green becoming orange. Paraphysoids c. 1μ thick, only slightly branched and anastamosed. Asci long cylindric, without a dimple or with a very large one formed by a slight thickening of the wall at the tip; no reaction with KOH; 95-100 x 12μ. Spores eight in the ascus, obliquely uniseriate, brown, with the terminal cells somewhat lighter in color, fusiform, 5-6-septate when mature, often slightly constricted at the septa, the central cells largest decreasing in size toward the ends, lumina cylindrical and the walls of uniform thickness; no gelatinous outer layer present; 18-24 x 5-9μ.

The white thallus, shiny black pseudothecia depressed around the pore and brown spores with more than three septa are the diagnostic characters of this species.

The recognition of this species in North America has been complicated by the presence of a non-lichenized fungus found only on the living bark of _Populus tremuloides_. This fungus apparently does not occur in Europe. American collections under the name _Pyrenula leucoplaca_ in herbaria seem to be split about evenly between _M. leucoplaca_ and the fungus. The fungus is easily distinguished by its smaller ascocarps, lack of IKI reaction and constantly 3-septate spores with a thick gelatinous outer layer. These 3-septate spores caused Fink (1902), thinking that the European species was constantly

3-septate, to describe a variety *pluriloculata* for the 5-6-septate lichen. However, European material is also more than 3-septate and identical to ours, although European authors tended to gloss over the extra septa in order to include it in *Pyrenula*.

In the Great Lakes region *M. leucoplaca* has been collected on *Ulmus americana*, *Acer saccharum*, *Tilia*, *Populus*, *Quercus* and *Fraxinus*. The only collection seen from North America outside of the Great Lakes is from New Hampshire. The range of the fungus, while somewhat more western and northern, overlaps *M. leucoplaca*, especially in northern Michigan and Minnesota.

Exsiccati examined. Cummings I. 194 (MSC, WIS); Cummings II. 126 (MICH); Krypt. Vind. 2153 (FH); Rel. Far. 453 (MICH, WIS); Stenh. 179 (MICH).

Specimens seen.

CANADA

ONTARIO: Carleton County, Ottawa, *Macoun*, 18 Apr. 1896 (US).

QUEBEC: county unknown, Montmorency, Macoun, 7 Jan. 1905 (MICH).

UNITED STATES

IOWA: Fayette County, Fayette, *Fink*, June 1894 (MICH, Thomson, WIS), *Fink*, July 1894 (MICH, Thomson, WIS), *Fink*, 17 Aug. 1895 (MICH), *Fink*, 4 Dec. 1895 (MICH, MSC, WIS).

MICHIGAN: Cheboygan County, Pine Grove campground east of Wolverine, *Harris* *780* (MSC); Iosco County, Iargo Springs on the Au Sable River north of Tawas, *Harris* *827* (MSC); Menominee County, Big Cedar River campground north of Cedar River, *Harris* *735*, *736*, *737*, *738*, *742*, *743* (MSC); Ontonagon County, Porcupine Mtns. ½ mile east of parking lot, *Harris* *674*, *677*, *685*, *690* (MSC).

MINNESOTA: county unknown, Auburndale, *Fink*, 6 Sept. 1902 (MICH), Minneapolis, Fink 153a, 11 July 1896 (MICH), Pork Bay, Fink, 25 Aug. 1902 (MICH); Beltrami County, Bemidji, Fink 555, 9 July 1900 (MICH), Red Lake, Fink 1073, 3 Aug. 1900 (MICH); Koochiching County, Koochiching, Fink 914, 26 July 1901 (MICH); Otter Tail County, Henning, Fink 357, 29 June 1900 (MICH); Pennington County, Thief River Falls, Fink 789, 18 July 1900, 821, 19 July 1900 (MICH); Yellow Medicine County, Granite Falls, Fink, 15 July 1899 (MICH).

NEW HAMPSHIRE: Carroll County, Chocorua, Farlow, May 1906 (MICH, WIS).

For the sake of completeness and clarity I will include here a description of the fungus which has been confused with *M. leucoplaca*. R. A. Shoemaker (in litt.) has suggested that the fungus is an undescribed species of *Melanomma*.

"Thallus" white, powdery, apparently consisting entirely of dead bark cells; occuring exclusively on the living bark of *Populus tremuloides*. Pseudothecia scattered, black, hemispherical, c. 0.1mm in diameter, mostly completely immersed in the loosened bark cells. Pseudothecial walls entire, brown, 25-45µ thick. Nucleus IKI-. Paraphysoids c. 1µ thick, much branched and anastamosed. Asci cylindrical to clavate-cylindrical, tip not much thickened, dimple not evident, tip expanding in KOH and a small dimple becoming clearly evident; 60-80 x 12-15µ. Spores eight in the ascus, biseriate, brown, fusiform, constantly 3-septate, usually strongly constricted only at the median septum, spore halves equal or more commonly unequal, with the upper half broader; heavy gelatinous layer evident in KOH; 15-24 x 6-8µ.

Apparently common on *Populus tremuloides* in the northwestern Great Lakes region. Also common in the Black Hills.

Specimens seen.

UNITED STATES

MICHIGAN: Alger County, Rock River, Lowe 2205 2229 (MICH); Cheboygan County, Pine Grove campground east of Wolverine, Harris 786 (MSC); Iron County, junction of USF hwy. 139 and Co. 657 south of Kenton, Harris 718 (MSC); Keweenaw County, Isle Royale Nat. Park, Hay Bay, Lowe 741 (MICH), McCargo Cove, Lowe 276 (MICH), Rock Harbor, Lowe 151 (MICH); Menominee County, Big Cedar River campground north of Cedar River, Harris 751 (MSC).

MINNESOTA: Cook County, Grand Marais, Fink, 31 July 1902 (MICH), Grand Portage Island, Fink, 21 June 1897, Rose Lake, Fink 209, 27 June 1897 (MICH, MSC, Thomson); Otter Tail County, Leaf Hills, Fink 268, 27 June 1900 (MICH); Pennington County, Thief River Falls, Fink 767, 17 July 1900 (MICH); St. Louis County, Harding, Fink 591, 19 Aug. 1901 (MICH).

POLYBLASTIOPSIS Zahlbr.

Engler & Prantl, Natuerl. Pflanzenfam. I. Teil, Abt. I*: 67. 1903.

Ascocarp a pseudothecium, spores hyaline, submuriform to muriform.

Polyblastiopsis traditionally has been distinguished from *Microglaena* Koerb. on the basis of simple paraphyses and protococcoid algae in *Microglaena* and branched and anastamosed paraphysoids and *Trentepohlia* in *Polyblastiopsis*. Morgan-Jones and Swinscow (1965) have shown that *Microglaena* actually has branched and anastamosed paraphysoids and bitunicate asci as in *Polyblastiopsis*. They have transferred one species of *Polyblastiopsis*, *P. sericea* Massal., to *Microglaena* but have not yet suggested that the two genera should be combined. Since P. sericea seems to be quite typical of the genus, this combination would seem to be indicated. The combined genus would have to bear the name Microglaena as it is by far the oldest. Keeping the genera seperate on the basis of the phycobiont does not seem valid if they are similar in all other respects. I have made no studies of Microglaena and prefer, therefore, to keep the genera separate since Morgan-Jones and Swinscow have not seen fit to combine the genera.

Polyblastiopsis fallaciosa (Arn.) Zahlbr.
Engler & Prantl, Natuerl. Pflanzenfam. I. Teil, Abt. I*: 65. 1903.
Polyblastia fallaciosa (Stizenb. ex Arn.) Arn. Flora 46: 604. 1863.

This species has been something of a problem nomenclaturally. Arnold and some other European workers used the name Arthopyrenia punctiformis fallax for collections of this species before the spores were examined. When Arnold (1863) discovered the spores were muriform and not 1-septate as in Arthopyrenia, he corrected his misidentification and described a new muriform-spored species, Polyblastia fallaciosa. American workers in the late 1800's and early 1900's were apparently unaware of Arnold's correction and continued to perpetuate the original error. As a result American herbarium material under the illegitimate combination Polyblastiopsis fallax or the legitimate one, Arthopyrenia fallax tends to be a mixture of both genera. Fink (1935) recognized P. fallax as distinct from P. fallaciosa but they are nomenclaturally and taxonomically the same.

Description. "Thallus" light gray to white or not at all evident when on Betula. Algae absent or a few scattered protococcoid cells around the pseudothecia. Pseudothecia scattered, black, sometimes shiny, hemispherical especially when young but in age flat-topped or depressed in the center, 0.2-0.3mm in diameter; when on Betula with a dark elliptical hyphal ring. Pseudothecial wall entire, brown above, 20-30µ thick, brown to hyaline below, often appearing dimidiate, thinner below. Nucleus IKI-. Paraphysoids thick, 1.5-2µ, septate with short cells, much branched and anastamosed, occasionally almost parenchymatous in appearance. Asci clavate to cylindrical, without a dimple and only slightly thickened at the tip or with a shallow to medium flat-topped dimple and the tip thicker; tip expanding in KOH to form a small thimble-shaped dimple in the much expanded tip; 50-105 x 15-25µ. Spores initially eight in the ascus, 1-2-(4) spores commonly not developing but usually visible in the ascus, irregularly arranged, hyaline, oblong-elliptical, submuriform with 5-7 transverse septa and 1-2 longitudinal septa, usually constricted at the transverse septa, more so at the median septum, one half sometimes broader; usually with a thick gelatinous outer layer; 17-25 x 7-10µ. Pycnidia usually present, black, 0.05-0.1mm in diameter. Microconidia c. 10 x 1µ, hyaline, simple, rod-shaped. Macroconidia have also been attributed to this species which are brown, 3-septate, 9-12 x 3-4µ.

Polyblastiopsis fallaciosa occurs commonly on Quercus alba, Betula papyrifera and young Acer saccharum and rarely on Juglans cinerea and Fraxinus. Verified specimens range from Tennessee north to Massachusetts and around the Great Lakes west to Minnesota and Iowa. Specimens seen.

CANADA

ONTARIO: Algoma District, tundra strip along Lake Superior north of Batchawana, Imshaug 25959 (MSC), along Sand River Rapids, Lake Superior Prov. Park, Imshaug 26269 (MSC), Kinny Lake, Lake Superior Prov. Park, Harris 600 (MSC); Simcoe County, Blue Mtns. between Singhampton and Duntroon on hwy. 24, Imshaug 26943, 26971, 26997 (MSC).

UNITED STATES

ILLINOIS: Cook County, Calkins 332 (WIS).

IOWA: Fayette County, Fayette, Fink, Apr. 1898 (MICH, MSC).

MICHIGAN: Allegan County, State game area southeast of Perch Lake, Harris 400, 401 (MSC); Alger County, Kingston Lake, Harris 628 (MSC); Berrien County, Warren Woods, Harris 213, 218 (MSC); Charlevoix County, Fox Lake, Beaver Island, Imshaug 27478 (MSC), old apple orchard, Beaver Island, Imshaug 27568 (MSC); Cheboygan County, Pine Grove campground east of Wolverine, Harris 775, 776, 777, 778, 782 (MSC); Emmet County, Straits west of Mackinaw City, Imshaug 25869 (MSC); Ingham County, Sanford Woodlot, East Lansing, Harris 911, 916 (MSC); Iosco County, Iargo Springs on Au Sable River north of Tawas, Harris 830, 833, 835 (MSC); Iron County, junction of USF 139 and Co. 657 south of Kenton, Harris 717 (MSC); Kalamazoo County, Kellog Forest north of Augusta, Harris 140, 316, 417, 512 (MSC); Keweenaw County, Fort Wilkins, Thomson 2998, 3006 (Thomson, WIS); Mackinac County, Mackinac Island, Sugar Loaf Rock, Imshaug 27270B, 27271, 27273 (MSC), Leslie Avenue, Imshaug 27289 (MSC); Menominee County, Big Cedar River campground north of Cedar River, Harris 740, 748, 755, 756 (MSC); Ontonagon County, Porcupine Mtns. ½ mile east of parking lot, Harris 671, 672 (MSC); Washtenaw County, Crooked Lake, Harris 1, 6, 8, 860, 863, 865 (MSC).

MINNESOTA: Beltrami County, Bemidji, Fink 670, 12 July 1900 (MICH); Cook County, Grand Marais, Fink, 12 Aug. 1902 (MICH), 28 July 1902 (US), Grand Portage, Fink 58, 21 June 1897 (MICH); Grand Portage Island, Fink 85, 23 June 1897 (MICH), Gunflint, Fink 276, 30 June 1897 (US), Misquah Hills, Fink 503, 5 July 1897 (MICH).

WISCONSIN: Oneida County, near Big Stone Lake, Culberson 1604 (WIS).

Polyblastiopsis lactea (Massal.) Zahlbr.

Engler & Prantl, Natuerl. Pflanzenfam. I. Teil, Abt. I*: 65. 1903.

Blastodesmia lactea Massal. Ricerch. Auton. Lich. 181. 1852.

"Thallus" gray to whitish. Algae not found. Pseudothecia scattered, black, slightly shiny, hemispherical to conical, 0.3-0.4mm in dimeter, initially immersed but finally appearing to be raised on a small mound in age, surrounded by a dark hyphal ring. Pseudothecial wall entire, brown, thicker above, c. 50µ thick, thinner below, 15-20µ. Nucleus IKI-. Paraphysoids c. 1 µ thick, septate, branched and anastamosed. Asci cylindrical to clavate, with a broad rounded dimple in the tip which is little thicker than the walls; tip expanding in KOH to form a long narrow dimple in the tip which is now up to 10µ thick. Spores four in the ascus, occasionally fewer, irregularly arranged, hyaline, long elliptical, muriform, with 6-8 transverse septa and 2-3 longitudinal septa, slightly constricted at the septa, especially the median one; thick gelatinous outer layer evident in KOH; 35-45 x 12-13µ.

The only verified collection of P. lactea is on Fraxinus from Michigan. All of the other North American material of this European species under this name in herbaria has turned out to be P. fallaciosa. Polyblastiopsis lactea is apparently the only species in the genus with four spores to the ascus. All others are initially two or eight spores in the ascus. The initially eight-spored P. fallaciosa has a strong tendency for spore abortion. It is commonly found with 6-7 spores and rarely with as few as four mature spores in the ascus. This, for the most part, accounts for the previous records of P. lactea in North America. The spores of P. fallaciosa are smaller and if asci with less than eight spores are carefully examined, the remains of the undeveloped spores can be found. Massalongo (1852) allowed up to six spores per ascus in this species but only a single European collection has shown more than four spores.

Exsiccati examined. Arn. 564 (FH); Koerb. 381 (US); Lojka 149 (FH); Massal. 143 (FH); Rabenh. 201 (FH).

Specimens seen.

UNITED STATES

MICHIGAN: Emmet County, Wilderness State Park, Harris 816 (MSC).

Polyblastiopsis meridionalis Zahlbr.

Annal. Naturh. Hofmus. Wien. 23: 223. 1909.

"Thallus" pale gray. No algae found. Pseudothecia scattered, bluish- or greenish-black, circular to elliptical in outline, very much flattened and occasionally somewhat sunken in the center. Pseudothecial wall dimidiate, greenish-black or greenish-brown, 10-25µ thick. Nucleus IKI-. Paraphysoids not abundant, c. 1µ thick, septate, branched and anastamosed. Asci cylindrical, wall and tip uniform in thickness, c. 2µ, tip often appearing somewhat truncate; tip expanding slightly in KOH with the formation of a small dimple; 65-75 x 12-15µ. Spores eight in the ascus, uniseriate to biseriate, hyaline, submuriform, oblong-elliptical, with 3-(6) transverse septa and 1-(2) longitudinal septa, constricted at the septa especially the median one; gelatinous outer layer present; 21-25 x 8-9µ.

This species, which is distinctive in its flattened green pseudothecia, has not been recognized in North America previously although all of the specimens seen are from old herbarium material. The only collection from the Great Lakes region is from Northern Ohio. Usually found on smooth bark.

Exsiccati examined. Krypt. Vind. 1646 (Isotype?, FH, US); Merrill II. 93 (sub Mycoporum pyrenocarpum, MICH, MSC).

Specimens seen.

UNITED STATES

IOWA: Black Hawk County, La Porte, Peck, 21 Feb. 1896 (MICH); Fayette County, Fayette, Fink, Aug. 1895 (MICH).

MAINE: Oxford County, Hartford, Parlin 13451 (Thomson).

MISSOURI: Saline County, Emma, Demetrio, 6 July 1898 (MICH).

OHIO: Ashtabula County, Orwell, Bogue, 1899 (MICH, MSC).

PYRENULACEAE Zahlbr.

Engler & Prantl, Natuerl. Pflanzenfam. I. Teil, Abt. I*: 62. 1903.

This is the earliest use of the name Pyrenulaceae which I have verified. Further research may bring to light earlier uses of the name.

PLAGIOCARPA gen. nov.

Ascocarp a perithecium surrounded by a stromatic shell. Ostiole borne on one side of the perithecium at the end of a short neck, spores hyaline, endospore very slightly thickened, transversally septate. Type species: Verrucaria hyalospora Nyl.

Apparently most closely related to Pyrenula, especially in ascocarp structure but differing in the hyaline spores with little endospore thickening. The spores are quite similar in appearance to Arthopyrenia and Pleurotrema which differ in having pseudothecia.

The type species is the only species known. It was considered by Fink (1935) to be an Arthopyrenia. The material in his herbarium from Iowa and Minnesota under this name is, in fact, either A. quinqueseptata or A. quisquiliae. Even if Fink had not misinterpreted the species, Plagiocarpa hyalospora could not be included in Arthopyrenia since that genus is ascolocular in development while Plagiocarpa is ascohymenial. Also the exit pore in Arthopyrenia is vertical not on one side. Degelius (1941) collected this species in Tennessee and noting the ostiole on the side of the perithecium placed it in the genus Pleurotrema, describing a new species, P. solivagum. This disposition is also incorrect since all all of the species of Pleurotrema examined, including the type of the genus, are ascolocular although they do have their exit pores on the side of the pseudothecium. The type of asci and paraphyses seems to exclude it from any close relationship with Trypethelium, which represents one ascohymenial line. The other ascohymenial pyrenolichen line, as represented by Pyrenula, seems at present, to have Plagiocarpa's nearest relatives. Both Pyrenula and Plagiocarpa have a stromatic shell surrounding a well-developed exciple and to have similar paraphyses and asci. Plagiocarpa differs from Pyrenula in having a tilted ostiole and in having hyaline spores with a relatively thin endospore, although the endospore is better developed than in the ascolocular genera. For these reasons a new genus is required.

Plagiocarpa hyalospora (Nyl.) comb. nov.

Verrucaria hyalospora Nyl. Mem. Soc. Acad. Maine-et-Loire 4: 48. 1858. (Expos. Syn. Pyrenocarp.). Mem. Soc. Imper. Sci. Nat. Cherb. 5: 337, 1857 (nom. nud.). Pyrenula hyalospora (Nyl.) Tuck. Gen. Lich. 273. 1872. Arthopyrenia hyalospora (Nyl.) Fink, Lich. Flora 50. 1935.

Pleurotrema solivagum Degel. Ark. Bot. 30A(3): 21. 1941.

Nylander stated in his original description that his material came from Tuckerman's herbarium. Tuckerman (1872) says that Nylander found this species mixed with some other material which Tuckerman had sent. I have examined all of Tuckerman's material of this species but have not seen any material from Nylander's herbarium. Therefore no type has been selected. All of Tuckerman's material is uniform and correctly determined. An isotype of Pleurotrema solivagum (US) has been examined. Degelius listed the substrate as Tsuga, it seems to me to be Acer saccharum.

Description. Thallus endophloeodal, pale gray or whitish, KOH+ yellow becoming yellow-brown, smooth. Trentepohlia usually abundant and well-developed, forming short chains. Ascocarps scattered, dark brown, not shiny, subglobose, initially completely immersed in the bark but commonly almost entirely free in age. Ostiole displaced to one side, not vertical, with a short neck; occasionally vertical or not projecting. Involucrellum entire, dark brown, c. 80u thick above, thinner below, 20-40u. Exciple thin c. 10-20u, pale brown to almost colorless, often entirely free from the involucrellum and shrinking away from it on drying except at the ostiole. Nucleus IKI+ greenish-blue becoming red-orange if the iodine concentration is high enough. Paraphyses septate, very rarely branched but apparently never anastamosed. Asci cylindrical or somewhat obclavate, not much thickened at the tip, dimple present, often cross-shaped in optical section; tip expanding in KOH for a distance of 20-30μ back from the end, forming a narrow canal; 65-90 x 20μ. Spores eight in the ascus, roughly biseriate to irregularly arranged, hyaline, ellipsoid, 3-septate, with the end cells smaller than the median cells, not constricted at the septa, endospore slightly thickened, lumina spherical to almost cylindrical; no gelatinous outer layer; 18-25 x 9-11μ.

Plagiocarpa hyalospora is most frequently found on *Acer saccharum* but also occurs on *Tilia americana*, *Betula lutea* and *Carya*. I have seen a single collection on lignum. *Plagiocarpa* is quite common around the Great Lakes occuring east to New England and south to Tennessee. A single collection with slightly smaller ascocarps and spores, collected by H. A. Imshaug in the West Indies, is very tentatively included.

Exsiccati examined. Lojka 200 (MICH); Merrill I. 102 (MICH, US).

Specimens seen.

CANADA

ONTARIO: Carleton County, Ottawa, *Macoun*, 18 Apr. 1896 (US); Hastings County, Belleville, *Macoun 3,41*, 1894 (FH); Middlesex County, London, *Drummond 38*, 1869 (FH); Nipissing District, Lookout trail, Algonquin Prov. Park, *Imshaug 26879* (MSC); Parry Sound District, Magnetawan, *Plitt*, 29 July 1920 (US).

UNITED STATES

MAINE: Knox County, Rockland, *Merrill*, 15 Aug. 1909 (MICH, MSC).

MARYLAND: Baltimore County, Catonsville, *Plitt 402*, 14 Jan. 1911 (US).

MASSACHUSETTS: Bristol County, New Bedford, Willey, 1868 (FH), Willey, Dec. 1885 (US); Hampshire County, Amherst, Tuckerman, 1857 (FH).

MICHIGAN: Alger County, Au Train Lake, A. H. Smith 2103 (MICH), Kingston Lake, Harris 618, 667 (MSC); Berrien County, Warren Woods, Harris 216A, 217 (MSC); Cheboygan County, gorge near Douglas Lake, Nichols, June-Aug. 1923 (MICH); Ingham County, East Lansing, Harris 910 (MSC); Iosco County, Iargo Springs on Au Sable River north of Tawas, Harris 829, 836, 837, 838, 840, 841, 842, 843 (MSC); Iron County, Teepee Lake south of Kenton, Harris 694, 696, 727, 728, 730A (MSC).

NEW HAMPSHIRE: County unknown, White Mtns., Tuckerman, 1847 (FH); Grafton County, Warren, Willey, 1882 (US).

NEW YORK: County unknown, Trenton Falls, Willey, 1880 (US); Genessee County, Bergen swamp, Muenscher & Brown, 17 Nov. 1946 (MICH); Niagara County, Goat Island, Tuckerman, Aug. 1848 (FH); Otsego County, Richfield Springs, Willey, 1884 (US).

OHIO: Franklin County, Georgesville, Bogue, 12 May 1894 (MICH).

SOUTH CAROLINA: Chester County, Chester, Green, 30 Jan. 1886 (MICH, MSC), Green, 9 Apr. 1884 (US).

TENNESSEE: Sevier County, Cherokee Orchard, Degelius, 11 Sept. 1939 (US).

WISCONSIN: Sawyer County, Flambeau River State Forest, Hale 2037 (WIS).

WEST INDIES

ST. LUCIA: Quarter of Soufriere, southwest slope of Gros Piton, south of Soufriere, Imshaug 29653 (MSC).

PYRENULA Massal.

Ricerch. Auton. Lich. 162. 1852.

Ascocarp a perithecium surrounded by a stromatic shell, spores brown, transversally septate, endospore much thickened so that the spore lumina are lenticular or spherical.

Pyrenula Massal. was published as an emendation of *Pyrenula* Ach. (Lich. Univ. 64, 314. 1810) but does not include any of Acharius' original species with which *Pyrenula* Ach. would have to be typified. None of these original species were even pyrenocarpous. Therefore, it would seem best to conserve *Pyrenula* Massal. against *Pyrenula* Ach.

Pyrenula neglecta sp. nov.

Thallus endophloeodal, yellowish-green to olive-green, smooth, often shiny; upper layer c. 0.1mm thick consisting of bark cells intermingled with hyphae. *Trentepohlia* abundant, very well-developed, forming a very definite layer. Ascocarps dark brown to black, dull to shiny, scattered or occasionally clustered and fused, 0.4-0.6mm in diameter, initially covered by bark and thallus but finally almost completely emergent. Ostiole evident, c. 40μ across, flush with the ascocarp surface or often raised in a small papilla. Involucrellum dark brown in section, c. 50-60μ thick, mostly dimidiate, reaching about to the base of the perithecium, often containing bark cells. Exciple brown, 10-15μ thick, often separating from involucrellum and bark. Nucleus containing an abundance of oil droplets, IKI+ blue-green at the base. Paraphyses simple, c. 1μ thick. Asci cylindrical to somewhat clavate, 70-85 x 15-18μ. Spores eight in the ascus, mostly uniseriate, pale olive-brown, 3-septate, not constricted at the septa; lumina oval in optical section, the terminal lumina smaller and pressed directly against the outer hyaline spore wall; usually a least one half as wide as long, 14-20 x 7-12μ.

This widespread species has previously been considered to be identical with the European species, Pyrenula nitida (Weig.) Ach. On careful examination the two species are quite different. The most obvious differences are summed up in the following chart.

Pyrenula nitida	Pyrenula neglecta
Ostiole tends to be depressed	Ostiole tends to be raised
Involucrellum contains crystals	Involucrellum without crystals
Brown layer around base of nucleus KOH+ red	No KOH+ layer around base of nucleus
Nucleus IKI-	Nucleus IKI+ bluish-green at the base
Nucleus with very little oil, if any	Nucleus with much oil
Spore width/length ratio mostly less than 1:2	Spore width/length ratio mostly more than 1:2
Terminal lumina separated from outer spore wall by endospore at tip	Terminal lumina directly against outer spore wall at tip
Lumina usually angular, diamond-shaped in optical section	Lumina not angular, oval in optical section

Several other species from Southern Ohio and further south have also been called Pyrenula nitida but none of them are comparable to the European species, which apparently does not occur in North America. The fact that American lichenologists have been confused by Pyrenula neglecta is indicated by the fact that much material of this species is also found under Pyrenula laevigata or its synonym, P. glabrata.

Pyrenula neglecta is almost always found on hard barks of such trees as *Fagus grandifolia*, *Quercus borealis*, *Q. veutina* or *Acer saccharum*. On the basis of specimens so far examined the species ranges from coast to coast along the U.S.-Canada border, south in the Eastern United States to Florida, although it seems to be rare south of Washington, D.C. Specimens collected by H.A. Imshaug in the Canary Islands may belong to this species also.

Exsiccati examined. Cummings I. 150 (MICH, MSC, WIS); Macoun I. 68 (MICH, WIS); Macoun II. 228 (MICH, Thomson); Merrill I. 186 (MICH); Rel. Far. 454 (WIS); Rel. Tuck. 131 (MICH, Thomson, WIS).

Specimens seen.

CANADA

ONTARIO: Carleton County, Ottawa, Macoun, 26 Apr. 1891 (MICH, WIS), Macoun, 6 Sept. 1891 (MICH, Thomson); Simcoe County, Blue Mtns. between Singhampton and Duntroon on hwy. 24, Imshaug 26936, 26968 (MSC).

UNITED STATES

ILLINOIS: Cook County, Calkins 288 (Thomson).

IOWA: Clayton County, Pikes Peak, bluffs along Mississippi River near McGregor, Imshaug 27896 (MSC); Delaware County, Maquoketa River valley, Backbone State Park north of Dundee, Imshaug 27998 (MSC); Fayette County, Fayette, Fink, Apr. 1894 (MICH); Jackson County, Maquoketa Caves Park northwest of Maquoketa, Imshaug 28063, 28090 (MSC).

MICHIGAN: Alger County, Au Train, Lowe 1555, 1567 (MICH); Benzie County, Benzie State Park, Imshaug 27419 (MSC); Charlevoix County, Beaver Island, old apple orchard, Imshaug 27588, Sandy Bay, Imshaug 27645 (MSC); Cheboygan County, Bois Blanc Island, Imshaug 3309 (MSC), Colonial Point, Douglas Lake, Nichols, June-Aug. 1923 (MICH), gorge near Douglas Lake, Imshaug 3137 (MSC); Crawford County, Hartwick Pines State Park, Imshaug 21385 (MSC); Emmet County, 4 miles south of Mackinaw City, Sierk, 18 July 1957 (WIS); Houghton County, Lake Superior near Calumet, Imshaug 20852 (MSC); Luce County, Upper Tahquamenon Falls, Imshaug 19890 (MSC); Mackinac County, Mackinac Island, Fort Holmes, Imshaug 27244 (MSC).

WISCONSIN: Door County, Valmy at Cave Point, Culberson 3619 (WIS); Grant County, T6N, R6W, sect. 19, Hale 1129 (WIS); Green Lake County, T14N, R12E, sect. 26, Hale 1018 (WIS); Sauk County, Baraboo Range, Thomson 1401 (Thomson, WIS); Vernon County, T13N, R6W, sect. 32, Hale 1226 (WIS); Washburn County, near Long Lake, Culberson 1730 (WIS).

Pyrenula agawae sp. nov.

Thallus endophloeodal, indicated only by greenish color under upper layer of bark or by a grayish blotch in age. *Trentepohlia* abundant, well-developed. Ascocarps scattered, dark brown, usually covered by thin layer of bark, flattened subglobose, 0.2-0.4mm in diameter. Involucrellum mostly entire, continuous with clypeus which extends c. 0.1mm beyond the involucrellum, containing numerous bark cells. Exciple brown, c. 20-50µ thick. Nucleus IKI-, without oil. Paraphyses unbranched, septate, c. 1µ thick. Asci cylindrical-clavate to clavate, 40-70 x 10-15µ; unchanged in KOH. Spores eight in the ascus, uniseriate to biseriate, gray-brown, ellipsoid to lemon-shaped, 3-septate, not constricted at the septa; lumina ellipsoid to somewhat diamond-shaped in optical section, terminal lumina not directly against outer spore wall but separated from it by a layer of endospore; 17-20 x 9-10µ.

This species is known only from a single collection on *Betula lutea*. It differs from our only other northern species of *Pyrenula*, *P. neglecta*, in having a poorly developed thallus, distinct clypeus, lack of oil in the nucleus, IKI- nucleus and position of the terminal spore lumina.

Specimens seen.

CANADA

ONTARIO: Algoma District, Lake Superior Prov. Park, ½ mile north of Doc Grieg Lake, *Harris 569* (MSC).

TRYPHETHELIACEAE Zahlbr.

Engler & Prantl, Natuerl. Pflanzenfam. I. Teil, Abt. I*: 69. 1903.

This is the earliest use of the name which I have verified. Further research may bring to light earlier uses of the name.

TRYPHETHELIUM Spreng

Anleitung zur Kenntn. der Gewaechse, 3: 309. 1805. (conserved over *Bathelium* Ach. Method. Lich. 111. 1803)

Tryphethelium virens Tuck. in W. Darl.

Fl. Cest. ed. 3. 453. 1853.

Description modified from Johnson (1959). Thallus endoploeodal, smooth, greenish, yellowish-gray or yellow-brown to orange-brown; upper layer of fused hyphae and bark cells, cortex-like, 45-90µ thick. *Trentepohlia* abundant, well-developed, in a layer 15-23µ thick. Perithecia aggregated and imbedded in a pseudostroma up to 7mm in length, slightly elevated, more-or-less concolorous with the thallus (especially when young) but becoming lighter or darker with age; outer layer of bark cells up to 55µ thick, with perithecial initials forming below this layer, raising the bark layer as the perithecia enlarge, sometimes altering the bark cells to a blackish color or interwoven hyphae becoming carbonaceous. Perithecia 0.4-0.6mm high by 0.2-0.5mm across. Ostioles seen from above as black dots c. 0.1mm in diameter. Exciple carbonaceous, 30-60µ thick. Paraphyses c. 1µ thick, anastamosed, forming a broad net. Asci clavate to clavate-cylindrical, 100-125 x 15-17µ. Spores eight in the ascus, irregularly biseriate, hyaline, 7-9-septate, not constricted at the septa; lumina elliptical or diamond-shaped in optical section, 38-52 x 7-10µ. Pycnidia large, embedded in stroma, labyrinthiform, with long thin conidiophores; microconidia hyaline, rod-like, c. 5 x 1µ.

In the Great Lakes region the usual substrate of this lichen is _Fagus_ but it has been also found on _Carpinus_.

The species is of special interest as it is the only representative of a very large tropical group, which is highly developed along stromatic lines. It apparently reaches its northern limit at about the Straits of Mackinac, east to Vermont and New Hampshire, west to Wisconsin, reaching its southern limit in Oklahoma, Mississippi and Florida.

Exsiccati examined. Cummings I. 253 (MSC); Cummings II. 193 (MICH); Merrill I. 69 (MICH); Rel. Far. 456 (MICH); Zahlbr. 231 (MICH).

Specimens seen.

CANADA

ONTARIO: Parry Sound District, Indian Docks, Parry Sound, _Cain 26671_ (WIS); Simcoe County, Blue Mtns. between Singhampton and Duntroon on hwy. 24, _Imshaug 26975_, _26992_ (MSC).

UNITED STATE

MICHIGAN: Benzie County, Benzie State Park, Bayliss 41 (MSC); Cheboygan County, Pine Grove campground east of Wolverine, Harris 783, 784 (MSC), Douglas Lake, Nichols, June-Aug. 1923 (MICH); Eaton County, near Vermontville, Imshaug 29231, 29232 (MSC); Ingham County, Baker Woodlot, East Lansing, Harris 62, 77 (MSC).

OHIO: Lake County, Painesville, Fink, 649, 6 Oct. 1915 (MICH).

WISCONSIN: Door County, near Jacksonport, Culberson 3709, 3913 (WIS).

SUMMARY

This survey of the corticolous pyrenocarpous lichens in the Great Lakes region treats nine genera and 23 species. Spores are illustrated for all the species treated. Their morphology and ecology are discussed briefly. Molestia and Plagiocarpa are described as genera new to science. Arthopyrenia quisquiliae, A. thomsonii, A. willeyana, Pyrenula agawae, and P. neglecta are described as species new to science. Arthopyrenia myricae (Nyl.) Zahlbr., Leptorhaphis atomaria (Ach.) Szatala, L. parameca (Massal.) Koerb., and Polyblastiopsis meridionalis Zahlbr. are reported as new to North America. Microthelia wallrothii (Hepp) Rehm is reported as new to the Great Lakes region. Pyrenula nitida (Weig.) Ach. and Arthopyrenia alba (Schrad.) Zahlbr. are excluded from the flora.

The study was based on field work and examination of material from the Farlow Herbarium, Michigan State University, Smithsonian Institutuin, University of Michigan, University of Wisconsin and the personal herbarium of J. W. Thomson.

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APPENDIX I. BASIC ECOLOGICAL DATA

Stand # 1. Boreal forest, dominated by Abies balsamea, Betula lutea and B. papyrifera. Lake Superior Prov. Park, ½ mile north of Doc Grieg Lake, Algoma District, Ontario.

Tree species	Diameter in cm.					Lichens		
	10-19	20-29	30-39	40-	Total	Microthelia micula	Pyrenula agenae	Total
Abies balsamea	13	10	2	1	26	1		1
Acer rubrum				1	1	1		1
Betula lutea	3	5	9	16	33	3	1	4
Betula papyrifera	1	6	13		20			
Picea glauca	2	9	4		15			
Sorbus americana	1				1			
Thuja occidentalis			2	2	4			
Total	20	30	30	20				6

Stand # 2. Wet-Mesic Northern forest, an almost pure stand of *Acer rubrum* and *Fagus grandifolia*. East side of road just north of Kingston Lake, Alger County, Michigan. T49N, R15W, sect. 32.

Tree species	Diameter in cm.					Lichens		
	10–19	20–29	30–39	40–	Total	Plagiocarpa hyalospora	Microthelia micula	Total
Abies balsamea	8		4		8			
Acer rubrum	33	11	4	4	52		1	1
Betula lutea	1	1	1	2	5	1		1
Fagus grandifolia	6		6	12	24		2	2
Pinus strobus	3		1	2	6			
Tsuga canadensis				5	5			
Total	51	12	12	25				4

Stand # 3. Northern Mesic forest, mixed hardwoods without any obviously dominant tree species. Porcupine Mountains, ½ mile east of parking lot, Ontonagon County, Michigan. T51N, R43W, sect. 15.

Tree species	Diameter in cm.					Lichens					
	10–19	20–29	30–39	40–	Total	Polyblastiopsis fallaciosa	Molestia leucoplaca	Microthelia micula	Leptorhaphis epidermidis	Leptorhaphis atomaria	Total
Abies balsamea	4	4			8						
Acer saccharum	5	7	7	1	20	2	3	4			9
Betula lutea	1				1						
Betula papyrifera	11	1			12				6		6
Fraxinus sp.	4	2	1		7		1				1
Populus tremuloides	1	2	1		4					1	1
Quercus borealis	7		1	4	12						
Thuja occidentalis	1	1	1		3						
Tilia americana	4	7	5		16						
Tsuga canadensis	1	7	5	4	17						
Total	39	31	21	9							17

Stand # 4. Swamp forest, dominated by <u>Acer rubrum</u>, <u>Ulmus</u> and <u>Fraxinus</u>. Big Cedar River State Forest campground, Menominee County, Michigan. T36N, R25W, sect. 28.

Tree species	Diameter in cm. 10–19	20–29	30–39	40–	Total	Lichens Polyblastiopsis fallaciosa	Molestia leucoplaca	Total
Abies balsamea	2				2			
Acer rubrum	26	10	6		42			
Acer saccharum	2				2			
Betula lutea		1			1			
Betula papyrifera	2				2			
Fraxinus sp.	22	1			23	1		1
Pinus strobus				1	1		6	6
Ulmus americana	2	11	7	7	27			
Total	56	23	13	8				7

Stand # 5. Northern Mesic forest, mostly Acer saccharum.

Pine Grove State Forest campground, Cheboygan County, Michigan.

T33N, R1W, sect. 16.

Tree species	Diameter in cm. 10-19	20-29	30-39	40-	Total	Lichens Polyblastiopsis fallaciosa	Molestia leucoplaca	Microthelia micula	Trypetuelium virens	Total
Acer saccharum	31	20	1	4	56	49				49
Betula papyrifera		1			1					
Fagus grandifolia		3	2	10	15				2	2
Populus grandifolia		1			1					
Prunus sp.	2	2			4			1		1
Tilia americana	6	8	2	2	18		1			1
Tsuga canadensis			1	1	2					
Ulmus americana	1	1	1		3					
Total	40	36	7	17						53

Stand # 6. Northern Mesic forest, mixed hardwoods with no clear dominants. Iargo Springs on the Au Sable River north of Tawas, Iosco County, Michigan. T24N, R6E, sect. 26.

Tree species	Diameter in cm.					Lichens					
	10-19	20-29	30-39	40-	Total	Molestia leucoplaca	Microthelia micula	Plagiocarpa hyalospora	Polyblastiopsis fallaciosa	Pyrenula neglecta	Total
Acer rubrum			1	1	2						
Acer saccharum	11			1	12		1	1	1		3
Betula lutea	1		2	1	4						
Fraxinus sp.	9	33	2	1	15	1		1	1		3
Ostrya virginiana	9	5			14						
Pinus strobus		2		3	5						
Populus grandidentata				1	1						
Quercus alba	1	1			2						
Quercus bicolor				1	1						
Quercus borealis	1	2	1	2	6					1	1
Thuja occidentalis		1			1						
Tilia americana	8	7	4	8	27			6			6
Tsuga canadensis	2	1			3						
Ulmus americana	2				2						
Total	44	22	10	19							13

Stand # 7. Dry Southern Hardwoods, dominated by *Quercus velutina* and *Q. alba*. Near relict prairie northeast of Newaygo, Newaygo County. T13N, R11W, west side sect. 19.

Tree species	Diameter in cm. 10-19	20-29	30-39	40-	Total
Acer rubrum	4				4
Malus sp.	1				1
Pinus strobus	1	2	1		4
Populus grandidentata	4	9			13
Prunus serotina	4				4
Quercus alba	24	6	1	2	33
Quercus borealis		4			4
Quercus velutina	15	20	2		37
Total	53	41	4	2	

No lichens found.

Stand # 8. Soutern Wet-Mesic forest. Sanford woodlot, East Lansing, Ingham County. T4N, R1W, sect. 18.

Tree species	Diameter in cm.					Lichens				
	10-19	20-29	30-39	40-	Total	Arthopyrenia willeyana	Plagiocarpa hyalospora	Trypethelium virens	Polyblastiopsis fallaciosa	Total
Acer rubrum		5	4	4	13					
Acer saccharum	9	5	2	5	21		1		1	2
Carya sp.	1				1					
Fagus grandifolia	4	1	2	4	11			2		2
Fraxinus sp.	4	2		4	10	1				1
Ostrya virginiana	1				1					
Platanus occidentalis				1	1	1				1
Quercus alba	4	1			5					
Quercus borealis	1	1			2					
Tilia americana	8	9	1	1	19					
Ulmus americana	6	6	3	3	16	3				3
Total	38	28	12	22						9

Stand # 9. Southern Dry-Mesic forest, oak-hickory woods.

North of Crooked Lake, Washtenaw County, Michigan. T1S, R3E, sect. 6.

Tree species	Diameter in cm.					Lichens				
	10-19	20-29	30-39	40-	Total	Arthopyrenia willeyana	Arthopyrenia sphaeroides	Arthopyrenia finkii	Polyblastiopsis fallaciosa	Total
Acer rubrum	3	1		1	5					
Acer saccharum		1	1		2					
Carya ovata	1	2			3					
Carya sp.	4	7	3	2	16					
Fraxinus sp.	1		3		4	1				1
Populus grandidentata			2		2					
Prunus sp.	1				1					
Quercus alba	5	11	13	8	37	15	1	1	13	21
Quercus bicolor	2	1		2	5					
Quercus borealis	1	2	8	11	22	1				1
Sassafras albidum	3				3					
Total	21	25	30	24						23

Stand # 10. Southern Dry-Mesic forest, oak-hickory woods.

Kellog Forest north of Augusta, Kalamazoo County, Michigan.

T1S, R9W, sect. 22.

Tree species	Diameter in cm.					Lichens			
	10-19	20-29	30-39	40-	Total	Arthopyrenia willeyana	Polyblastiopsis fallaciosa	Microthelia micula	Total
Acer rubrum	10	11	3	1	20				
Acer saccharum	5	2	3	3	13				
Carya ovata				1	1	1			1
Carya sp.			2	7	9	1		4	5
Cornus florida	1				1				
Jugans cinerea		1			1				
Prunus sp.	5	3	1	7	12				
Quercus alba	5	3		9	17	9	3		9
Quercus borealis	5	1		8	14			1	1
Sassafras albidum	2	1			3				
Ulmus americana	2	1			3				
Total	35	23	9	33					16

APPENDIX II. PYRENOLICHEN SUBSTRATES IN THE GREAT LAKES REGION

	Abies balsamea	Acer rubrum	Acer saccharum	Betula lutea	Betula papyrifera	Carpinus caroliniana	Carya ovata	Carya sp.	Fagus grandifolia	Fraxinus sp.	Gleditsia triacanthos	Juglans cinerea	Platanus occidentalis	Populus tremuloides	Prunus sp.	Quercus alba	Quercus borealis	Tilia americana	Ulmus americana
Arthopyrenia finkii																X			X
A. myricae	X																		
A. puncti-ormis		X			X														
A. sphaeroides																X			
A. thomsonii											X								
A. willeyana			X	X			X			X			X	X		X		X	
Dermatina pyrenocarpa									X										
Leptorhaphis atomaria														X					
L. contorta														X					
L. epidermidis					X														
L. parameca					X										X				
Microthelia micula	X	X	X	X			X	X							X			X	
M. wallrothii					X														
Molestia leucoplaca			X							X				X		X		X	X
Plagiocarpa hyalospora			X	X						X									
Polyblastiopsis fallaciosa			X	X	X					X		X							
P. lactea										X									
Pyrenula agawae				X															
P. neglecta			X						X								X		
Trypethelium virens						X			X										

Plate 1. Map of Great Lakes region showing sites of ecological sample stands

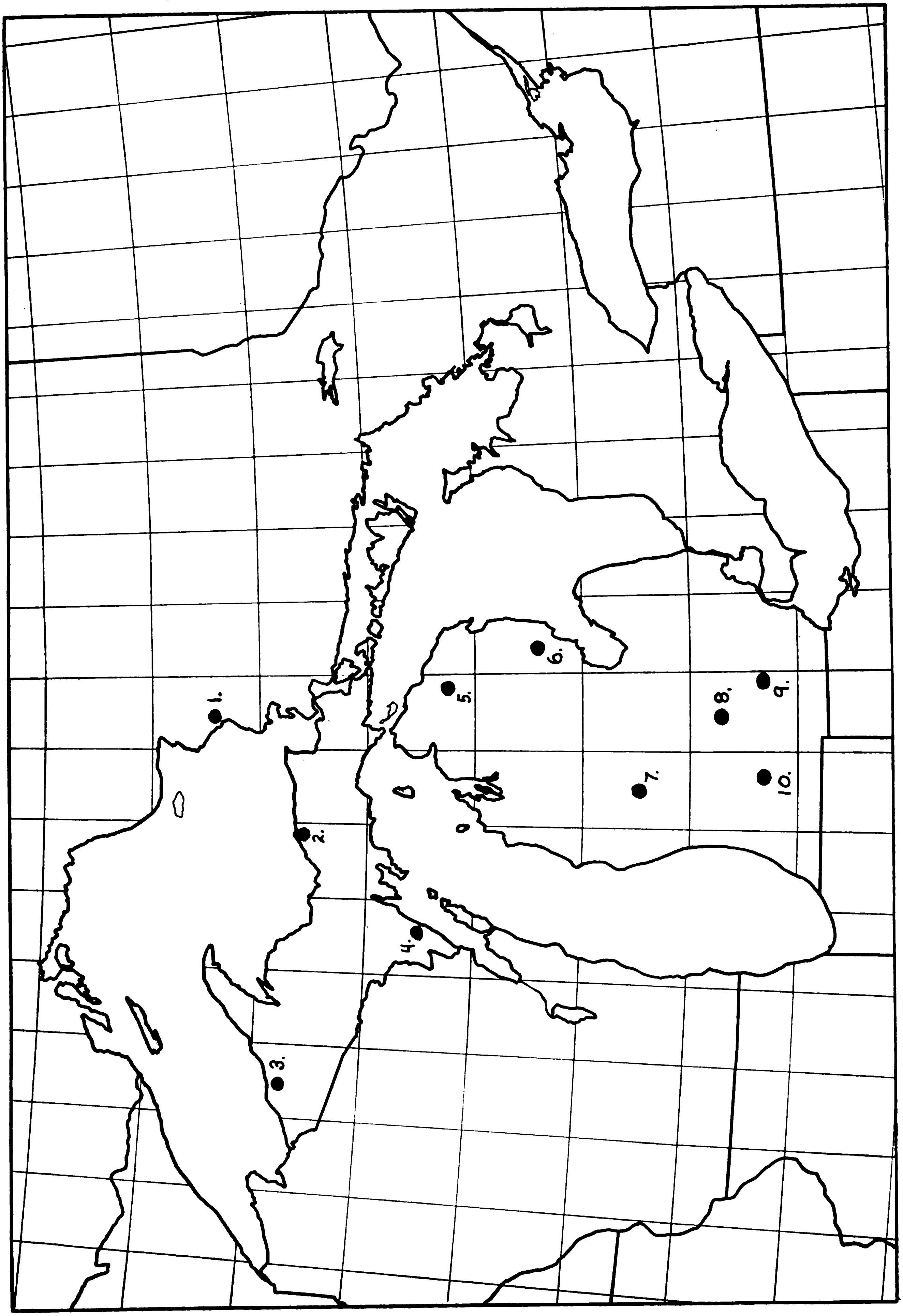


Plate 2. Spores of *Arthopyrenia*

Fig. 1. *Arthopyrenia finkii*

Fig. 2. *A. sphaeroides*

Fig. 3. *A. punctiformis*

Fig. 4. *A. willeyana*

Fig. 5. *A. quisquiliae*

Fig. 6. *A. quinqueseptata*

Fig. 7. *A. quinqueseptata* (with two longitudinal septa).

Fig. 8. *A. myricae*

Fig. 9. *A. thomsonii*

Plate 3. Spores of Leptorhaphis, Microthelia and Polyblastiopsis

Fig. 1. Polyblastiopsis lactea

Fig. 2. P. meridionalis

Fig. 3. P. fallaciosa

Fig. 4. Microthelia wallrothii

Fig. 5. Spore representative of Microthelia micula group.

Fig. 6. Leptorhaphis contorta/L. parameca

Fig. 7. L. atomaria

Fig. 8. L. epidemidis

Plate 4. Spores of _Dermatina_, _Melanomma_, _Molestia_, _Plagiocarpa_, _Pyrenula_ and _Trypethelium_

Fig. 1. _Trypethelium virens_

Fig. 2. _Plagiocarpa hyalospora_

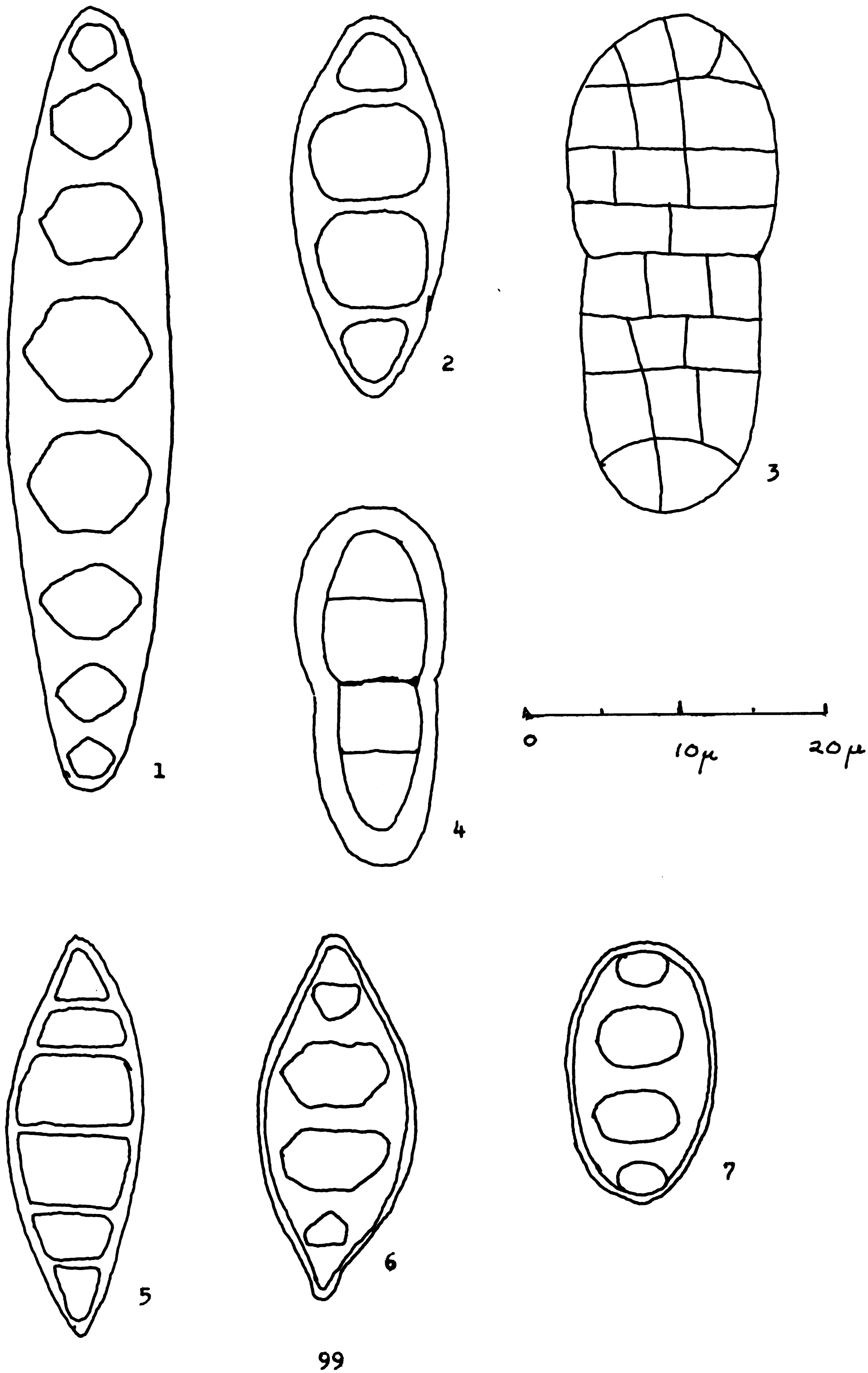
Fig. 3. _Dermatina pyrenocarpa_

Fig. 4. _Melanomma_ sp.

Fig. 5. _Molestia leucoplaca_

Fig. 6. _Pyrenula agawae_

Fig. 7. _P. neglecta_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