LICHENS of the OTTAWA REGION

IRWIN M. BRODO

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ABSTRACT

The city of Ottawa is situated in eastern Ontario approximately half way between Quebec City and Toronto in the deciduous forest region. The lichen flora within a 30-mile radius of Ottawa consists of about 370 species of lichens, and is fairly representative of this entire populated corridor.

This work opens with a short general discussion of lichens as organisms, including pointers on their collection, preservation, and study. Diagnostic keys are then presented to the genera of crustose lichens based on fertile or on sterile material. Individual species are then keyed out within their genera. Keys to foliose lichens and fruticose lichens (without respect to particular genera) complete the section. A glossary of special terms used in the keys is presented as an appendix, together with an index of the species covered. The keys and glossary are illustrated with 75 black-and-white drawings depicting many of the lichens and some of their microscopic features.

RÉSUMÉ

La ville d'Ottawa, situé dans l'est de l'Ontario approximativement à mi-chemin entre Québec et Toronto, se trouve dans la région des forêts décidues. La flore lichénique, dans un rayon de 48 kilomètres autour d'Ottawa, comprend environ 370 espèces de lichens, et elle est veritablement représentative de cette région peuplée dans son entier.

Cet ouvrage présente d'abord une discussion générale sur les lichens en tout qu'organismes et fournit des instructions concernant leur collection, leur préservation et leur étude. Ensuite apparaîssent des clefs diagnostiques des genres des lichens crustacés basées sur des spécimens fertiles ou stériles. Alors, il y a une série des clefs pour identifier les espèces individuelles; ces clefs sont classés selon les genres. Les clefs des lichens foliacés et des lichens fruticuleux terminent cette section. Un glossaire de termes spéciaux, employés dans les clefs, constitue une annexe, ainsi qu'un répertoire des espèces comprisés dans l'ouvrage. Les clefs et le glossaire comprennent 75 dessins au trait qui représentent plusieurs lichens et quelques-unes de leurs caractéristiques microscopiques.

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PREFACE

In 1967, two articles were published on lichen identification in the Ottawa Field-Naturalists' journal, "Trail & Landscape" (Brodo, 1967a, b). The third and final article of the series was published in the same journal a few years later (Brodo, 1972). These articles were written with the serious amateur naturalist in mind with technical language and techniques kept to an absolute minimum. To enable the reader to name the local lichens, the material was presented as an identification "key" to the common species.

There has been a great demand for these keys over the past 10 to 12 years, but not from the amateur naturalists for whom the articles were written. The demand seems to have been from high school and college students for the most part. These individuals seem prepared to make greater use of microscopes and chemical reagents, and they want the keys to include all known species from the area, not just the common ones.

Because of the demand and because of the need for more comprehensive keys, the three articles and keys have been combined and completely revised. This edition (available in both French and English) is still, in a sense, an interim version because a great deal more exploration of the Ottawa region needs to be done before we can be reasonably sure that the entire flora has been sampled. The author will welcome additions and corrections to these keys from amateurs and professionals alike.

INTRODUCTION

One aspect of the natural history of southern Ontario and Quebec which has received relatively little attention is the lichen vegetation. These interesting plants, forming colourful displays on rocks and roadside trees, deserve more of a place in the naturalist's notebook.

Some basics

To the casual observer, lichens are often mentally grouped with mosses, or sometimes algae, or, more rarely, fungi. People I speak to are often baffled by the wide array of forms lichens can take. Can they all be lichens? How can a black smudge on a rock be closely related to the richly branching, shrubby "reindeer moss"? We can only come close to answering this question by first attempting to answer another: what *is* a lichen?

The most significant thing about all lichens is that they are *two* plants, not one. Each lichen plant body or "thallus" is a biological twosome composed of a fungus living in initimate contact with an alga. The relationship involves much more than the mere contact or even relative position of the constituents; it results in the formation of the entirely new, self-sufficient, functioning unit which gathers raw materials, manufactures food, conducts an exchange of vitamins and growth substances, and often even reproduces as if it were a single plant. In its form and structure, the lichen is different from the lichen fungus or the lichen alga growing alone, i.e., in an "unlichenized" state. No lichen fungi have yet been definitely found growing naturally without their algal component, and so the only thing we know about their form in this state comes from growing artificially isolated, cultured material. Many species of lichen algae, however, are found free-living.

Observers in the Ottawa region can find lichens of all descriptions in a tremendous variety of habitats. There are lobed or "leafy" forms (called *foliose* lichens); stalked, shrubby, or hair-like forms (called *fruticose* lichens); and the crust-like forms (called *crustose* lichens). Most species can be found on soil, boulders, pebbles, tree bark, or wood, but some are confined to submerged rocks in streams, or grow on decaying mosses and heaths, or are found along the rocky shores of the ocean growing on wave-washed rocks or even barnacle shells. You probably won't find many species close to the centre of a city or industrial centre because lichens are notoriously sensitive to polluted and dehumidified air.

Previous work and this one

The classic work on the lichens of the Ottawa area was written by Canada's first federally employed botanist, John Macoun, about 80 years ago (Macoun, 1898a,b,c; 1902). Macoun was an excellent collector and, although his publications consisted of nothing but a list of names and are now hopelessly out of date, his specimens are still at the National Herbarium and are extremely important in documenting the past and present flora of the region.

With the growing interest in lichens, many useful articles are beginning to appear. Several articles in popular Canadian magazines give excellent introductions to the subject of lichenology (Bennett, 1979; McMillan, 1979). The naturalist interested in naming lichens has more of a problem. Certainly the best book available for our area is the second edition of Mason Hale's "How to Know the Lichens" (Hale, 1979). The treatment covers a very wide area, however, (all of the United States and most of Canada) and therefore contains many more species than would be found in southern Canada. This array of species may be a source of confusion for the amateur. A further limitation is that it only deals with the "macrolichens", that is, the foliose and fruticose species. You are on your own with regard to crustose lichens.

There was a need, therefore, for a guide to the identification of lichens of southern Canada. The Ottawa region was chosen as a focal point simply because of my familiarity with the area and the fact that it is rather central to the more populated corridor between Quebec City and Toronto. Some experience with the keys has shown that they are applicable for most of the Great Lakes-St. Lawrence Forest region in southeastern Canada. They will be less useful in the maritime region and west of the Great Lakes.

The keys which follow cover about 370 species, all the species known to occur within a 30-mile radius of central Ottawa. Most of this area is typical deciduous woodland from open poplar-birch stands and elm and oak woods, to mature beech-sugar maple forests. Some coniferous forest types occur in parts of Gatineau Park on the Quebec side of the Ottawa river.

How to use these keys

Because of the large number of species treated, the keys have been written in sections. The first section is devoted to the *crustose* species, and includes all species which are truly crustose (forming a superficial crust over or within a substrate, and so intimately attached to it that the lichen cannot be separated from it), as well as the squamulose or "scale-like" species. It should be noted that some "crustose" species become

so conspicuously lobed at the margins of the thallus or plant body that they appear to be foliose. Some of these intermediate species are keyed out under both the crustose and foliose keys, but some will have to be sought under the alternative key if the first one does not produce a satisfactory answer.

The section on crustose species begins with a key to the genera of fertile crustose lichens (i.e., lichens having fruiting bodies of some kind). Those genera having only one species within the Ottawa region will end their treatment here with a brief description or "diagnosis" of the species at the last choice. [All the keys are, in fact, "diagnostic", having an abbreviated description of the taxon at the final couplet.] Following the key to fertile genera is a key to sterile species of crustose and squamulose lichens (i.e., those species lacking fruiting bodies). Then, there is a series of keys to crustose species within their genera, with the genera arranged in alphabetical order.

The next section is devoted to *foliose* lichens, lichens which are "leafy" in appearance, more or less flattened with distinguishable upper or lower surfaces, and generally attached to the substrate over many points, most often by means of tiny, root-like hairs called rhizines. Sometimes the foliose lichens are extremely closely attached and appear almost crustose (such as *Physciopsis*, couplet 89), and some growth forms have ascending, almost erect lobes and appear to be virtually fruticose (such as *Cetraria arenaria*, couplet 100).

The foliose lichens are keyed out together, that is, without regard to genus. This is done because many of the genera now recognized are based on microscopic or otherwise minute characteristics. The long, general key to foliose species is preceded by an abbreviated "synopsis" key. Most users, especially those not familiar with lichens, will find that the synopsis key will be most useful *after* they have gained some familiarity with the general key.

The last section includes the keys to *fruticose* lichens, those lichens which are erect or pendent and are attached to the substrate by one or at most a few points. Fruticose lichens usually grow in cushions, mats, or tufts, and include the familiar Cladonias, the reindeer lichens, the hairlike "old man's beard", and similar forms. Some lichens such as *Baeomyces* have a crustose "primary thallus" from which arise fruticose stalks or "podetia". These species are treated with fruticose lichens when fertile, and crustose lichens when sterile. *Cladonia* species all have a squamulose to almost foliose primary thallus, but all the species are included in the fruticose key.

Thus, to use the keys, one must first made a decision as to the growth form of the lichen in question, and then turn to one of the four primary keys: the key to fertile crustose genera (page 14), sterile crustose species (page 27), foliose species (synopsis, page 69; general key, page 70), or fruticose species (synopsis, page 98; general key, page 99).

Much of the terminology in the key will, of course, be unfamiliar to you if you have never dealt with lichens before. An illustrated glossary has therefore been provided on pages 113 to 119.

Colour: to use it in a key invites trouble, and to avoid it is absurd. It is simply one of those things which requires some experience to use with confidence. Certainly, the trickiest colour designation is "yellowish" or "yellow-green". This usually refers to lichens containing the pale yellow pigment, usnic acid. Generally, if a lichen has any aspect of a yellowish tint, even if one might normally call it simply "green", it is best to follow the leads for "yellowish" thalli.

As each species is keyed out, a note on its ecology and relative abundance is given. The abundance description is, admittedly, very subjective, but to make the notes comparable, only the words "common", "frequent", "infrequent" and "rare" are used. By "common", I mean that the lichen has been found in many localities throughout the region; "frequent" indicates that I have several specimens, but the species tends to be spotty in distribution; "infrequent" indicates that I only have a few specimens and one doesn't encounter the species often; and "rare" means that the taxon has only been found once or twice in the area. I should point out, however, that these notes on abundance apply only to the Ottawa region; a "rare" species here may be "common" farther east or west.

Methods of collection and study

Foliose and fruticose lichens

There is generally no problem with collecting the "macrolichens." Almost all of them can be removed from or with the substrate with little more than a good knife. A pair of pruning clippers is handy for species which grow on twigs, but this is a luxury. Put the specimens in paper bags (*never* plastic bags) with the substrate and habitat data written on the outside.

Many of the macrolichens are rather bulky and fragile and require some preparation to make them convenient "specimens". Bulky foliose and fruticose lichens should be moistened with distilled (or rain) water (to avoid colour changes in the lichens caused by the alkaline tap water reacting with "lichen

substances".) The specimens can then be pressed lightly and dried using a small fan to hasten the process. (Heat should not be used; it will often ruin species containing blue-green algae.) The specimens are stored in envelopes or in "packets" folded from 8½ x 11" sheets.

You will need a good hand lens (about 10X magnification) for examining the specimens, although a dissecting microscope would, of course, be better. For handling the material, you will need some good, single edged razor blades, and a pair of fine forceps or tweezers. Some sort of needle mounted in a wooden handle would also be handy. Most characters are easily seen, such as surface texture, presence or absence of reproductive structures, and the colour of the upper and lower thallus surfaces.

To use the keys most effectively, you will also need a smaller dropper bottle of undiluted bleach (e.g., "Javex"), a small dropper bottle containing a solution of household lye (about 10 lye pellets in ½ oz. of water) or 10% potassium hydroxide, and some para-phenylenediamine (to be described below). The chemicals are used to test the lichens for the presence of certain lichen substances which are specific to some species. Tests are made by simply wetting the upper surface of the lichen or the "medulla" (see Figure 65) with a tiny drop of the chemical. The medulla is exposed by cutting away the overlying cortex and algal layer with a razor blade. The less liquid used in each test, the better. The lye solution or potassium hydroxide is abbreviated "KOH" in the keys, and the bleach solution is abbreviated "C" (standing for the "chlorite" part of the chemical name of bleach, sodium hypochlorite). Para-phenylenediamine is abbreviated "PD". If the appropriate lichen substance is present, a colour reaction will occur turning your tested area yellow, orange, or red. A "KC" test is made by moistening the spot to be tested with KOH, and then applying the C on the moistened area. Watch closely because the C and KC tests are very ephemeral. The testing chemicals and the reactions to be looked for are mentioned in the keys. The lichen substances responsible for these reactions are also mentioned, in most cases.

The use of PD requires some special comment because, although it is extremely useful for the study of lichens, it can be destructive or even dangerous if mishandled. This chemical was once used extensively in photographic developing, but is rarely used today. The result is that it is hard to come by. It is, however, generally available from scientific supply houses in lots of 100 gms (enough for 25 years or so).

To make the most sensitive PD test, dissolve a few crystals of PD in 2 or 3 drops of ethyl alcohol (70%). A tiny dish or vial is a good container. Then, using a thin brush (2 or 4 bristles) or a very slender pipette or

dropper, wet the surface of the lichen to be tested with the PD solution. The colour will develop within a few seconds.

Prepare only a few drops of PD solution at a time because it decomposes very quickly (within a few minutes). Old, dark PD will not work, and neither will the redissolved residue of old solutions which have evaporated. After the test, discard the tested piece of lichen. This is important because PD irreparably stains paper, desks, ties, shirts, etc., and will become a nuisance if handled carelessly. It is also a deadly poison, so keep it out of the reach of children.

If one has access to a few more reagents, a stable aqueous solution of PD can be prepared. First, make a 10% solution of sodium sulfite (10 gms Na_2SO_3 dissolved in 90 ml of water), add five or six drops of a detergent ("Photo-flo", a Kodak product, is best) and then 1 gm of p-phenylenediamine. Stir and shake the mixture for several minutes until as much of the PD has gone into solution as possible. Then filter the saturated solution and throw away the undissolved crystals. The light pink solution which results is fairly sensitive and will last a month or more (especially if kept in a dark bottle). It is still very toxic and will stain objects, so precaution is still needed in handling the solution. When it turns a dark pink, it should be discarded.

Crustose lichens

Crustose lichens are not always inconspicuous, although some are admittedly little more than black smudges. Some have large brightly coloured thalli or fruiting bodies and cover large areas of rock, bark, or soil. They are especially interesting because of their intimate attachment to their "host" or substrate, often not only growing on but into the material. Even limestone- or granite-inhabiting crusts are known to grow into the rock, between grains and crystals, to depths of several millimeters. Many bark species develop with all their tissues below the outermost bark layer. Significantly, many of these crusts are quite "substrate-specific" being found on only one or at most a few tree species. Some crustose lichens, on the other hand, seem to grow over everything. For example, some tundra species may start growing on the soil but continue developing over dead vegetation, mosses and even rocks. These fast-growing species are not the rule, however, since most crusts grow very slowly, especially in the Arctic. A moderately large patch of a crustose lichen on an arctic boulder, therefore, might be hundreds of years old, and some individual thalli have been estimated to be over 1000 years old.

Since crustose lichens grow attached at all points to the substrate, one must collect the substrate in order to collect the lichen. There is no particular difficulty with bark-dwelling species (bark is easy to remove), but rock lichens present something of a problem. Most lichen collectors use a small ($\frac{1}{2}$ - $\frac{3}{4}$ inch) cold chisel and geologist's hammer to deal with the rock crusts. Wearing safety goggles when using a cold chisel is a very good idea. With a sharp chisel, good aim, and a little practice, most plants can be coaxed into becoming specimens, but I must admit that I still can't do very much with those infuriating crusts (always the most interesting) on smooth, vertical rock walls.

Although lichens are composites of two plants, fungi and algae, it is only the lichen fungi that are used in lichen classification. In identifying lichens, therefore, we have to deal mainly with the fungi, especially their fruiting structures. All the lichens in the Ottawa area belong to a class of fungi called the ascomycetes or "sac fungi". All these fungi produce their sexual spores in small club-shaped or cylindrical sacs called asci (Figure 71). Each ascus usually has eight spores (although there can be as few as one or as many as hundreds). The asci are generally formed together in a layer called a hymenium (Figure 70) together with sterile fungal threads (paraphyses). This hymenium, together with other supporting tissues, is found in fruiting bodies of various types: generally cup- or disk-shaped structures called apothecia (Figures 65, 74a), or more or less embedded, flask-shaped structures called perithecia (Figures 69, 74c). There are other, special types of fruiting bodies as well, as you will see.

In order to use the keys to crustose lichens, you will need a compound microscope. This will allow you to make use of spore characters which make identification relatively easy, quick, and sure. Since the key will rarely call for the observation of anything more involved than spore shape, size, colour, and cross-wall type (septation), 100x magnification will often be adequate, and 400x magnification will be the limit of anyone's needs. Of course, the better the light source, the cleaner the lens, and the smoother the focusing apparatus, the easier and more effective using the microscope will become.

To examine the spores, it is necessary to prepare microscopic preparations of the fruiting bodies. To begin with, you will need a few items near your microscope: a dropper bottle with water, another with some KOH (the same "recipe" as was used for colour tests), a dissecting needle (or a heavy sewing needle embedded in a wooden handle), and a box of single-edged razor blades.

The first step in preparing the "mount" (i.e., microscopic preparation) consists merely of wetting the fruiting body to be examined with a drop of water, and after the water has been absorbed and has softened the tissue, making four or five vertical slices through the central area. If the slicing is done with the aid of a hand lens or, better still, a dissecting microscope (at about 12x), amazingly thin sections can be made with very little practice. This is especially true if you use sharp, new razor blades. Do not remove the fruiting body to be sectioned before you cut it; its natural attachment will very neatly hold it in place while you make the slices.

After you make your sections, pick them up on the corner of the razor blade and transfer them to a small drop of water on a clean microscope slide. With any luck, at least one of the sections with be thin enough to examine. If they don't float free from one another in the water drop, they are probably attached a bit at the base. Don't worry about it. Put the cover-slip over the sections and gently move the cover-slip back and forth until the sections become free and lie in a single plane.

Usually, enough spores escape from the cut hymenium to allow their examination with no further work. However, if the spores insist on staying inside the asci, while you look through the scope under low power (100x), press down on the cover slip with the side of the tip of your dissecting needle in the vicinity of a spore-packed bit of hymenium. You will actually see the spores come free of the asci. This is also the best way to spread out the asci so that you can count how many spores are in each. If you still have trouble (in some species, the hymenium doesn't squash easily), add a drop of KOH to the edge of the cover-slip and draw it under by absorbing the water under the cover-slip from the opposite edge with a tissue or bit of paper towel. This will dissolve the substance which holds the asci together within the hymenium. Another try at a squash will usually do the trick.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the considerable help of my able assistant, Pak Yau Wong. His help in many of the determinations, his testing of the early drafts of the keys, and his valuable collections all were extremely useful. Anne Hanes, who drew Figures 6, 9, 10 and 68-74, also commented on the *Trail & Landscape* keys (Brodo, 1967a,b; 1972) and added many new records to the flora. Susan Laurie-Bourque prepared all the illustrations except for those mentioned above and Figures 54, 57, 58, 62-64, 66 and 67 which were done by Brenda Carter. To all these people, and to the many students, friends and colleagues who used the early keys and tactfully revealed errors they discovered, I owe my thanks.

GENERA OF CRUSTOSE LICHENS (FERTILE SPECIMENS)

1. Fruiting bodies on short, hair-like stalks up to 1 mm tall (Figure 6); spores mostly free (i.e., not within asci) and massed together in cup-like structures. On old stumps and snags, or occasionally on bark . . . . . Caliciales

1. Fruiting bodies without stalks: either attached directly to the thallus or immersed in it . . . . . 2.

2. Thallus gelatinous when wet, black, containing blue-green algae; spores non-septate; apothecial margin containing algae . . . . . 3.

2. Thallus not gelatinous when wet; contains green algae with the exception of *Placynthium* which has lecideine apothecial margins (lacking algae) and septate spores, and *Pannaria* which has a squamulose thallus (see couplet 43) . . . . . 4.

3. Thallus membranous, with algae in bead-like chains (*Nostoc*); apothecia more or less sunken into thallus or thalline ridges (see Foliose key, couplet 30). Rare, on earth or moss . . . . . Lempholemma

3. Thallus granular, with algae in tight packets of a few cells *(Gloeocapsa)*; apothecia almost globular, superficial, at first perithecium-like, then gradually opening at summit to give a lecanorine appearance; spores 12-14 x 6-7 µm. Rare; on limestone rock . . . . . Psorotichia schaereri

4. Thallus or fruiting bodies bright yellow, orange, or yellow-green . . . . . 5.

4. Thallus and fruiting bodies grey, brown, black, or green, without yellow pigments (although some species keying out here will have very pale yellowish-brown apothecia) . . . . . 17.

5. Growing on bark or wood . . . . . 6.

5. Growing on rock . . . . . 11.

6. Thallus or apothecia KOH+ dark red-violet; spores polaribilocular (Figure 72d) . . . . . Caloplaca

6. Thallus and apothecia KOH- . . . . . 7.

7. Thallus pale yellow-green (contains usnic acid) or grey-green; apothecia yellow-brown to bright yellow; spores colourless, 8 per ascus . . . . . 8.
7. Thallus bright yolk-yellow or bright greenish yellow . . . . . 9.

8. Spores one-celled, ellipsoid to slightly elongate-ellipsoid; apothecia yellowish . . . . . Lecanora
8. Spores septate, elongate-fusiform; apothecia pale orange . . . . . Dimerella

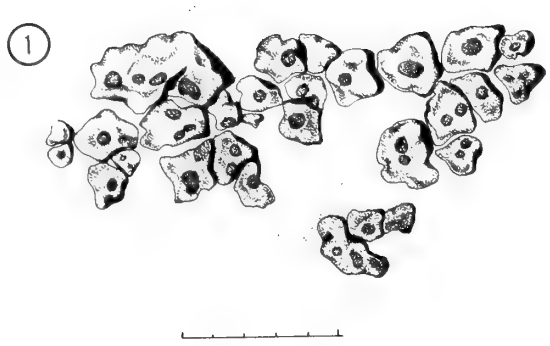
9. Thallus areolate (Figure 68) or coarsely granular (not sorediate) . . . . . 10.
9. Thallus consisting of bright yellow, granular soredia; spores colourless, one-celled, small, ellipsoid, 16 per ascus . . . . . (Figure 3) Candelariella efflorescens

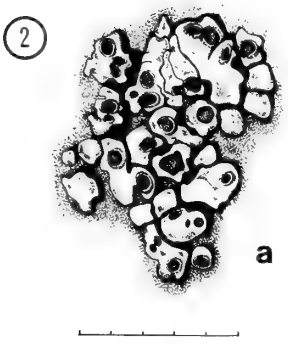
10. Fruiting body yellow, disk-like (typical apothecium); thallus consisting of large yellow granules or small areoles; spores colourless, one-celled, often 16 per ascus . . . . . Candelariella
10. Fruiting body black, actually a mass of loose spores in a kind of "cup" sunken into bright yellow thallus areoles; spores dark brown, 2-celled, not in asci. Infrequent; on fence rails and conifer stumps . . . . .(Figure 7) Cyphelium tigillare

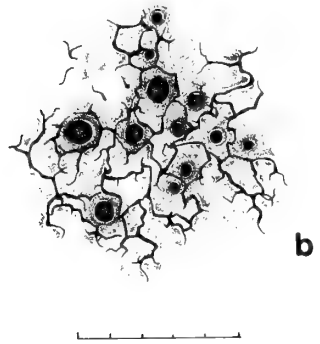
11. Thallus distinctly lobed at margins, with central area becoming areolate . . . . . 12.
11. Thallus margins not lobed at all . . . . . 14.

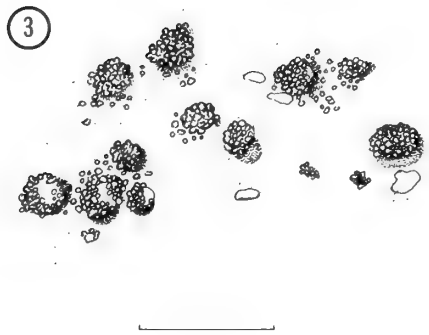
12. On acid rocks, e.g., granite or gneiss . . . . . 13.
12. Usually on calcareous rocks, e.g., limestone; apothecia pale yellow-brown; spores colourless, one-celled. Common . . . . . Lecanora muralis

13. Apothecia dark brown to black; spores dark brown, two-celled. Infrequent . . . . . (Figure 22) Dimelaena oreina









Figures 1-4 -1. *Acarospora fuscata*, -2. *Aspicilia cinerea*, (a) rimose-areolate thallus, (b) continuous to rimose thallus. -3. *Candelariella efflorescens*. -4. *Candelariella xanthostigma*. Scale: each unit = 1 mm.

13. Apothecia yellowish or orange- to red-brown; spores colourless, one-celled . . . . . Lecanora

14. Thallus or apothecia KOH+ red-violet . . . . . 15.
14. Thallus and apothecia KOH- or + yellow (not red-violet) . . . . . 16.

15. Spores one-celled; apothecia convex with a disappearing margin. Rare; on calcareous rock . . . . . Protoblastenia rupestris
15. Spores polaribilocular (Figure 72); apothecia generally flat, with a distinct, persistent margin (lecanorine) . . . Caloplaca

16. Spores one-celled, colourless; apothecia lecanorine, yellow . . . . . Candelariella
(Note: The pale orange, aquatic lichen *Hymenelia lacustris*, may also key out here. (See key to *Aspicilia*.)
16. Spores muriform (Figure 72), brown or colourless; apothecia lecideine, black or dark reddish brown . . . Rhizocarpon

17. Fruiting bodies irregular in shape, especially elongate and often branched (Figures 9, 10), never immersed in thallus. All species from the Ottawa region are on bark or wood . . . . . 18.
17. Fruiting bodies circular dots, disks, cups, or warts, not elongate or irregular except some which are immersed in thallus tissue . . . . . 21.

18. Spores muriform (Figures 72a, b), very large. Uncommon . . . . . Arthothelium
18. Spores only transversely septate (Figures 72e-h), 2-14-celled . . . . . 19.

19. Spore cells lens-shaped (Figure 72h), spores colourless to very pale brown, 6-14-celled; fruiting bodies narrow with a distinct, narrow, longitudinal fissure, or broad, but always with distinct black walls. Extremely common on various trees . . . . . (Figure 9) Graphis scripta
19. Spore cells "square" (i.e., cylindrical; Figure 72g) . . . . . 20.

20. Fruiting bodies prominent, usually with a distinct fissural opening; wall black, carbon-like and thick; spores 4 to 6-celled. Rare; on bark or wood . . . . . Opegrapha pulicaris

(Note: Species of the fungus genus *Hysterium* look very much like *Opegrapha* spp.)

20. Fruiting bodies flat (not prominent), with no fissural opening; external wall absent . . . . . (Figure 10) Arthonia

21. Fruiting body at least partially immersed in thallus . . . . . 22.

21. Fruiting body superficial, not usually immersed in thallus (although sometimes between thallus areoles; see Figure 68), distinctly disk- or cup-shaped, sometimes convex or even hemispherical (Figures 70, 74a) . . . . . 42.

22. Apothecia buried in a sorediate mound or area . . . . . 23.

22. Apothecia not buried in a sorediate mound or area . . . . . 24.

23. Spores muriform, one per ascus; thallus KOH+ red (norstictic acid). Rare; on bark . . . . . Phlyctis argena

23. Spores non-septate, 1 or 2 per ascus (Figure 71c); thallus KOH- or KOH+ yellow . . . . . Pertusaria

24. Fruiting body opening to surface by a more-or-less broad area, although sometimes appearing like an ostiole; fruiting body in section *not* flask-shaped, with no black, carbon-like wall (except in *Acarospora badiofusca*); spores colourless, not septate . . . . . 25.

24. Fruiting body usually flask-shaped and appearing as a pointed or rounded dot or tiny "volcano" under magnification, opening to the outside by means of a small pore or ostiole (Figures 26, 69, 74c-d), partially or entirely enclosed in a black, carbon-like wall . . . . . 27.

25. Fruiting bodies immersed in a raised thalline "wart", usually more than one per wart (Figures 24, 74b); spores very large, one-celled, often thick-walled, most commonly 2-4 per ascus (Figure 71c) . . . . . Pertusaria

25. Fruiting bodies not in raised warts; entirely immersed in thallus . . . . . 26.

26. Spores very small, 32 or more per ascus; thallus dispersed areolate (Figure 1) usually brown, sometimes pruinose . . . . . Acarospora
26. Spores 8 per ascus; thallus continuous, smooth to rimose-areolate (Figure 2), usually grey, never pruinose . . . . . Aspicilia

27. Spores muriform . . . . . 28.
27. Spores one to many-celled, not muriform . . . . . 32.

28. On rock or soil . . . . . 29.
28. On bark. Thallus extremely thin to absent . . . . . 31.

29. Thallus a shade of brown, smooth, thick, C-; fruiting bodies (perithecia) opening by a tiny pore (Figure 74c); spores usually brown, very large, 2-6 per ascus; small algal cells present in hymenium among asci (Figure 26) . . . . . 30.
29. Thallus grey to white, areolate, very thick, C+ red; fruiting bodies opening by a deep, often broad pit into hymenial cavity (Figure 74d). Very common; on dry, sunny, exposed rocks and adjacent soil . . . . . Diploschistes scruposus

30. Thallus squamulose, dispersed to contiguous; perithecia entirely buried in the squamules, with only tiny black ostioles showing at the thallus surface. Rare; on limestone . . . . . Endocarpon pusillum
30. Thallus continuous to rimose-areolate; perithecia sometimes partially exposed . . . . . Staurothele

31. Fruiting bodies with several chambers, each having its own ostiole; spores hyaline to brown, 30-48(-51) x (12-)15-18(-21) µm (Harris, 1973). [The Ottawa specimen had no spores.] Rare; on deciduous trees, especially oak and maple . . . . . Mycoporum pycnocarpum
31. Fruiting bodies with single chamber; spores colourless (Figure 72b). Infrequent, especially on white birch, but very inconspicuous and possibly just overlooked . . . . . Polyblastiopsis fallaciosa

32. Growing on rock or soil . . . . . 33.
32. Growing on bark . . . . . 35.

33. On soil. Spores one-celled, elongate-ellipsoid, 15-25 x 7-10 µm; paraphyses persistent; thallus forming a green, membranous crust over bare soil with the perithecia showing only as tiny black dots. Rare . . . . . Thrombium epigaeum
33. On rock. Spores one- or two-celled; paraphyses disappearing . . . . . 34.

34. Spores one-celled, ellipsoid; thallus thin or thick . . . . . Verrucaria
34. Spores two-celled, ellipsoid, 22-30(-33) x 14-17(-20) µm; thallus grey to white, epilithic or endolithic; perithecia forming pits in rock. Rare; on limestone . . . . . Thelidium decipiens

35. Spores up to 36-celled, colourless, very long and thread-like, sometimes breaking into small segments (Figure 72f); fruiting bodies black, slightly raised, and opening by a deep pit; thallus producing white patches on sugar maple trees or, rarely, on other deciduous trees. Common . . . . . (Figure 8) Conotrema urceolatum
35. Spores up to 7-septate, narrowly fusiform to ellipsoid; fruiting bodies generally with small, inconspicuous pores (not deep pits) . . . . . 36.

36. Several fruiting bodies (perithecia), each with its own ostiole, clustered into a single, fertile verruca, the verruca ellipsoid to elongate, up to 3 mm in length; spores colourless, 7-9-septate, with angular to lens-shaped cells (as in *Graphis*, Figure 72h), 38-52 x 7-10 µm (Harris, 1973). [Ottawa specimens usually sterile.] Rare; on beech, or, rarely, on other deciduous trees . . . . . Trypethelium virens
36. Fruiting bodies single, not clustered into verrucae . . . . 37.

37. Fruiting bodies with the ostiole at one side, not at the vertical summit, often having a conspicuous neck; fruiting body 0.5-0.8 mm in diameter; spores colourless or brown,

3-7 septate. Rare; on deciduous trees, especially maple or ash . . . . . Plagiocarpa

37. Fruiting bodies with ostiole central, at the vertical summit, often inconspicuous; fruiting bodies 0.1-0.8 mm in diameter . . . 38.

38. Fruiting bodies tiny, 0.1-0.3 mm in diameter; thallus with or without algae; spores with cylindrical or lens-shaped cells . . . . . 39.

38. Fruiting bodies 0.3-0.8 mm in diameter; thallus always containing algae (*Trentepohlia*); spores with lens-shaped cells . . . . . 41.

39. Spores brown, 5-6 septate, 18-24 x 5-9 µm (Harris, 1973) with lens-shaped cells; perithecia ca. 0.2-0.4 mm in diameter; base of perithecial wall pale; thallus white, hypophloedal. Rare; on deciduous trees, especially maple . . . . . Eopyrenula leucoplaca

39. Spores colourless, 0-3-septate, with cylindrical cells; fruiting bodies 0.1-0.25 mm in diameter . . . . . 40.

40. On white birch trees, producing an almost imperceptible, pale patch on the white bark; spores narrowly fusiform, 20-30 x 2-4 µm (Harris, 1973), banana-shaped (slightly curved), sometimes with one or two cross-walls visible. Frequent, but very inconspicuous . . . . Leptorhaphis epidermidis

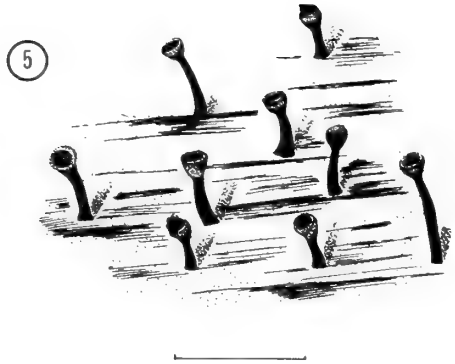
40. Usually on other tree species. Spores 1(-3)-septate, fusiform, straight, 15-20 x 4.5-6.0 µm (Harris, 1973) . . . . . Arthopyrenia s.l.

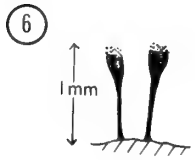
41. Spores 5-6-septate; perithecia 0.2-0.4 mm in diameter; ostioles depressed, conspicuous . . . . . (see couplet 38) Eopyrenula leucoplaca

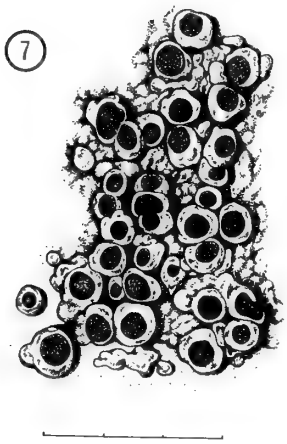
41. Spores 3-septate; perithecia 0.3-0.8 mm in diameter, ostiole almost imperceptible, not depressed . . . . . Pyrenula

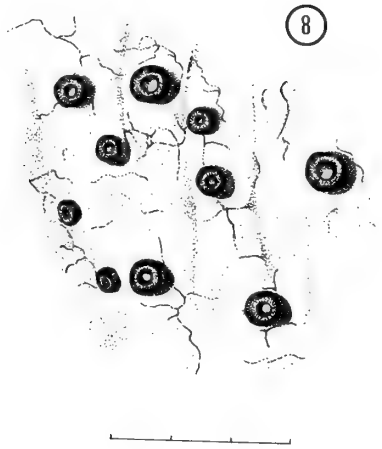
42. Algae blue-green (algal layer dark grey-green to blue-green) . . . . . 43.

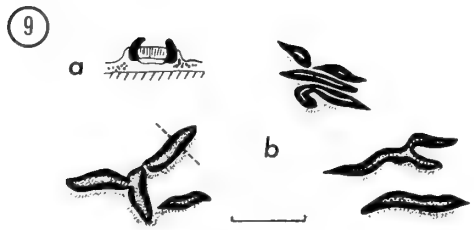
42. Algae (and algal layer) grass-green . . . . . 44.











Figures 5-10. -5. *Calicium trabinellum*; -6. *Mycocalicium parietinum*; -7. *Cyphelium tigillare*; -8. *Conotrema urceolatum*; 9. *Graphis scripta*, (a) vertical section of ascocarp (see dotted line), (b) elongate ascocarps (apothecia); -10. *Arthonia radiata*, (a) ascocarps, (b) vertical section of ascocarp (see dotted line on "a") showing ascolocular features. Scale: each unit = 1 mm.

43. Thallus consisting of brownish, imbricate, lobed squamules; spores simple; apothecia sometimes lecanorine, sometimes lecideine. Infrequent; on rock, usually in shaded or moist situations . . . . . *Pannaria leucophaea*

43. Thallus almost black, coarsely granulose to isidiate, becoming areolate; usually surrounded by a conspicuous blue-black margin; spores one-septate; apothecia black, lecideine. Frequent; on rocks of all types, but most frequently on calcareous rock . . . . . *Placynthium nigrum*

44. Algae present in the margins or below the hymenium of the fruiting bodies (Figure 70b) . . . . . 45.

44. Algae not present in the fruiting bodies (Figure 70a) . . . 52.

45. Fruiting bodies in sorediate mounds or warts on thallus . . . . . 46.

45. Fruiting bodies not in sorediate mounds . . . . . 47.

46. Spores muriform, colourless, 1 per ascus (see couplet 23) . . . . . *Phlyctis argena*

46. Spores one-celled, colourless . . . . . *Pertusaria*

47. Spores one per ascus, huge . . . . . *Pertusaria*

47. Spores (4-)8 per ascus (Figure 71a) . . . . . 48.

48. Spores one-celled, ellipsoid . . . . . 49.

48. Spores two or more-celled, ellipsoid or vermiform . . . . . 50.

49. Apothecia up to 3 mm across with very thick margins; spores quite large, over 30 µm long, ellipsoid; disks usually a shade of pink . . . . . *Ochrolechia*

49. Apothecia usually under 1.5 mm; spores under 20 µm long; apothecia pale brown to dark brown or black . . . . . *Lecanora*

50. Spores colourless . . . . . 51.

50. Spores dark brown; spore walls often uneven in thickness (Figure 72m) but sometimes uniform (Figure 72*l*); apothecial disks very dark brown . . . . . *Rinodina*

51. Spores ellipsoid, two-celled (for the most part within any particular apothecium) (Figure 72e); thallus and apothecial

margins KOH- . . . . . Lecania

51. Spores fusiform, twisted and curved, often vaguely septate; thallus thick, verrucose, KOH+ bright yellow (thamnolic acid); apothecial disks red-brown, sometimes pruinose, up to 2 mm in diameter; apothecial margins often appear to be double, the outer, thallus-coloured margin becoming somewhat ragged or tattered. Rare; on bark, especially of white cedar . . . . . Haematomma ochrophaeum

52. Spores one-celled . . . . . 53.
52. Spores two- to many-celled . . . . . 56.

53. Numerous small spores in each ascus (often giving the ripe ascus a coarsely granular appearance; Figure 71b); apothecia black or pruinose; thallus often virtually absent (endolithic). On rock . . . . . Sarcogyne
53. Eight spores in each ascus . . . . . 54.

54. Thallus composed entirely of coarse, green granules or granular soredia; fruiting bodies almost black, without distinct rims; thallus C+ red. Rare; on soft, rotting wood . . . . . Micarea viridescens
54. Thallus never entirely sorediate; fruiting bodies (apothecia) usually with distinct rims (Figure 74a), although in some species, the margins disappear in the older apothecia . . . . . 55.

55. Thallus squamulose . . . . . Psora s.l.
55. Thallus continuous to areolate, not squamulose, sometimes disappearing or very thin . . . . . Lecidea s.l.

56. Spores muriform . . . . . 57.
56. Spores not muriform, only transversely septate . . . . . 58.

57. On bark (usually white cedar). Apothecia black; spores huge, colourless, many-celled, one per ascus; thallus olive-green, often in little patches or areoles. Rare (?) . . Lopadium pezizoideum
(Note: This species was recorded for Ottawa by John Macoun, but there are no voucher specimens in CANL.)

57. On non-calcareous rock. Apothecia black or dark brown, usually sunken between (or rarely in) thallus areoles (Figure 68); spores colourless to dark greenish or brown, 8 per ascus . . . . . Rhizocarpon

58. Spores dark brown, two-celled; apothecia black . . . . Buellia
58. Spores colourless . . . . . 59.

59. Exciple distinct, radiate (see Figures 70a, 74a); paraphyses (sterile threads between asci in hymenium) simple or sparingly branched, usually distinctly expanded at tips (ascohymenial fruiting body) . . . . . 60.
59. Exciple indistinct or absent, never radiate (Figure 10b, section); threads between asci much branched and anastomosing, tips not expanded (ascolocular fruiting body) . . . . . 64.

60. Spores (2-)4-16-celled . . . . . 61.
60. Spores constantly 2-celled . . . . . 62.

61. Spores (especially young ones) with a thick, clear, gelatinous "halo" or epispore outside of normal cell wall (Figure 72a); spores (2-)4-celled, ellipsoid to short-fusiform. Rare; on rock . . . . . Rhizocarpon
61. Spores lacking a gelatinous epispore, fusiform to needle-shaped, 3-16-celled . . . . . Bacidia

62. Apothecia pale pink to pale orange-brown; asci long and slender; spores fusiform to almost needle-shaped. Rare, on bark . . . . . Dimerella
62. Apothecia black or very dark brown; asci club-shaped; spores ellipsoid, not more than three times as long as they are wide . . . . . 63.

63. On bark. Spores 12-17(-21) x 4.5-6.5 µm (Figure 72k); hypothecium reddish- to violet-brown, more intensely purplish red in KOH; exciple greenish also often turning violet in KOH. Infrequent . . . . . Catillaria laureri
63. On rock. Spores 18-24 x 8-10 µm; hypothecium and exciple brownish to black, unchanged in KOH . . . . . Rhizocarpon hochstetteri

64. Fruiting bodies "frosted" grey or blue-grey (pruinose), black beneath the pruina; thallus entirely granular sorediate, pale yellowish green or pale green; spores 4-celled, constricted somewhat at the cross-walls. Frequent; on tree bark . . . . . Arthonia caesia

64. Fruiting bodies not pruinose . . . . . 65.

65. Thallus thin to essentially absent (within bark), sometimes producing a greyish "stain" on bark . . . . . Arthonia

65. Thallus thick, granular to pulverulent, greenish or very dark green. On rotting wood or bark . . . . . Micarea

STERILE CRUSTOSE AND SQUAMULOSE SPECIES

1. Growing on soil, wood or rock, sometimes over moss . . . . . 2.
1. Growing on bark . . . . . 25.

2. Growing on rock . . . . . 3.
2. Growing on soil or wood, sometimes over moss . . . . . 12.

3. Thallus black, containing blue-green algae. On calcareous rock . . . . . 4.
3. Thallus various shades, not black; containing green algae; on calcareous or non-calcareous rock . . . . . 5.

4. Thallus orbicular with a distinct blue or blue-green edge (prothallus); thallus consisting of isidia-like granules which cluster into areolate patches. Common. . . . . Placynthium nigrum
4. Thallus effuse, verrucose or granulose; phycobiont is *Gloeocapsa*. Rare . . . . . Psorotichia schaereri

5. Thallus entirely sorediate . . . . . 6.
5. Thallus without soredia . . . . . 9.

6. Thallus blue-grey or mineral grey; directly on rock in exposed habitats . . . . . 7.
6. Thallus green or yellowish green; usually on soil or peat over rocks in shaded habitats . . . . . 8.

7. Thallus PD+ deep yellow, KOH+ yellow (alectorialic acid), often forming zonate orbicular patches; granules very coarse. Very common in sunny locations . . . . . Lepraria zonata
(Note: A population with atranorin and fumarprotocetraric or protocetraric acid (PD+ red) can be called L. lobificans Nyl.)
7. Thallus PD-, KOH+ yellow (atranorin), thin, blue-grey, indefinite, not zonate. Common on shaded rocks and tree bases . . . . . Lepraria incana

8. Thallus forming a thick, indefinite crust, KOH+ yellow, PD+ orange (stictic acid and zeorin). Common on rocks and tree bases . . . . . Lepraria finkii

8. Thallus forming small shelf-like, membranous outgrowths of soredia, KOH+ yellow, PD+ orange (pannaric and roccellic acids and atranorin). Rare; on shaded rock walls . . . . . Lepraria membranacea
(Note: Perhaps not in the Ottawa region.)

9. Thallus red-brown, thick, squamulose, the squamules having white margins; medulla KOH-, C-, PD-. Rare; on limestone . . . . . Psora russellii
9. Thallus grey-green to yellowish green, continuous to areolate or lobed . . . . . 10.

10. Thallus grey-green, KOH+ yellow, PD+ orange (stictic acid), indefinite, areolate to continuous. Rare; shaded habitats . . . . . Baeomyces rufus
10. Thallus yellow-green (usnic acid), orbicular with lobate margins; in sunny habitats . . . . . 11.

11. Thallus lobes thick, not becoming areolate in centre, medulla KOH-, PD-, C-. Common; on calcareous rock or, rarely, on non-calcareous rock associated with bird perches . . . . Lecanora muralis
11. Thallus lobes thin, closely appressed, becoming areolate except at margins; medulla C+ red or sometimes PD+ red. Infrequent; on non-calcareous rock . . . (Figure 22) Dimelaena oreina

12. Thallus yellow-orange, KOH+ red-purple, areolate, with areoles becoming sorediate. Infrequent; on fence rails and bark . . . . . Caloplaca microphyllina
12. Thallus black, grey, white, or yellow, KOH- . . . . . 13.

13. Thallus squamulose (Note: See also the *Cladonia* treatment in the key to fruticose lichens, page 99) . . . . . 14.
13. Thallus areolate, verrucose, or effuse sorediate . . . . . 20.

14. On soil or over limestone . . . . . 15.
14. On wood or mossy logs . . . . . 18.

15. Thallus consisting of thick, red-brown squamules with white margins, not sorediate, not imbricate; medulla KOH-, C-, PD-. Rare; on calcareous soil or limestone . . . . . Psora russellii

15. Thallus consisting of thin, usually imbricate squamules, grey-green above and white below, KOH+ yellow on white undersurface (atranorin). On soil . . . . . 16.

(Note: Many species of *Cladonia* can be found growing without podetia, and will therefore key out here. The following three species are the ones most frequently collected without podetia.)

16. Squamules PD+ bright yellow (psoromic acid), large, narrow (4-6 mm long, 2-3 mm broad), ascending and curled back revealing the white undersurface. Rare . . . . . Cladonia dahliana

16. Squamules PD+ red or PD- . . . . . 17.

17. Squamules very large and ascending, often more than 6 mm long, deeply lobed and irregular; PD+ red (fumarprotocetraric acid). Infrequent . . . . . C. turgida

17. Squamules small, not more than 3 mm long, entire or slightly lobed, regular in size; PD+ red or PD-. Common . . Cladonia cariosa

18. Thallus squamules sorediate, not lobed; on wood, often somewhat charred . . . . . 19.

18. Thallus squamules finely lobed, elongate, branched, not sorediate; PD+ red (fumarprotocetraric acid). Rare, on mossy logs . . . . . Cladonia caespiticia

19. Squamules shell-like, convex, with soredia formed on the undersurface; thallus C+ red, PD- (lecanoric acid). Frequent . . . . . (Figure 21) Hypocenomyce scalaris

19. Squamules flat to slightly convex, with soredia on margins of squamules. PD+ red, C- (unknown substance). Rare . . . . . Hypocenomyce anthracophila

20. Thallus areolate-continuous, not sorediate (see couplet 10) . . . . . Baeomyces rufus

20. Thallus sorediate, entirely or in discrete patches . . . . . 21.

21. Thallus bright yellow-green, effuse, K-, PD-, C-. Rare . . . . . Coniocybe furfuracea

21. Thallus green or grey, C+ pink or red . . . . . 22.

(Note: *Lecidea botryosa* has a dark, ashy grey, verrucose to coarsely granulose thallus becoming sorediate in patches like *L. granulosa*, but is C- (containing perlatolic acid instead of gyrophoric acid.) It is known from a locality just west of the Ottawa region and is almost certainly also found in the region.)

22. Thallus in discrete patches on a continuous or verrucose thallus, pale grey-green or grey . . . . . 23.
22. Thallus leprose, effuse granular sorediate, yellowish green. Rare; on wood . . . . . Micarea viridescens

23. Thallus coarsely verrucose, with some verrucae bursting into patches of whitish or pinkish granular soredia. Common on soil, rare on wood . . . . . Lecidea granulosa
23. Thallus continuous, granular, with patches of yellowish soredia . . . . . 24.

24. Soralia small, soredia fine to granular; thallus thin, fluoresces orange in UV light (long wave). Frequent on bark but rare on wood . . . . . Ochrolechia arborea
24. Soralia large, irregular; soredia coarsely granular; thallus thick, uneven, UV-. Very rare, on moss and wood . . . . . Ochrolechia androgyna

25. Thallus yolk-yellow to orange . . . . . 26.
25. Thallus green to grey or white . . . . . 29.

26. Thallus effuse granular sorediate or granular; KOH- . . . . 27.
26. Thallus areolate to almost squamulose, some areoles becoming sorediate; KOH+ dark red-purple. Infrequent; on elm bark or on wood . . . . . Caloplaca microphyllina

27. Thallus effuse, granular, not sorediate; granules ca. 0.05-0.15 mm in diameter. Frequent; especially on elm . . . . . (Figure 4) Candelariella xanthostigma
27. Thallus effuse sorediate . . . . . 28.

28. Soredia in small clusters originating from the breakdown of tiny spherical granules or areoles; no foliose lobes anywhere.

Infrequent; on tree bark of many kinds.
. . . . . (Figure 3) Candelariella efflorescens

28. Soredia scattered in heaps (not in clusters), with a few foliose lobes usually in evidence. Frequent; on bark of many kinds . . . . . Candelaria concolor var. effusa

29. Thallus leprose (consisting entirely of soredia) . . . . . 30.
29. Thallus having discrete soralia (which can become confluent on older parts of thallus) . . . . . 33.

30. Thallus with a distinct white, fibrous ("fungal") prothallus; yellowish green, thin, KOH+ yellowish, C-, PD- (atranorin, zeorin, usnic acid). Common, especially on sugar maples
. . . . . Lecanora thysanophora
30. Thallus lacking a white prothallus, pale green to blue-green, not yellowish green (lacking usnic acid) . . . . . 31.

31. Thallus thick, pale greenish, KOH+ yellow, PD+ orange (stictic acid and zeorin). Common . . . . . Lepraria finkii
31. Thallus thin, blue-grey . . . . . 32.

32. Thallus PD-, KC-, KOH± yellowish (atranorin and zeorin). Frequent . . . . . Lepraria incana
32. Thallus PD+ bright yellow, KC+ red, K± (alectorialic acid). Frequent . . . . . Lepraria sp.#2 *sensu* Harris, 1977

33. Thallus and soredia C+ red (gyrophoric acid); thallus pale grey, smooth (or assuming texture of bark substrate); soralia in small mounds, often yellowish, UV+ orange (lichexanthone). Rare . . . . . Ochrolechia arborea
33. Thallus and soredia C- . . . . . 34.

34. Soralia PD-, KOH- . . . . . 35.
34. Soralia PD+ yellow or orange, KOH+ yellow or red, *or* soralia PD+ red, KOH- . . . . . 36.

35. Soralia white (these are actually sorediate ascocarps which may or may not contain fertile asci); thallus thin. Infrequent; on bark of many kinds . . . . . Pertusaria ophthalmiza

35. Soralia yellowish green, coarsely granular. Rare; on tree bases, especially ash . . . . . Lecidea sp. #4 *sensu* Harris, 1977

36. Soralia PD+ red (fumarprotocetraric acid), whitish, granular. Rare . . . . . Lecidea cinnabarina

(Note: *Pertusaria multipunctoides*, with fertile, sorediate tubercules, also is PD+ red.)

36. Soralia PD+ yellow or orange, *or* PD- . . . . . 37.

37. Thallus KOH+ bright yellow, PD+ orange-yellow (thamnolic acid); thallus pale grey to white, with hollow pustules bursting into granular soredia. Infrequent . . . . . Haematomma sp.

(Note: *Pertusaria trachythallina*, with fertile, sorediate tubercules, also contains thamnolic acid.)

37. Thallus KOH+ yellow or red, PD+ pale to dark yellow or PD- (thamnolic acid absent); soredia not originating in hollow pustules . . . . . 38.

38. Thallus KOH+ yellow, PD- or pale yellow (atranorin); thallus pale grey, with discrete sorediate patches (often yellowish). Common, especially on roadside trees . . . . . Lecanora impudens

38. Thallus KOH+ yellow turning red, PD+ yellow (norstictic acid); thallus pale grey, verruculose, breaking down in places into granular soredia. Rare; on tree bark . . . . . Phlyctis argena

ACAROSPORA

1. Thallus or apothecial disks with a thin or thick white pruina; areoles pale grey-green to grey-brown, up to 4 mm across and lobed, or infrequently, reduced to an apothecial margin; apothecia at first immersed, later *Lecanora*-like. Frequent on calcareous rock . . . . . A. glaucocarpa
1. Thallus and apothecia epruinose; areoles brown, usually less than 1.5 mm across . . . . . 2.

2. Apothecia becoming sessile when mature, sometimes with a distinct black, almost *Lecidea*-like margin; areoles shiny. Rare; on non-calcareous rock . . . A. badiofusca
2. Apothecia immersed, or becoming *Lecanora*-like (with a thallus-coloured margin) when mature . . . . . 3.

3. Areoles shiny brown; apothecia usually several per areole, remaining immersed with small openings; thallus usually C+ pink (difficult to see). Common, on granite and other non-calcareous rock in the open . . . . . (Figure 1) A. fuscata
3. Areoles dull red-brown; apothecia one per areole, becoming *Lecanora*-like when mature. Rare; on calcareous rock . . . . . A. canadensis

ARTHONIA

1. Ascocarps blue-grey, pruinose, round; thallus yellowish green to grey-green, leprose; spores 4-celled. Common; on trees . . . . . A. caesia
1. Ascocarps not pruinose, black to dark brown; thallus smooth to disappearing . . . . . 2.

2. Ascocarps elongate, often branched . . . . . 3.
2. Ascocarps round to somewhat irregular, not elongate or branched . . . . . 5.

3. Spores 2-celled; thallus hypophloedal, producing a white or pale grey "stain" or patch on the bark; ascocarps thin, delicate (often under 0.1 mm across), often branched once. Common; on deciduous tree bark, especially maple . . . . . A. dispersa

3. Spores 4-celled; thallus dark grey or almost absent; ascocarps broader, often branched, 0.15-0.35 mm across. On tree bark of various kinds . . . . . 4.

4. Ascocarps remain black when wet; upper hymenium black-brown. Infrequent . . . . . (Figure 10) A. radiata

4. Ascocarps becoming transluscent brown when wet; upper hymenium pale brown. Frequent . . . A. sp. #3 *sensu* Harris, 1977

5. Spores 2-celled; ascocarp black, round, resembling a *Lecidea*; thallus producing a pale patch on the bark. Rare; on popular bark . . . . . A. patellulata

5. Spores 4-5-celled (but usually absent); ascocarps irregular; thallus virtually absent. Infrequent; on deciduous trees. . . . . A. punctiformis

ARTHOPYRENIA s.l.

1. Spores 1-septate, with lower cell somewhat longer than upper one (in ascus); pseudoparaphyses consisting of short, thick cells, much branched. Rare; usually on smooth bark, e.g., of red maples and alder . . . . . A. punctiformis

1. Spores 1(-3)-septate, with lower cell obviously shorter than upper cell(s) (in ascus); pseudoparaphyses slender, thread-like, branched. Rare; on soft or thick bark, e.g., of elm, sugar maple, and ash . . . . Anisomeridium willeyana (Syn.: *Arthopyrenia willeyana)*

ARTHOTHELIUM

1. Thallus white, usually well-developed; ascocarps KOH+ violet-red at least in part; spores 30-35 x 15-20 µm, hyaline, muriform to submuriform. Infrequent; on deciduous trees, especially maple . . . . . A. spectabile
1. Thallus thin to disappearing, usually only a grey stain; ascocarps KOH-; spores 16-25 x 5-10 µm . . . . . 2.

2. Spores becoming dark brown, broad (9-10 µm); fruiting layer (i.e., layer containing the asci) greenish. Rare; on bark . . . . . A. ruanideum
2. Spores hyaline, narrow (5-7.5 µm); fruiting layer brown-black. Rare; on bark . . . . . A. anastomosans

ASPICILIA s.l.

1. Thallus pale orange; apothecial disks pink-orange; spores 11-17 x 5-6.5 µm. Frequent; on rocks at least periodically covered by water . . . . . Hymenelia lacustris
1. Thallus grey-green to ashy grey; not aquatic . . . . . 2.

2. Apothecial disks red-brown; thallus dark green-grey, KOH-; spores less than 10 µm long. Rare . . . . Lecanora sp. #2
2. Apothecial disks black; thallus pale to dark ashy grey; spores 15-22 x 9-11(-13) µm . . . . . 3.

3. Thallus (cortex and medulla) KOH-, PD-; thallus fairly thick, ashy grey, rimose-areolate; apothecia more-or-less craterform, often with a white rim around the disk; spores broadly ellipsoid 15-18 x 11-12 µm . . . . . A. cfr. verrucigera (inactive strain)
3. Thallus (cortex and/or medulla) KOH+ yellow or red; thallus usually dark ashy grey but can be pale; usually verrucose-areolate . . . . . 4.

4. Thallus cortex or medulla KOH+ red (norstictic acid); thallus continuous, rimose-areolate to somewhat verrucose. Frequent . . . . . A. cinerea

4. Thallus cortex or medulla KOH+ persistent yellow (stictic acid) . . . . . 5.

5. Thallus areolate to thickly verrucose, the verrucae becoming somewhat lobed and almost squamulose in older portions. Frequent . . . . . A. verrucigera

5. Thallus smooth, thin, continuous to rimose and finally areolate, pale ashy grey. Infrequent . . . . A. cinerea var. laevata

BACIDIA

1. On rocks; spores 25-35 x 2-3 µm, acicular . . . . . 2.

1. On moss, lignum, or bark . . . . . 3.

2. Spores curved and twisted in ascus; hypothecium hyaline; epithecium brown. Rare . . . . . Scoliciosporum umbrinum

2. Spores straight, rod-shaped; hypothecium reddish brown above, hyaline below, or pale yellow; epithecium aeruginose; exciple violet-red, more intense in KOH. Rare . . . . . B. cfr. inundata

(Note: Perhaps this is sp. #1 *sensu* Harris, 1977; true *B. inundata* has a brownish epithecium.)

3. On moss . . . . . 4.

3. On bark and wood . . . . . 7.

4. Spores fusiform . . . . . 5.

4. Spores acicular, 3-7-septate, 35-40 x 2.5-3.5 µm; epithecium greenish; hypothecium brown, thin; exciple mostly colourless to pale reddish purple in KOH. Rare . . . . . B. bagliettoana

5. Apothecia pale yellowish to buff, never darkening (except in poorly dried herbarium material), very convex when mature; hypothecium pale yellow; spores constantly 3-septate,

15-20 x 5-6 µm; thallus granulose. Rare . . . . . B. sphaeroides

5. Apothecia pale brown to black, rarely yellowish . . . . . 6.

6. Spores 3-5-septate, 18-30 x 5.7-7.5 µm; hypothecium red-brown, brown, or rarely pale brown (especially above); hypothecium KOH+ reddish violet; thallus coarsely granulose to almost squamulose. Frequent . . . . . (Figure 13) B. sabuletorum

6. Spores (1-)3-septate, 20-25 x 6-7 µm; hypothecium hyaline to pale brown; apothecia yellow-brown to red-brown to black; margin disk-coloured or paler; thallus granulose. Infrequent . . . . . B. obscurata

7. Apothecia minute, 0.10-0.16 mm in diameter, black, hemispherical and without a distinct margin; thallus dark green, granulose to verruculose . . . . . 8.

7. Apothecia 0.25-1.6 mm across; thallus grey-green to olive; spores acicular . . . . . 9.

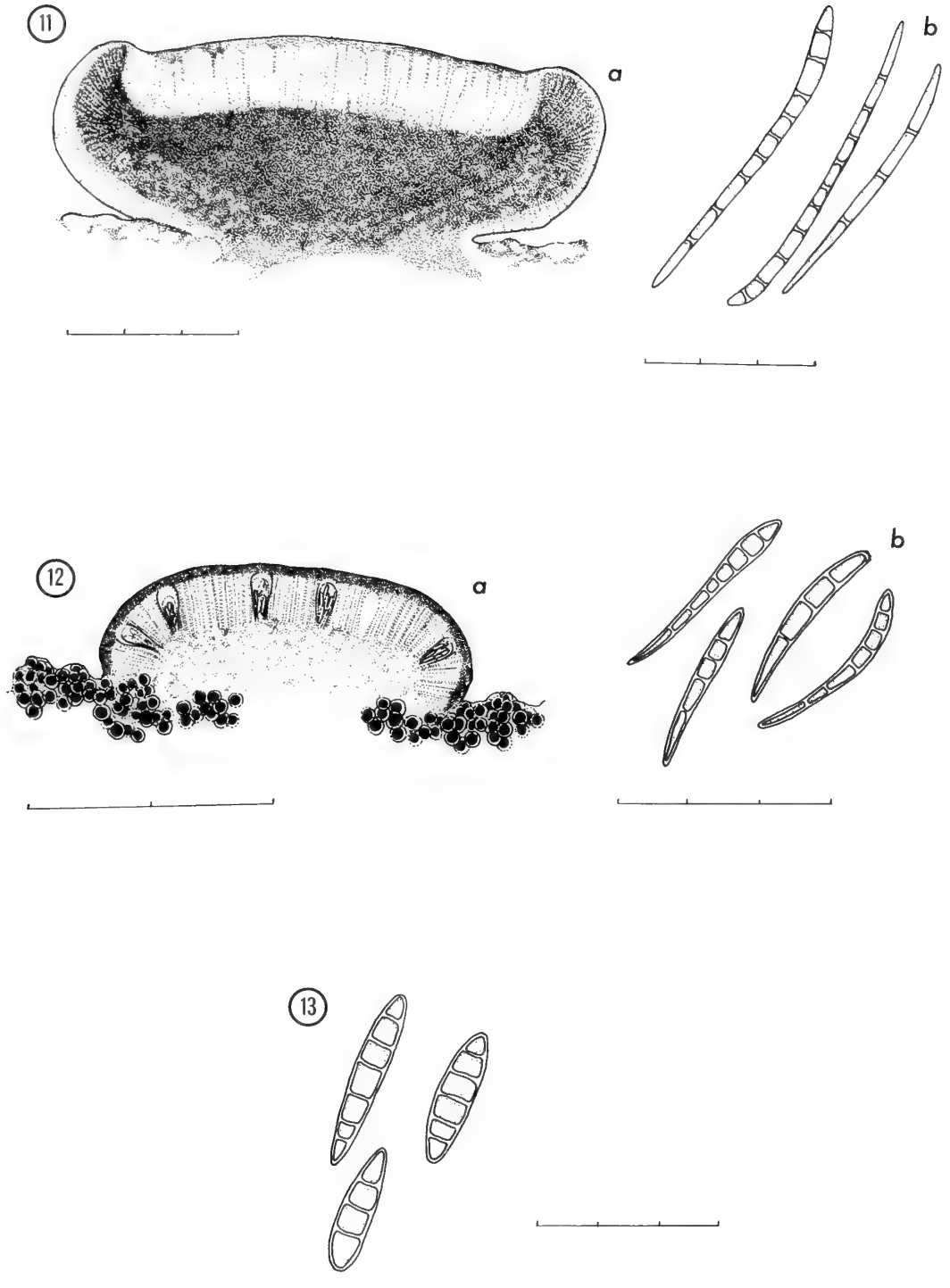
8. Spores fusiform, 16-19 x 5-6 µm, 1-3-septate. Infrequent; on logs and rotting wood . . . . . Micarea melaena

8. Spores fusiform to almost acicular, usually strongly tapering at one end, 25-33 x 3-4.5 µm, 3-5-septate; epithecium greenish. Common; on shaded bark and wood . . . . (Figure 12) Scoliosporum chlorococcum

9. Spores (1-)3-septate, 25-31 x 1.3-2.5 µm; apothecia 0.25-0.35 mm in diameter, black to brown-black, margin thin; hypothecium pale yellow-brown; epithecium green; exciple hyaline to pink within, greenish black at edge. Rare; on lignum (and bark) . . . . . B. beckhausii

9. Spores 3-15-septate, more than 30 µm long; apothecia 0.4-1.6 mm in diameter . . . . . 10.

10. Apothecia large, 0.8-1.6 mm diameter, distinctly constricted at the base; disk flat, pitch black, with thin but prominent black margins; hypothecium brown grading into red-brown exciple which is paler to hyaline at margin; epithecium green; spores 3-8-septate, 30-55 x 2-3 µm; thallus smooth to granulose



Figures 11-13. -11 *Bacidia schweinitzii*, (a) vertical section of apothecium, (b) ascospores; -12. *Scoliciosporum chlorococcum*, (a) vertical section of apothecium; (b) ascospores; -13. *Bacidia sabuletorum*, ascospores. Scale: -11a, 12a: each unit = 100 µm; -11b, 12b, 13: each unit = 10 µm.

or almost isidiate. Frequent; especially in shaded forests, on tree bark . . . . . (Figure 11) B. schweinitzii

10. Apothecia 0.4-0.8 mm in diameter, appressed to thallus; apothecia, if black, then with a margin even with the disk (not prominent) disappearing in maturity . . . . . 11.

11. Apothecia black, never pruinose; margin disappearing; hypothecium red-brown; epithecium grey-olive; exciple hyaline to yellow-brown within; spores 7-septate, 30-37 x 3.5-5.0 µm. Rare; on bark . . . . . B. accendens *sensu* Harris, 1977

(Note: *B. atrogrisea* is another rather rare species known from eastern Canada differing from *B. accedens* in having a dark red-brown to black apothecium, a hyaline to yellowish hypothecium, epithecium with a dark purple pigment and spores which are up to 18-septate, 45-60(-70) x (1.7-)2.2-4.0 µm.)

11. Apothecia dark to pale red-brown or yellow-brown, often pruinose at least in part . . . . . 12.

12. Thallus consisting of granules often becoming elongate and isidia-like; spores up to 10-celled, (38-)40-50 x 2-3 µm (Harris, 1977). Rare . . . . . B. rubella

12. Thallus not isidiose-granulose . . . . . 13.

13. Apothecia bright red-brown to yellow-brown, rarely becoming very dark red-brown (almost black); some apothecia often lightly pruinose, especially on the margins; margins low, often almost disappearing; hypothecium brownish, at least in upper part; exciple hyaline to brown or purple-brown; exciple and hypothecium turn pink-violet in KOH; thallus smooth; spores 3-7-septate, (30-)33-55 x 2-3(-4) µm; Frequent; on deciduous tree bark . . . . . B. fuscorubella

13. Apothecia dark red-brown, with prominent margins, usually heavily pruinose on disks and margins; hypothecium hyaline to pale yellow, exciple KOH+ pale yellow (never pink-violet); thallus becoming thick, rimose; spores 6-12(-15)-septate, 45-72 x 3-4 µm. Infrequent; on deciduous tree bark . . . . B. suffusa

BUELLIA

1. On non-calcareous stone; thallus ashy grey to brownish grey, thick, verrucose; apothecia slightly convex; margin thin to disppearing; spores 9.5-13.0 x 5.5-7.0 µm. Rare . . . B. turgescens
1. On bark or wood . . . . . 2.

2. Apothecia large, 0.5-1.2 mm in diameter, flat, with a prominent persistent margin; spores 12-17 x 5-7 µm; apothecial sections KOH+ strong yellow finally developing red crystals in most cases (norstictic acid). Common; on hardwood and conifer bark . . . . . B. stillingiana
2. Apothecia small, usually less than 0.5 mm in diameter; lacking norstictic acid . . . . . 3.

3. Spores 12-24 per ascus, 8.8-9.5 x 4.8-4.9 µm; exciple pale within, black at edge; apothecial margin thin, persistent. Rare; on hardwoods . . . . . B. polyspora
3. Spores 8 per ascus, 11-20 x 5-8 µm . . . . . 4.

4. Thallus fairly thick, verruculose to granulose, grey-green, PD+ red (fumarprotocetraric acid); apothecia hemispherical with a disappearing margin; spores 14-20 x 7.5-8.0 µm. Rare; on conifers, especially *Tsuga* . . . . . B. dialyta
4. Thallus thin, white, or almost absent, PD-; apothecia usually flat with a persistent, thin margin; spores 12-15 x 6-7 µm. Infrequent; on bark and wood, especially *Ulmus* . . . . . B. punctata

CALICIALES

1. Ascocarps without a stalk; mazaedium in thalline verrucae appearing like a lecanorine apothecium; thallus greenish yellow; spores 2-celled. Infrequent; on old, hard wood . . . . . (Figure 7) Cyphelium tigillare

1. Ascocarps at the summit of a short or long hair-like stalk . . . 2.

2. Parasitic on lichens (especially *Lecanora* or *Pertusaria*); stalk extremely short, grey or pale; spores spherical, 8-10 µm in diameter. Rare . . . . . Sphinctrina microcephala
2. Not parasitic; growing on bark, wood, or peat . . . . . 3.

3. Spores septate, brown (Figure 72j) . . . . . 4.
3. Spores non-septate, brown or colourless (Figure 72i) . . . . . 6.

4. Growing on 2-4 year old branches of *Rhus typhina* (staghorn sumac); stalks less than 0.4 mm tall, simple or branched once; ascocarp entirely black; spores pale brown, smooth, ellipsoid, hardly constricted, 11.5-14.5 x 3.5-5.0 µm. Frequent . . . . . Phaeocalicium curtisii
4. Growing on wood; stalks over 0.5 mm (up to 1 mm) tall . . . 5.

5. Spores dark brown, constricted at septum, rough on surface, 9.3-11.0 x 3.5-5.5 µm; stalks stout; ascocarps usually with a distinct yellowish margin; flask-like pycnidia often abundant, with a yellowish margin around the ostiole; usually on the wood of conifers. Frequent . . . . . (Figure 5) Calicium trabinellum
5. Spores pale brown, ellipsoid to cylindrical, vaguely septate and not constricted, smooth, 5.5-7.5 x 2.0-2.6 µm; stalks slender, hair-like, turning red in concentrated nitric acid; ascocarps without a yellow rim; pycnidia not seen. Usually on wood of deciduous trees. Rare . . . . . Chaenothecopsis dibilis
(Note: Reported by Tibell, 1975; no specimen in CANL.)

6. Spores ellipsoid to fusiform, brown (Figure 72i), 6-9 x 2.5-3.5 µm; thallus entirely absent or forming a white stain; ascocarps black, flat and almost disk-like. Common on old wood, especially of conifers . . . . . (Figure 6) Mycocalicium parietinum
6. Spores spherical, 2.5-4.0 µm in diameter; ascocarps brownish or yellowish . . . . . 7.

7. Stalks and ascocarps covered with a yellowish pruina; thallus bright greenish yellow, leprose, fairly thick. Often among the

deeply shaded roots of overturned trees or in similar, shaded habitats. Infrequent . . . . . Coniocybe furfuracea

7. Stalks black, ascocarps brownish, without a yellow pruina. On exposed dead wood . . . . . 8.

8. Phycobiont appearing square or rectangular in outline (*Stichococcus*), very small; thallus conspicuous, greenish leprose. Rare . . . . . Chaenotheca stemonea

8. Phycobiont circular in outline (Chlorococcales); thallus absent or thin, bluish grey, leprose. Rare . . . . . Chaenotheca brunneola

CALOPLACA

1. Thallus parasitic on foliose lichens (*Physciopsis*) . . Caloplaca sp.

1. Thallus growing on rock, bark or wood . . . . . 2.

2. Thallus growing on rock . . . . . 3.

2. Thallus growing on bark or wood . . . . . 6.

3. Thallus consisting mainly or entirely of yellow granular soredia, often sterile. Rare; on limestone . . . . . C. citrina

3. Thallus without soredia . . . . . 4.

4. Thallus conspicuous, pale sulphur yellow; apothecia 0.4-1.2 mm in diameter, dark orange, with margins almost the same colour when mature; spores 13-14 x 6-7.5 µm; isthmus broad, more than 1/3 spore length. Common on calcareous rock and cement . . . . . C. flavovirescens

4. Thallus inconspicuous or absent, blackish or grey if present; spore isthmus very narrow, less than ¼ spore length; apothecia brownish orange with a paler orange margin . . . . . 5.

5. Apothecia small, under 0.25 mm across, dull orange to orange-brown; apothecial margins paler than disk, usually yolk-yellow; spores 14-16 x (6-)7-9 µm (Figure 14); thallus often

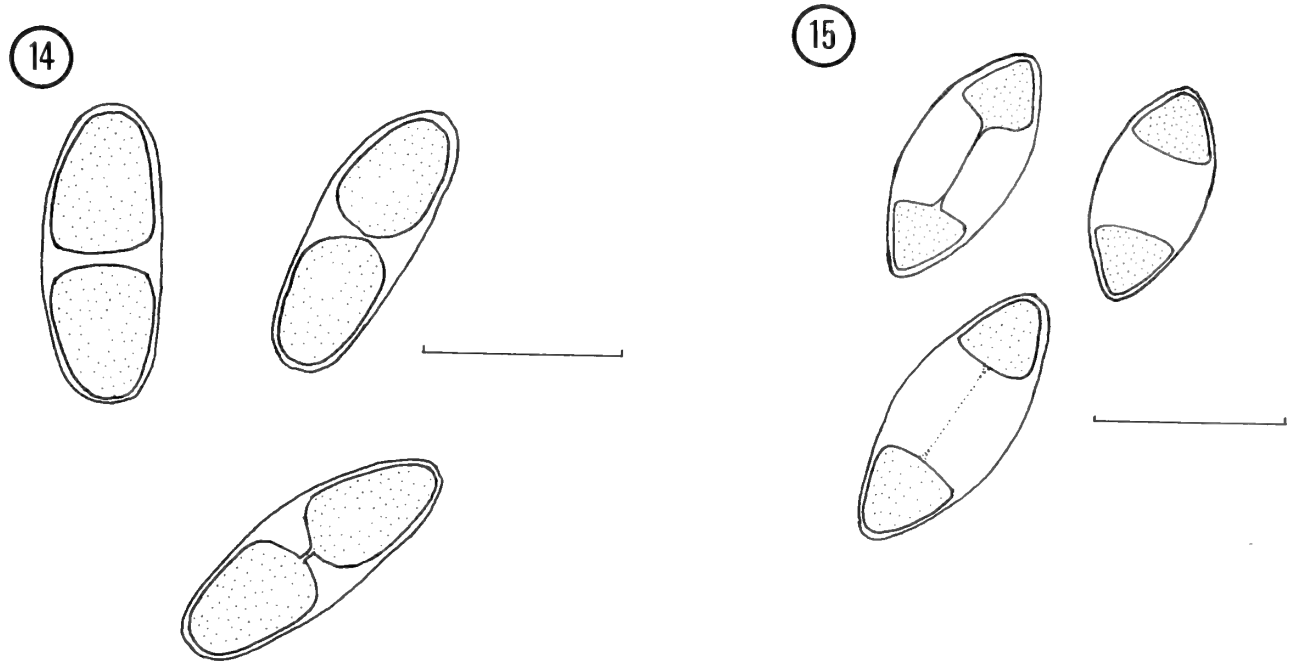
seen as a blackish crust around apothecia. Common; on limestone and concrete . . . . . C. feracissima

5. Apothecia 0.25-0.50 mm in diameter, bright orange; margins almost the same colour as disk; spores 10-14 x 4-5 µm; thallus usually absent, never blackish. Frequent; on rocks of all kinds . . . . . C. arenaria

6. Thallus yellow to orange, KOH+ purple . . . . . 7.
6. Thallus white, grey, or absent . . . . . 8.

7. Thallus yellowish orange to orange, areolate to squamulose, granular sorediate, usually sterile. Frequent; on roadside trees and fence rails . . . . . C. microphyllina
7. Thallus pale sulphur yellow, more or less continuous; apothecia frequent, orange with paler margin. Infrequent; on fence posts . . . . . C. flavorubescens

8. Apothecia with a conspicuous grey margin; apothecia can be over 0.5 mm in diameter . . . . . 9.



Figures 14-15. -14. *Caloplaca feracissima*, ascospores showing narrow isthmi; -15. *Caloplaca holocarpa*, ascospores showing broad isthmi. Scale: unit = 10 µm.

8. Apothecial margin yellow or orange in most apothecia, slightly paler than the disk; apothecia small, 0.3-0.5 mm in diameter, dark orange to yellow-orange; spores 10.5-13.0 x 6-8 µm (Figure 15). Common on elms, poplars and wood . . . . . C. holocarpa

9. Apothecial margins white pruinose; apothecial disks yellow pruinose; thallus often becoming squamulose; apothecia 0.5-1.7 mm in diameter. Infrequent; on roadside trees and wood . . . . . C. ulmorum

9. Apothecial margins and disks epruinose or almost so; thallus ashy grey, not squamulose; apothecia 0.4-0.9 mm in diameter. Frequent; on roadside trees and poplars . . . . . C. cerina

CANDELARIELLA

1. Thallus areolate or minutely squamulose or absent, not sorediate or finely granular; usually fertile . . . . . 2.

1. Thallus consisting of granules or soredia; usually sterile . . . 3.

2. On limestone rock; spores 8 per ascus; thallus usually not evident. Infrequent . . . . . C. aurella

2. On non-limy rocks or, rarely, wood; spores 16-32 per ascus; thallus usually conspicuous consisting of tiny or larger lobate areoles. Common . . . . . C. vitellina

3. Thallus consisting of scattered, distinctly corticate, round granules. Common; especially on elms and *Thuja* . . . . . (Figure 4) C. xanthostigma

3. Thallus entirely or almost entirely leprose (sorediate) . . . . . 4.

4. Thallus generally having a few distinctly foliose lobes among the soredia (soredia forming initially as marginal soralia) usually diffuse; spores 32 per ascus. Frequent. . . . . Candelaria concolor var. effusa

4. Thallus without foliose lobes; soredia in small clusters, developing at first from the edges of slightly flattened,

corticate granules; spores 32 per ascus. Infrequent
. . . . . (Figure 3) Candelariella efflorescens

DIMERELLA

1. Apothecia 0.5-2.0 mm in diameter, yellow to yellow-orange, flat; margins hardly prominent; spores 7-10 x 2.5-7.5 µm. Rare; on bark . . . . . D. lutea
1. Apothecia up to 0.5 mm in diameter, pale buff to pinkish; spores 10-15 x 3-3.5 µm. Rare; over moss or bark . . . . . D. diluta

HUILIA

1. Apothecia grey pruinose with a black margin, flat; thallus ashy grey, KOH+ deep yellow to red. Frequent; on acidic rocks in shaded woods . . . . . H. albocaerulescens
1. Apothecia epruinose, often strongly convex; thallus KOH- . . . . 2.

2. Apothecia very large, 0.5-2 mm in diameter; spores 17-19 x 6.5-7.5 µm; hymenium 100-120 µm high; thallus often thin or virtually absent. Common; on exposed acidic rocks
. . . . . (Figure 20) H. macrocarpa
2. Apothecia 0.35-0.75 mm in diameter; spores 14.5-16.0(-19.5) x 6.2-7.6(-8.7) µm; hymenium under 100 µm high; thallus ashy grey. Frequent; on exposed rocks . . . . . H. crustulata

LECANIA

1. Spores somewhat bent (Figure 72e), 13-16(-18) x 4.5-6.0 µm; apothecia minute, up to 0.25 mm in diameter, dark brown to black; margin thin, disappearing. Infrequent; on deciduous bark . . . . . L. dimera

1. Spores straight, (8.5-)11-13 x 3.3-4.0 µm; apothecia 0.25-0.8 mm in diameter, dark red-brown, convex; margin thin. Frequent on deciduous trees, especially black ash . . . . . L. cyrtella

LECANORA

1. Growing on bark or wood . . . . . 2.
1. Growing on rock . . . . . 23.

2. Thallus or apothecial margin sorediate . . . . . 3.
2. Thallus and apothecial margin esorediate . . . . . 5.

3. Thallus or apothecial margin yellowish green (usnic acid) . . . . 4.
3. Thallus and apothecial margin grey or white, KOH+ yellow; soredia granular, in patches on thallus; apothecia rare; bright red-brown with a distinct, white, often sorediate margin. Frequent, especially on roadside trees . . . . . L. impudens

4. Thallus sterile, thin, leprose, usually with a white, fibrous prothallus. Frequent, especially on sugar maple bark . . . . . L. thysanophora
4. Thallus fertile, with many yellow to brownish apothecia; thallus without a white, fibrous prothallus; thallus not leprose (usually, only the apothecial margins become sorediate). Frequent; on bark and wood of different kinds . . . . . L. strobilina

5. All apothecia with heavily pruinose disks . . . . . 6.
5. Apothecia epruinose when mature (i.e., in a few species, the apothecia are slightly pruinose when young) . . . . . 8.

6. Thallus and apothecial margins KOH-; spores 9-14 x 4-6(-7) µm. Rare; on bark or wood . . . . . L. hagenii
6. Thallus and apothecial margins KOH+ yellow (atranorin) . . . . . 7.

7. Apothecial margins persistent, raised; apothecia large, up to 1.2 mm across; apothecial sections (amphithecium) KOH+ yellow, not red. Infrequent; on bark . . . . . L. caesiorubella subsp. caesiorubella

7. Apothecial margins thin or disappearing in older apothecia; apothecia usually under 0.5 mm across; apothecial sections KOH+ red (norstictic acid). Rare; on bark. . . . . L. pallida. var. rubescens

8. Apothecial margins, disks, or thallus yellowish green or yellowish . . . . . 9.

8. Apothecial margins, disks, and thallus dirty grey to white, without a yellowish tint . . . . . 12.

9. Apothecia red-brown, margins yellowish; thallus dirty grey, KOH-; spores 8-12 x 4-7 µm (broadly ellipsoid); amphithecium packed with algae. Infrequent; on roadside trees and wood . . . . . L. saligna

9. Apothecial margins *and* thallus yellow to yellow-green, KOH+ yellowish; spores narrow, 7-14 x 3-6 µm . . . . . 10.

10. Apothecial margin disappearing in maturity, always smooth; amphithecium containing few algae (often appearing biatorine); apothecia yellow to yellow-orange; contains zeorin. Frequent; on bark or wood, especially of conifers . . . . . L. symmictera

10. Apothecial margin usually persistent; lacking zeorin . . . . 11.

11. Margin becoming granular or sorediate; apothecial margin often containing few algae; apothecia yellow to yellow-brown. Common on wood and bark . . . . . L. strobilina

11. Margin remaining smooth; apothecial margins packed with algae; apothecia very small, under 0.25 mm in diameter; disks yellow-brown to dark red-brown. Rare; on wood . . . . . L. piniperda

12. Thallus and apothecial margins KOH+ yellow (atranorin) . . . . . 13.

12. Thallus and apothecial margins KOH- (atranorin lacking) . . . . . 20.

13. Epithecium pigmented a clear red-brown (in the upper hymenium), not granular or the surface or between the tips of the paraphyses (Figure 18a) . . . . . 14.

13. Epithecium with fine or coarse granulars appearing on the hymenium surface (Figure 16a) or between the tips of the paraphyses (Figure 17a); upper hymenium pigmented or essentially hyaline; amphithecium containing clumps of large, colourless crystals (Figures 16b, 17b) (crystals and epithecial granules are strongly reflective in polarized light) . . . . . 17.

14. Amphithecium containing clumps of very large, irregular, KOH insoluble crystals (sometimes sparse); cortex distinct from amphithecial medulla, uniform in thickness; spores (9.0-)11.5-14.5(-16.5) x (5.5-)6.0-8.5 µm. Uncommon; on deciduous trees . . . . . L. subfuscata

14. Amphithecium and cortex containing very small, angular, KOH insoluble crystals, usually more-or-less filling amphithecium (Figure 18b) . . . . . 15.

15. Amphithecial cortex thick (especially at base), gelatinous, not distinct from medulla (Figure 18b) . . . . . 16.

15. Amphithecial cortex thin or absent, not at all gelatinous; spores 11-14 x 7.0-8.5 µm. Infrequent; on deciduous trees. . . . . L. imshaugii

16. Apothecial small, soon becoming convex, 0.3-0.6(-0.8) mm in diameter, closely adnate; apothecial margin smooth, thin; spores 9.5-14.5 x 6.0-7.0(-8.0) µm. Common; usually on beech or sugar maple bark . . . . . (Figures 18, 23) L. glabrata

16. Apothecia large, flat, 0.6-1.5(-2.0) mm in diameter, very constricted at base in maturity; apothecial margin conspicuous, commonly flexuous; spores (12-) 13-16(-19) x 7.5-10(-11) µm. Infrequent; on poplar and ash bark . . . . . L. allophana

17. Apothecia at first immersed in thallus, later becoming sessile; margins verrucose to discontinuous; apothecial disk orange- or red-brown; apothecial cortex very thin (less than

15 um), indistinct; epithecium PD+ orange (pannarin), producing clusters of small orange needles as seen under the microscope; spores 11.5-14.5 x 7.5-8.5 µm. Frequent; on deciduous trees . . . . . L. cinereofusca

17. Apothecia all sessile; apothecial margins entire, sometimes verruculose; epithecium PD-; cortex gelatinous, distinct . . . . . 18.

18. Apothecial margin PD+ red (fumarprotocetraric acid); epithecium pigmented, containing fine granules between tips of paraphyses. Frequent; especially on conifer bark . . . . . L. pulicaris

18. Apothecial margins PD+ yellow or PD- . . . . . 19.

19. Thallus verrucose, thick, pale grey to almost white; apothecia constricted at base, with coarsely verrucose margins; disks usually pale yellow- or pinkish brown, sometimes dark brown, often lightly pruinose when young; epithecium coarsely granular at surface, not pigmented (pigment confined to the tips of the paraphyses); spores 12-18 x 7-10(-11.5) µm. Infrequent; especially on *Thuja* bark . . . . . (Figure 16) L. rugosella

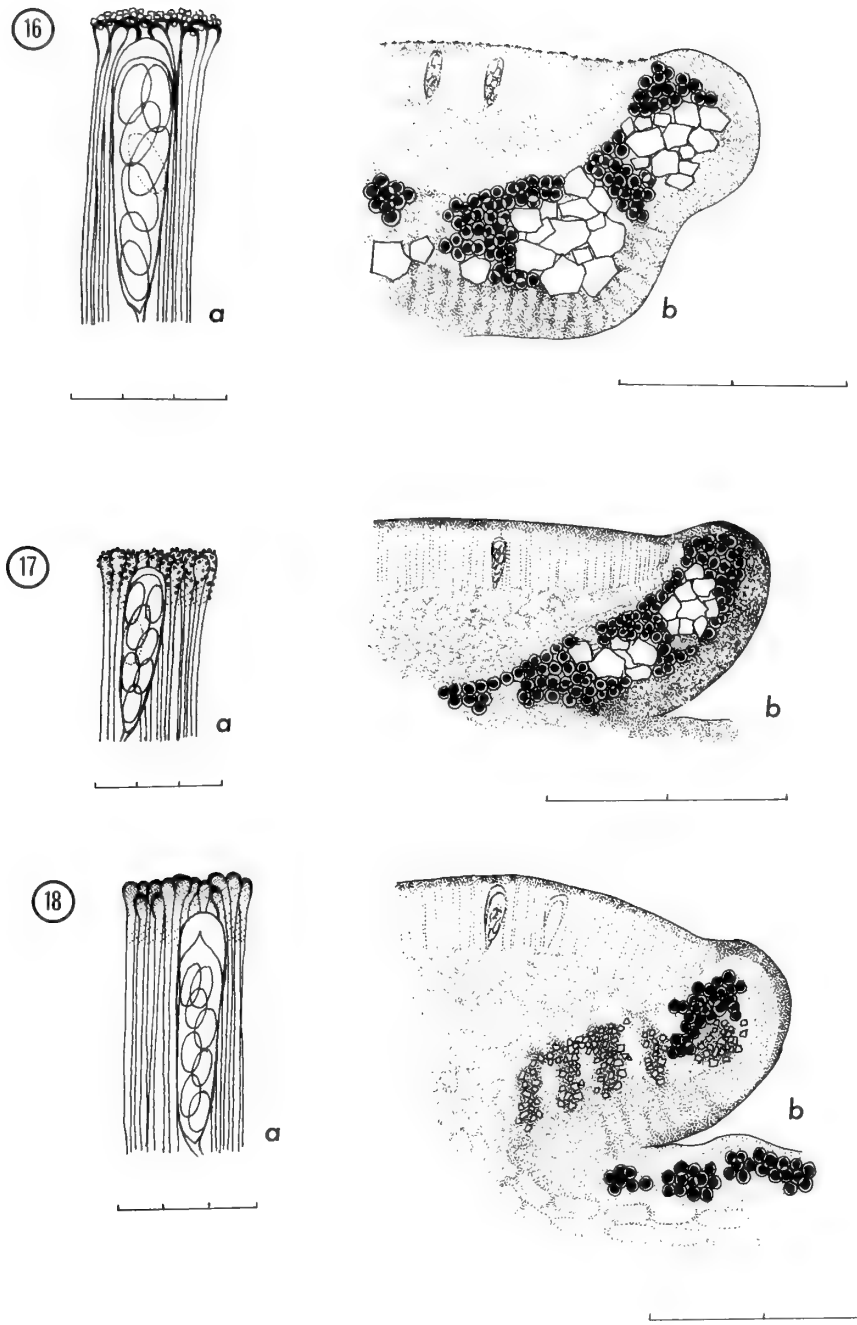
19. Thallus thin, ashy grey, verruculose or areolate; apothecia sessile, not constricted at base; margins smooth to slightly verruculose; disks red-brown, with tiny granules between tips of paraphyses; spores 10-13 x 6.5-8.5 µm. Common; on tree bark of all kinds . . . . . (Figure 17) L. pseudochlarotera

(Note: *L. chlarotera*, a similar species with coarse granules on the epithecial surface (as in *L. rugosella*) is not known with certainty from the Ottawa region; it is rare in Ontario.)

20. Apothecial margins thick, white; apothecia crowded, pale yellow-brown, some slightly pruinose; spores 11.5-12.5 x 7.0-7.5 µm; amphithecial cortex thin, indistinct, not gelatinous. Rare; on wood . . . . . L. umbrina f. gregaria

(Note: This may be a morphotype of *L. hagenii*.)

20. Apothecial margins thin or thick, yellowish, dark grey, or thallus-coloured, not white; apothecia pale to dark . . . 21.



Figures 16-18. -16 *Lecanora rugosella*, (a) portion of hymenium showing superficially granular epithecium, (b) vertical section of apothecium showing large crystal heaps in amphithecium; -17. *Lecanora pseudochlarotera*, (a) portion of hymenium showing inspersed epithecium, (b) vertical section of apothecium; -18. *Lecanora glabrata*, (a) portion of hymenium showing non-inspersed, pigmented epithecium, (b) vertical section of apothecium showing small amphithecial crystals extending into cortex. Scale: -16a, 17a, 18a: each unit = 10 µm; -16b, 17b, 18b: each unit = 100 µm.

21. Apothecial margin cortex distinct, gelatinous; apothecium almost biatorine with few algae in amphithecium; margin thin, disk-coloured, becoming excluded. Rare; on wood . . . . . L. subintricata

21. Apothecial margin cortex thin, indistinct, not gelatinous or expanded; amphithecium usually packed with algae; margin distinct, yellowish, usually persistent for a long time . . . . . 22.

22. Spores 8-12 x 4-7 µm (broadly ellipsoid); apothecial disks red-brown; apothecial margin thick, prominent, verrucose to crenulate; apothecia 0.4-0.75 mm in diameter, epruinose. Infrequent; on elm bark and wood . . . . L. saligna

22. Spores 7-12 x 3-4.5 µm (narrowly ellipsoid); apothecia yellow-brown to very dark brown; apothecial margin thin, prominent and smooth to even with disk; apothecia 0.2-0.4 mm in diameter, slightly pruinose. Rare; on wood . . . . . L. piniperda

23. Apothecia immersed in thallus, pale orange or orange-pink; thallus smooth to rimose (visible on the dry thallus), continuous. Frequent on rocks at least periodically covered by water . . . . . Hymenelia lacustris

23. Apothecia sessile, thallus not orange; not aquatic . . . . . 24.

24. Thallus distinctly lobate at margin, or with lobate areoles; yellowish green (with usnic acid) . . . . . 25.

24. Thallus continuous, or dispersed areolate, not lobate . . . 28.

25. Apothecia pruinose; medulla KOH- . . . . . 26.

25. Apothecia without pruina . . . . . 27.

26. Apothecia pinkish orange or yellow-orange; thallus dull, pale yellowish green, often almost umbilicate; contains pseudoplacodialic acid. Frequent on granitic rocks . . . . . L. chrysoleuca s. s.

26. Apothecia yellow-green, thallus shiny yellow-brown, areolate to barely lobate; contains fatty acids. Rare; on granitic rocks . . . . . L. cfr. subdiscrepans

27. Medulla KOH+ yellow (unknown substance); apothecia yellowish to yellow-buff; thallus with dispersed, loosely attached, lobate areoles; contains placodialic acid and an unknown substance. Infrequent; on granite . . . . . L. opiniconensis

27. Medulla KOH-; apothecia yellow-green to yellow-brown; thallus usually radiately lobed, closely appressed; contains zeorin. Common; on calcareous rock or acidic rock if associated with bird perches . . . . . L. muralis

28. Thallus or apothecia distinctly yellowish or yellow-green . . . . . 29.

28. Thallus and apothecia lacking a yellow tint of any kind . . 30.

29. Apothecia pruinose, yellow-green; thallus thick, areolate; contains fatty acids (see couplet 26) . . . . L. cfr. subdiscrepans

29. Apothecia epruinose, yellow-green; thallus usually absent for the most part; contains zeorin. Frequent; on non-calcareous rock . . . . . L. polytropa

30. Thallus and apothecial margins KOH+ yellow (atranorin); on non-calcareous rock . . . . . 31.

30. Thallus and apothecial margins KOH- . . . . . 34.

(Note: If thallus is C+ pink and KOH-, the specimen may be *Trapelia involuta*. See couplet 13 in *Lecidea* key.)

31. Apothecial disks pruinose; epithecium heavily granular . . . . . 32.

31. Apothecial disks epruinose; epithecium not at all granular . . . 33.

32. Apothecial disks heavily pruinose, C+ yellow (sordidone); apothecia often immersed when young; apothecial margins without large crystals. Rare . . . . . L. rupicola

32. Apothecial disk lightly pruinose, C-; contains a fatty acid; apothecia raised, often with a verrucose margin; margin contains clumps of large oxalate crystals. Infrequent . . . . . L. cenisia

33. Apothecial disks dark brown to black; margins usually thick, very coarsely verrucose; apothecial margin cortex thick (up to 65 µm at the base), radiate, inspersed with tiny granules, distinct; large crystals in margin sometimes absent; contains

gangaleoidin and an unknown. Infrequent . . . . . Lecanora sp. #1
(Note: Perhaps close to *L. cenisia* or *L. gangaleoides*.)

33. Apothecial disks red-brown; margins thin or thick, crenulate; apothecial margin cortex thin, 15-25 µm, distinct or indistinct, not radiate; large crystals in amphithecium; contains an unidentified substance. Frequent . . . . . L. galactinula

34. On calcareous rock. Thallus white or absent . . . . . 35.
34. On non-calcareous rock. Thallus dull grey-brown, rimose-areolate; spores 9-10 x 4.5-5.5 µm. Rare . . . Lecanora sp. #2

35. Apothecial disks black, grey-pruinose; thallus often conspicuous, white, areolate; spores narrowly ellipsoid, 11.0-13.5 x 5.0-6.5 µm. Infrequent . . . . . L. crenulata
35. Apothecial disks red-brown or yellow-brown, epruinose (or with a thin pruina when young); thallus absent; spores ellipsoid, 8.5-10.5 x 5.2-6.5 µm. Infrequent . . L. dispersa

LECIDEA s.l.

1. On wood, bark, moss, or soil . . . . . 2.
1. On stone . . . . . 11.

2. On bark . . . . . 3.
2. On wood, moss, or soil . . . . . 6.

3. Thallus sorediate, with discrete, rounded mounds of yellowish green soredia on a thin, continuous crust; apothecia rare, pale brown, all tissues hyaline; spores 11-13 x 2.5-3.5 µm, narrowly ellipsoid to fusiform. Rare; tree bases, especially ash . . . . . Lecidea sp. #4 *sensu* Harris, 1977
3. Thallus continuous, thin or thick, smooth or granulose, not with discrete soralia . . . . . 4.

4. Apothecia very small, flat, 0.18-0.40 mm in diameter, often clustered, red-brown; thallus thin, KC+ pale orange (sometimes KC-); hypothecium hyaline; spores 10-13 x 5.2-7.0 µm, rather

broadly ellipsoid. Frequent on deciduous trees . . . L. varians

4. Apothecia flat to convex, 0.2-0.75 mm in diameter, scattered, yellow- to red-brown or black; spores narrowly ellipsoid . . . . . 5.

5. Apothecia usually dark brown to black (rarely pale), more or less flat to slightly convex, with a thin, shiny margin; hypothecium dark brown; thallus very thin, continuous; spores 10-13.5 x 3.0-4.0 µm. Infrequent; on various trees . . . . . L. albofuscescens

5. Apothecia yellow- to red-brown, convex to hemispherical; margin soon disappearing; hypothecium hyaline to pale yellowish; thallus grey-green, granulose; spores 15-17 (-23) x 4.0-6.0 µm. Infrequent; on various trees near base . . . . . L. vernalis

6. Thallus dark brown to black, granulose, C-; apothecia black, marginless, with a dark brown hypothecium and exciple; spores (7.5)10-15 x (4.3-)5-7(-9) µm. Infrequent; on sandy or peaty soil or rotting wood . . . . . L. uliginosa

6. Thallus grey to grey-green or yellowish . . . . . 7.

7. Thallus grey to grey-green . . . . . 8.

7. Thallus yellowish; apothecia pale yellow (see *Lecanora* key, couplet 10) . . . . . Lecanora symmictera

8. Thallus thick, grey-green, verrucose, with some verrucae becoming sorediate, C+ pink (gyrophoric acid); apothecia irregular in shape, flat to convex, pinkish to brown-black or lead-black; spores 9-13 x 4-6 µm. Frequent; on soil or wood . . . . . L. granulosa

8. Thallus thin or thick, non-sorediate, C-; apothecia brown or pitch black . . . . . 9.

9. Apothecia pitch black, shiny, flat, irregular, with a thin margin; thallus thick, verrucose, KOH+ yellow, PD+ red (substance unidentified); spores 5.7-7.8 x 3.3-4.0 µm. Rare; on conifer lignum . . . . . L. elabens

9. Apothecia red-brown or yellow-brown; apothecia convex, round; thallus more or less verruculose to granulose; spores longer than 10 um . . . . . 10.

10. Hypothecium light to dark brown, paler below; spores 10-14(-17) x 3.6-4.8 µm. Frequent; on moss at base of trees . . . . . L. berengeriana

10. Hypothecium hyaline to pale yellowish; spores 15-17(-23) x 4-6 µm. Infrequent; on moss, wood and bark . . . . . L. vernalis

11. On calcareous rock. Thallus thick, grey, or thin, or even absent; apothecia round, thick flat margin; hypothecium hyaline to pinkish; exciple aeruginose externally (Figure 74a); epithecium black to olive-black; spores very broad, 10.5-13 x 7.5-8.0 µm; paraphyses free in water or at least in KOH. Common . . . . . Lecidella stigmatea

11. On non-calcareous rock. Thallus thick or thin; hypothecium brown-black, generally more or less confluent with exciple . . . 12.

12. Spores very large, 13-24 x 6-11 µm . . . . . 13.

12. Spores smaller, 6-13 x 3-7 µm . . . . . 15.

13. Thallus C+ pink (gyrophoric acid), areolate to dispersed verrucose; exciple thin, brown, sometimes enveloped in a secondary "thalline margin"; hypothecium hyaline; spores 17-22 x 8-10 µm. Infrequent . . . . . Trapelia involuta

13. Thallus C-; exciple well-developed, usually thick, dark brown to black and carbonaceous; hypothecium brown-black . . . . 14.

14. Exciple radiating, brown-black, paraplectenchymatous (see Figure 20); some spores, especially young ones, have a gelatinous epispore or "halo" (see Figure 72a). Common . . . . . (see key to *Huilia*)

14. Exciple uniformly carbonaceous, not radiate; apothecial margin often becoming cracked; thallus membranous, grey to disappearing. Rare . . . . . L. cinereoatra (Note: *L. subsimplex* is also a possibility.)

15. Epithecium greenish or aeruginose; exciple hyaline within, greenish black at edge (Figure 19); apothecia very small, 0.16-0.25 mm in diameter; spores 6.1-7.5 x 3.2-3.5 µm; thallus dark grey-green. Frequent, especially on pebbles . . . . . L. erratica

15. Epithecium brown; exciple brown within, becoming paler externally; apothecia 0.3-0.5 mm in diameter; spores 11-13 x 5-7 µm; thallus thin, continuous. Rare . . . . L. delincta

MICAREA

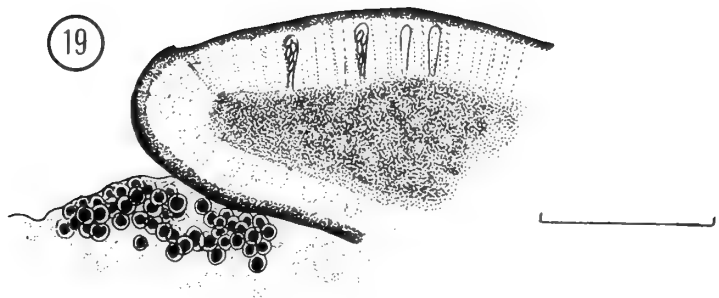
1. Spores non-septate . . . . . 2.
1. Spores 1-3-septate; thallus C- . . . . . 3.

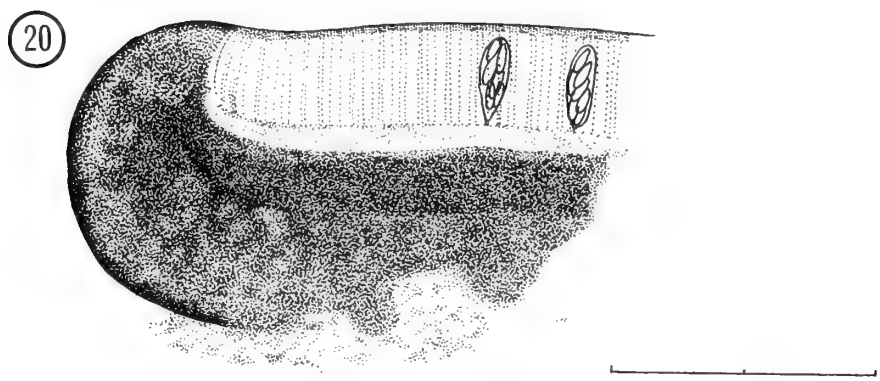
2. On old, rotted wood. Thallus light grey-green to brownish green, coarsely granulose to effuse sorediate, C+ pink (gyrophoric acid); ascocarps black, often crowded or clumped; spores 6-10(-12) x 3-4(-5) µm. Infrequent . . . . . M. viridescens

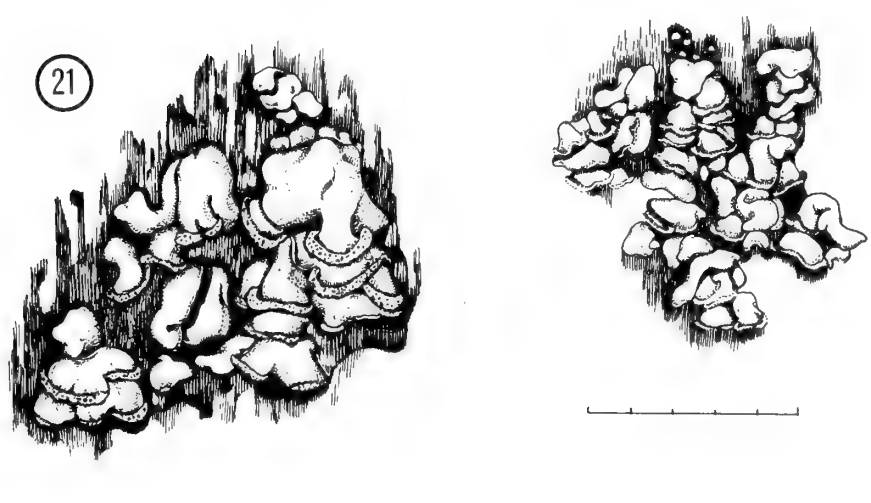
2. On rock, shaded habitats. Thallus greenish grey, continuous to rimose-areolate, finally becoming granulose, C-; ascocarps black to greenish brown, scattered, 0.2-0.4 mm in diameter; hypothecium hyaline; spores 9-13 x 3.3-4.3 µm. Rare . . . . . M. bauschiana

3. Spores 1-septate, 6-12 x 3-5 µm; ascocarps pink to yellowish, 0.1-0.3 mm in diameter, crowded; thallus greenish, pulverulent. Rare; on bark, or rarely, hard lignum . . . . . M. micrococca

3. Spores 1-3-septate, 16-19 x 5-6 µm; ascocarps pitch black, mostly scattered; thallus dark green to greenish black, smooth or verruculose to granulose. Infrequent; usually on logs and rotting wood . . . . . M. melaena







Figures 19-21. -19. *Lecidea erratica*, vertical section of apothecium;
-20. *Huilia macrocarpa*, vertical section of apothecium;
-21. *Hypocenomyce scalaris*. Scale: -19, 20: each unit = 100 µm;
-21: each unit = 1 mm.

OCHROLECHIA

1. Thallus sorediate in discrete soralia, sterile; soralia C+ pink (gyrophoric acid) . . . . . 2.
1. Thallus non-sorediate, fertile . . . . . 3.

2. Soralia UV+ orange (lichexanthone), finely granular or farinose; thallus thin. Frequent; on bark . . . . . O. arborea
2. Soralia UV-, very coarsely granular; thallus thick. Rare; on moss, vegetation, or rarely at tree bases . . . O. androgyna

3. Thallus and apothecial margin C-; disk C+ pink; apothecial section in KOH produces long, needle-shaped crystals (variolaric acid). Rare; on bark . . . . . O. pseudopallescens
3. Thallus and apothecial margins C+ pink (gyrophoric acid); variolaric acid absent. Frequent; on tree bark . . . . . O. rosella

PERTUSARIA

1. Fertile verrucae sorediate or lecanorine (with a thick, recognizable margin) . . . . . 2.
1. Fertile verrucae opening by one or several ostioles, not sorediate or lecanorine (see Figures 24, 74b) . . . . . 7.

2. Fertile verrucae sorediate . . . . . 3.
2. Fertile verrucae lecanorine; spores one per ascus . . . . . 6.

3. Sorediate verrucae and medulla KC+ purple, K-, C-, PD- (picrolichenic acid); thallus dark grey, with white, coarsely granular, sorediate mounds. Infrequent; on bark . . . . . P. amara
3. Sorediate verrucae and medulla KC- . . . . . 4.

4. Soredia K-, PD-, C-; spores 1 per ascus (often absent). Frequent; on bark . . . . . P. ophthalmiza
4. Soredia PD+ orange or red . . . . . 5.

5. Soredia KOH+ bright yellow, PD+ yellow-orange (thamnolic acid); spores 2 per ascus. Infrequent; on bark . . *P. trachythallina*

5. Soredia KOH-, PD+ red (fumarprotocetraric acid); spores 1 per ascus. Rare; on bark . . . . . *P. multipunctoides*

6. Disks C-, KOH+ red, PD+ yellow (norstictic acid); disks black, more or less pruinose; spores 95-142 x 30-46 µm. Rare; on bark . . . . . *P. waghornei*

6. Disks C+ red, KOH-, PD- (lecanoric acid); disks heavily grey pruinose; spores 180-274 x 47-81 µm. Infrequent; on bark . . . . . *P. velata*

7. Spores 4-8 per ascus . . . . . 8.

7. Spores 2 per ascus (Figure 71c) . . . . . 10.

8. Spores uniseriate; medulla (especially in verrucae) PD+ pale orange, KOH+ yellow (stictic acid) . . . . . 9.

8. Spores biseriate; cortex and medulla PD+ yellow, KOH+ yellow becoming blood-red (norstictic acid); spores 6-8 per ascus, 72-100 x 28-38 µm. Infrequent; on hardwood trees . . . . . *P. rubefacta*

9. Spores 8 per ascus, 36-60 x 18-32 µm. Infrequent; on bark . . . . . *P. alpina*

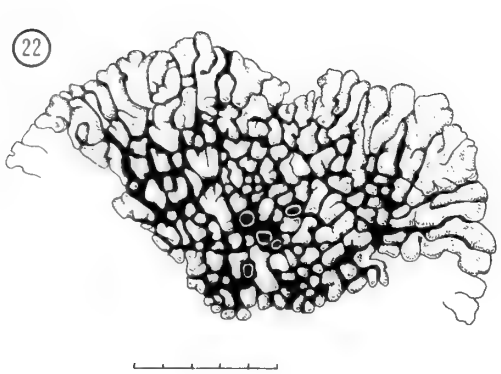
9. Spores (2-)4(-5) per ascus, 50-100 x 23-43 µm. Frequent; on bark . . . . . *P. leucostoma*

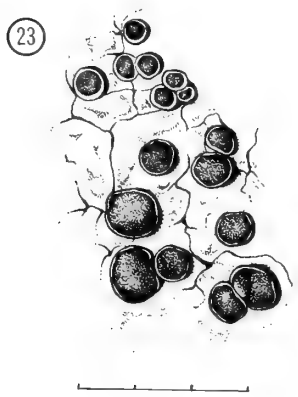
10. Medulla KOH+ yellow changing to red, PD+ yellow (norstictic acid); spore walls roughened; epithecium KOH-. Rare; on bark . . . . . *P. neoscotica*

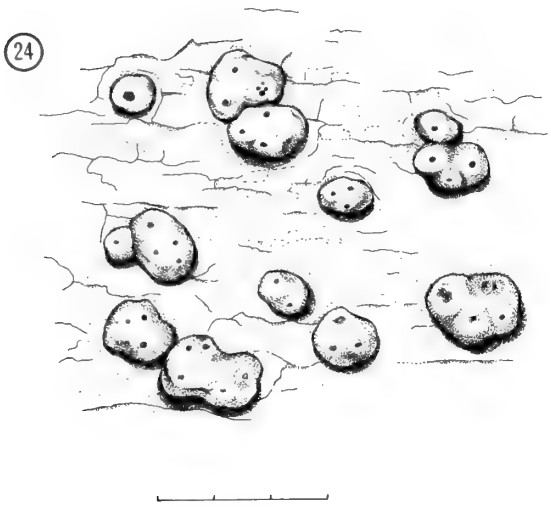
10. Medulla KOH+ yellow, PD+ pale orange (stictic acid) . . . . 11.

11. Epithecium KOH+ purple; spore walls smooth throughout, KOH-. Rare; on bark . . . . . *P. consocians*

11. Epithecium KOH-; spore walls conspicuously channelled (Figure 72n), often KOH+ purple on spores which have become dark. Common; on bark . . . . . (Figure 24) *P. macounii*







Figures 22-27. -22. *Dimelaena oreina*; -23. *Lecanora glabrata*; -24. *Pertusaria macounii*; -25. *Sarcogyne simplex*; -26. *Staurothele fissa*, vertical section of a perithecium; -27. *Verrucaria calciseda*. Scale: -22, 23, 24, 25, 27: each unit = 1 mm; -26: each unit = 100 µm.

PLAGIOCARPA

(Note: Spore measurements taken from Harris, 1973.)

1. Spores hyaline, 3-septate, 18-27(-30) x 7-10(-12) µm . . . . . *P. hyalospora*
1. Spores dark brown . . . . . 2.

2. Spores 3-septate, 30-40(-45) x (12-)14-16(-18) µm . . . . . *P. phaeospora*
2. Spores 7-septate . . . . . 3.

3. Spores 55-80 x 20-26 µm . . . . . *P. macrospora*
3. Spores 30-42(-45) x 12-15 µm . . . . . *P. septemseptata*

PSORA AND HYPOCENOMYCE

1. Growing on the soil or over limestone; squamules thick, brown to red-brown, with white margins; medulla and cortex PD-, C-. Infrequent . . . . . *Psora russellii*
1. Growing on wood, usually charred wood, or, rarely, bark . . . . 2.

2. Squamules sorediate on the margins of the lower surface . . 3.
2. Squamules esorediate, very small, PD-, C-, usually fertile with small black apothecia. Infrequent . . *Hypocenomyce friesii*

3. Squamules pale olive, very convex, C+ red, PD- (lecanoric acid). Frequent . . . . . (Figure 21) *Hypocenomyce scalaris*
3. Squamules brownish olive, usually more or less flat, C-, PD+ red (unknown substance). Rare . . . *Hypocenomyce anthracophila*

PYRENULA

(Note: Spore measurements taken from Harris, 1973)

1. Spores 13-24 µm in length . . . . . 2.
1. Spores 22-35(-46) µm in length . . . . . 3.

2. Thallus white to grey, UV-; hymenium not inspersed with oil droplets; spores 13-19(-21) x 8-9(-11) µm, end cells having clearly distinguishable walls. Rare; on deciduous trees . . . . . P. laevigata
2. Thallus olive to yellowish olive, UV+ yellow; hymenium inspersed with numerous oil droplets; spores 13-22(-24) x 7-12 µm, end cell walls very thin, causing cells to almost project out somewhat like papillae. Frequent; on smooth bark, especially of beech, oak and maple . . P. neglecta

3. Thallus with tiny white dots; hymenium inspersed with oil; spores 24-35(-46) x 10-15(-17) µm. Rare . . . . . P. imperfecta
3. Thallus without white dots; hymenium not inspersed with oil; spores 22-30 x 8-12 µm . . . . . P. macounii

(Note: Not yet found in the Ottawa region, but described from southern Ontario and known from three localities there; on smooth bark, e.g., *Carpinus*, blue-beech.)

RHIZOCARPON

1. Thallus greenish yellow, with a conspicuous black prothallus; crescent-shaped areoles or verrucae partially surrounding immersed apothecia; medulla IKI+ blue; spores very dark greenish brown, 30-38 x 12-16 µm, muriform, many-celled. (Rare?); on exposed granitic rocks . . . . . R. lecanorinum

(Note: This species, though not yet recorded from the Ottawa region, is to be expected there.)

1. Thallus grey to brown or sometimes more or less orange . . . . . 2.

2. Spores 1-3-septate (not muriform), hyaline . . . . . 3.
2. Spores muriform . . . . . 4.

3. Spores 1-septate, 18-24 x 8-10 µm; thallus continuous, becoming rimose, brown to brownish grey; apothecia sessile, margins thin, persistent. Infrequent . . . R. hochstetteri
3. Spores mostly 3-septate, 15-21 x 6-7.2 µm; thallus areolate, dark brown; apothecia immersed. Rare . . . . . R. tetramerum

4. Thallus KOH+ red, PD+ yellow (norstictic acid); thallus pale grey, verrucose-areolate; apothecia sessile, with thick, prominent margins; spores hyaline, becoming dark when old, 20-25(-34) x 8.5-11(-16) µm. Rare . . . R. eupetraeum
4. Thallus KOH- or + yellow, PD-; thallus grey to brown . . . . 5.

5. Spores dark brown, 27-31 x 12-14 µm; thallus dark, pinkish brown to grey-brown, thick, verrucose-areolate, with convex, marginless apothecia between the areoles; medulla IKI+ blue, cortex C+ pale pink (gyrophoric acid). Frequent; on exposed rock . . . . . R. grande
5. Spores hyaline; thallus areolate, flat; apothecia generally with a persistent, grey margin; medulla IKI-; cortex C- . . . . . 6.

6. Spores usually with 5-7(-9) transverse septa and 1-2 longitudinal septa, 23-35 x 10-15 µm; thallus pale pinkish brown to greyish brown, or ochraceous (orange); apothecia immersed between areoles. Frequent; on rocks in or close to running water . . . . . R. lavatum
6. Spores with 3-4 transverse septa and 1 longitudinal septum, 24-29 x 11-14 µm; thallus grey-brown, continuous to rimose; apothecia sessile to more or less immersed. Infrequent; on dry rocks . . . . . R. obscuratum

RINODINA

1. Growing on stone . . . . . 2.
1. Growing on bark or wood . . . . . 5.

2. Spores 30-35 x 12-16 µm; thallus olive-brown, thin, membranous, becoming almost squamulose in part, KOH-; apothecia with a thick, persistent margin, 0.50-0.75 mm in diameter. Rare on rock (more frequent on bark) . . . . . R. ascociscana

2. Spores under 25 µm long and 12 µm broad . . . . . 3.

3. Spores with a conspicuously darkened central belt (Figure 28), 16-20 x 9.5-11.5 µm; apothecia small, 0.25-0.33 mm in diameter, black; margin dark or grey, thin; thallus absent or grey and discontinuous. Rare; on limestone . . . . . R. bischoffii

3. Spore wall uniformly pigmented, without a belt; thallus thick . . 4.

4. Thallus white, verrucose, KOH+ yellow; apothecia large, 0.4-0.8 mm in diameter, with a thick, uneven, crenulate margin (which, on occasion, can disappear giving the apothecia a lecideine appearance); spores 22-23 x 10.5-12 µm, without a conspicuous septum. Frequent; on limestone . . . . . R. verrucosa

4. Thallus pale olive-brown, areolate to squamulose, KOH-; apothecia 0.4-0.5 mm in diameter, erumpent, with a thin to thick white margin; spores 18-26 x 9.5-12 µm. Rare . . . . . R. novoconfragosa

5. Spores over 25 µm long (see couplet 2) . . . . . R. ascociscana

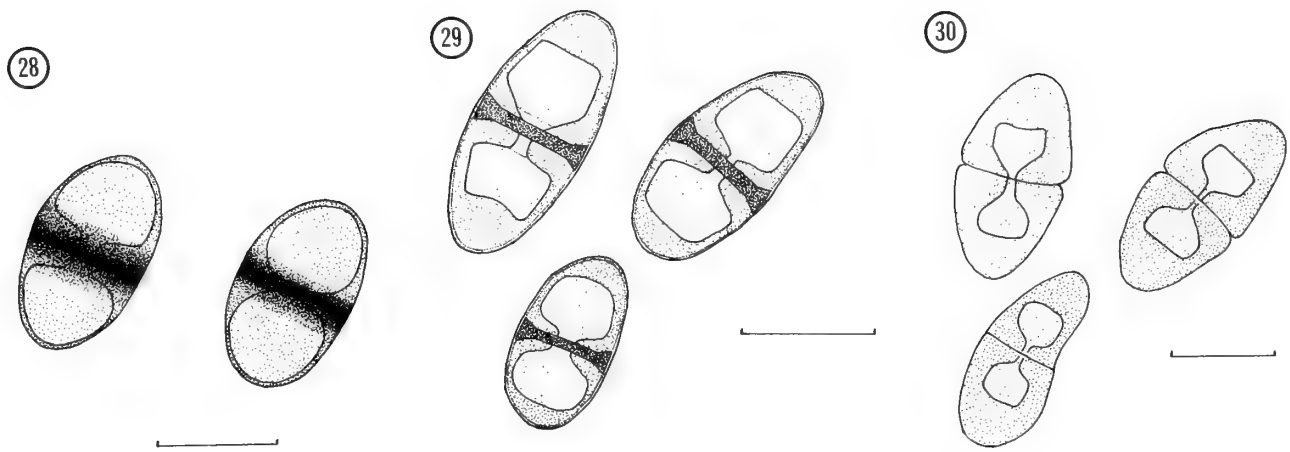
5. Spores under 25 µm long . . . . . 6.

6. Spores 8 per ascus, mostly over 16 µm long . . . . . 7.

6. Spores 12-32 per ascus, mostly under 16 µm long . . . . . 9.

7. Apothecia with a thick, even to crenulate margin, 0.33-0.66 mm in diameter; thallus verruculose, green-grey to brownish; spores 16-20 x 6.5-10 µm, septum distinctly darker brown (Figure 29). Frequent; on bark of all kinds . . . . . R. dakotensis

7. Apothecia erumpent, with grey, often "split" margins; thallus thin, membranous; spore septum distinct, but not darkened (Figure 30) . . . . . 8.



Figures 28-30. Ascospores. -28. *Rinodina bischoffii*; -29. *Rinodina dakotensis*; -30. *Rinodina halei*. Scale: each unit = 10 µm.

8. Thallus white; spores 13.5-20 x 7.5-9.5 µm; apothecia 0.33-0.50 mm in diameter. Frequent; on maple, basswood and ash bark . . . . . R. subminuta

8. Thallus green-grey; spores 15-21 x 8.0-10.5(-11.5) µm; apothecia 0.25-0.41 mm in diameter. Frequent . . . . R. halei

9. Spores 12-16 per ascus, 14.2-15.8 x 6.8-7.4 µm; spore wall uneven in thickness (Figure 72m); apothecial cortex barely discernable, brownish, about 15 µm thick; apothecial margin thin, finally disappearing and apothecium becoming convex; thallus white, thin, membranous. Rare; on poplar bark . . . . . R. polyspora

9. Spores 16-32 per ascus, 11-12 x 6 µm; spore wall even in thickness (as in *Buellia*; see Figure 72*l*)
apothecial cortex conspicuous, about 65 µm thick; apothecial margin thick, even, persistent; thallus brownish grey, verruculose. Infrequent; on poplar and elm bark . . . R. palustris

(Note: *R. populicola* is a similar species having spore walls even in thickness, but there are 12-16 spores per ascus, and the thallus is grey-green, sometimes disappearing.)

SARCOGYNE

1. On calcareous rock (e.g., limestone). Apothecia pruinose, (0.4-)1.0-2.0 mm in diameter; margin thin but distinct; exciple dark brown, not carbonaceous; thallus thin and superficial or developing within the rock and invisible. Frequent . . . S. regularis

1. On non-calcareous rock (e.g., granite, gneiss). Apothecia not pruinose; exciple carbonaceous; thallus not generally visible . . . . . 2.

2. Apothecia 1-2 mm in diameter, round, usually scattered; margin usually fairly smooth and even, sometimes prominent; disk smooth, red-brown (especially when wet), more-or-less flat. Infrequent . . . . . S. clavus

2. Apothecia less than 1 mm in diameter, angular; margin usually irregular and sometimes discontinuous . . . . . 3.

3. Apothecial disks with numerous carbonaceous ridges and lumps sometimes almost obscuring the red-brown epithecium; apothecia almost always crowded into clumps. Frequent . . . . . (Figure 25) S. simplex

3. Apothecial disks smooth, red-brown (especially when wet), concave, rarely with a central, carbonaceous "button"; apothecia scattered or crowded. Frequent . . . . . S. privigna

STAUROTHELE

1. On periodically submerged or wet rocks; thallus dark brown, smooth, rimose-areolate with buried perithecia forming conspicuous, prominent verrucae; spores 2 per ascus, 27-34 x 16-17 µm. Common; on non-calcareous rock . . . (Figure 26) *S. fissa*
1. On dry rock; perithecia entirely immersed in thallus . . . . . 2.

2. Spores 2 per ascus, 30-40 x 12-20 µm; thallus brown, verrucose to areolate. Frequent; on limestone . . . . . *S. catalepta*
2. Spores 4-6 per ascus, 25-28 x 10-12 µm; thallus pale greenish grey, smooth, rimose-areolate; medulla black. Infrequent; on acid rock . . . . . *S. diffractella*

VERRUCARIA

1. Thallus white, extremely thin, endolithic, or absent . . . . . 2.
1. Thallus dirty grey, or olive to dark brown, or black, thick or rather thin; epilithic . . . . . 3.

2. Perithecia entirely immersed, forming distinct pit in rock; perithecia very small, 0.15-0.16 mm in diameter; involucrellum fused to excipulum and generally not distinguishable; spores 23-31 x 10.5-13.5 µm. Frequent . . . . . (Figure 27) *V. calciseda*
2. Perithecia mostly immersed, sometimes forming pits in part of thallus; perithecia usually visible as black bumps, 0.25-0.4 mm in diameter; involucrellum usually distinct from excipulum; spores 18-26 x 9.3-11.5 µm. Infrequent . . . . . *V. muralis*

3. On wet rocks or in streams. Spores 25-30 x 10-12 µm; involucrellum thick, black, distinct from thin, brown to black excipulum; thallus thin, smooth to rimose. Rare . . . . . *V. aethiobola*

3. On dry rocks; spores less than 25 µm long . . . . . 4.

4. Thallus dispersed areolate, brown or grey-brown, thick; spores 13-21 x 6-7.5 µm; perithecium about 75% immersed in thallus, wall black only at apex (involucrellum); excipulum pale; medulla black below, colourless above. Rare . . . . . V. virens

4. Thallus continuous and rimose or rimose-areolate, not dispersed, thin or thick . . . . . 5.

5. Thallus dark brown to black, very thick, rimose-areolate; medulla black . . . . . 6.

5. Thallus greenish- to brownish-grey; medulla white (to somewhat brownish) or too thin to distinguish . . . . . 7.

6. Perithecia very small, 0.10-0.13 mm in diameter, many per areole, partly emergent; spores 16-17 x 6-7 µm. Infrequent . . . . . V. fuscella

6. Perithecia 0.16-0.24 mm in diameter, one to few per areole, entirely to only one-half immersed in thallus; spores 14-24 x 7-11 µm. Common . . . V. nigrescens

7. Spores narrow, 14-25 x 4-6 µm; perithecia small, 0.15-0.25 mm in diameter, 1/2 immersed in thallus; thallus olive to brown-grey, thin, granulose to minutely areolate. Rare . . . . . V. nigrescentoidea

7. Spores ellipsoid, 16-24 x 8-10 µm; perithecia 0.25-0.40 mm in diameter, only 1/3 immersed; thallus dirty grey. Infrequent . . . . . V. calkinsiana

FOLIOSE SPECIES

Synopsis

1. Thallus orange, yellow, or yellow-green . . . . . 2.
1. Thallus grey, grey-green, brown, or olive, without yellowish tint of any kind . . . . . 16.

2. Thallus orange or yellow-orange; upper surface KOH+ dark red-purple . . . . . 3. (p. 71)
2. Thallus yellow or yellow-green; upper surface KOH- . . . . . 5. (p. 71)

16. Thallus, when wet, appearing translucent and gelatinous; algae distributed throughout thallus . . . . . 17. (p. 74)
16. Thallus never gelatinous when wet; algae confined to a definite algal layer . . . . . 37.

37. Algal layer appearing dark blue-green when exposed (containing blue-green algae; thallus brownish green to brown when dry) . . . . . 38.
37. Algal layer appearing grass-green when exposed (containing green algae) . . . . . 54.

38. Soredia or isidia present . . . . . 39. (p. 79)
38. Soredia or isidia absent . . . . . 45. (p. 79)

54. Growing on submerged or occasionally submerged rocks in or at the edge of flowing water . . . . . Dermatocarpon weberi (p. 81)
54. Not growing on submerged or occasionally submerged rocks . . 55.

55. Thallus umbilicate. On rocks . . . . . 56. (p. 81)
55. Thallus not umbilicate . . . . . 61.

61. Thallus having very large fruiting bodies (apothecia) sunken into depressions. On mosses and soil over limestone rock; uncommon . . . . . Solorina saccata (p. 83)
61. Thallus lobes without apothecia sunken into depressions . . 62.

62. Thallus inflated and hollow throughout . . . . . 63. (p. 84)
62. Thallus solid (except at lobe tips in a few species . . . . . 64.

64. Thallus with soredia or isidia (not with flattened lobules) . . . . . 65.
64. Thallus without soredia or isidia, but some species have lobules . . . . . 99.

65. Lobes very broad, usually 8-30 mm across; thallus covered with a network of depressions and ridges . . . . . Lobaria pulmonaria (p. 84)
65. Lobes 0.5-8 mm across . . . . . 66.

66. With isidia, never with soredia . . . . . 67. (p. 84)
66. With soredia or coarse granular isidia which dissolve into soredia with age . . . . . 72.

72. Soredia mostly on lobe margins or tips . . . . . 73. (p. 86)
72. Soredia mostly in patches or on ridges on thallus surface, but occasionally on margins as well . . . . . 89. (p. 90)

99. Growing on the ground . . . . . 100. (p. 93)
99. Growing on rock, tree bark, or wood . . . . . 102.

102. Thallus brown, olive-brown, or dark green-grey, never pale mineral grey; upper surface KOH- . . . . . 103. (p. 93)
102. Thallus grey-white, mineral grey, or blue-grey; upper surface KOH+ yellow . . . . . 113. (p. 96)

General Key

(Note: Squamulose species are keyed out as "crustose"; see pages 14 and 27.)

1. Thallus orange, yellow, or yellow-green . . . . . 2.
1. Thallus grey, grey-green, brown, or olive, without yellowish tint of any kind . . . . . 16.

2. Thallus orange or yellow-orange, upper surface KOH+ dark red-purple . . . . . 3.
2. Thallus yellow or yellow-green; upper surface KOH- . . . . . 5.

3. Underside of the tips of the thallus lobes with abundant soredia, the lobes often becoming hood-like; apothecia absent. Common on roadside trees, especially elms, and sometimes on rocks . . . . . (Figure 31) Xanthoria fallax
3. Soredia entirely absent; lobes narrow, often finely divided . . . 4.

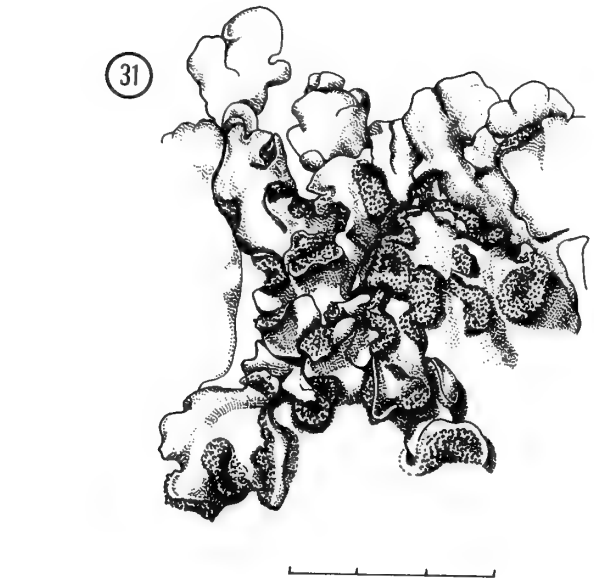
4. On trees. Thallus more or less circular, distinct; apothecia with orange disks almost always present and usually abundant; lobes stubby. Fairly common, especially on poplars and aspens . . . . . Xanthoria polycarpa
4. On rocks, usually limestone, or on rocks associated with birds (nests or roosts). Lobes narrow, often elongated; closely attached to the rock and almost crustose; apothecia rarely present in the Ottawa region . . . . . Xanthoria elegans

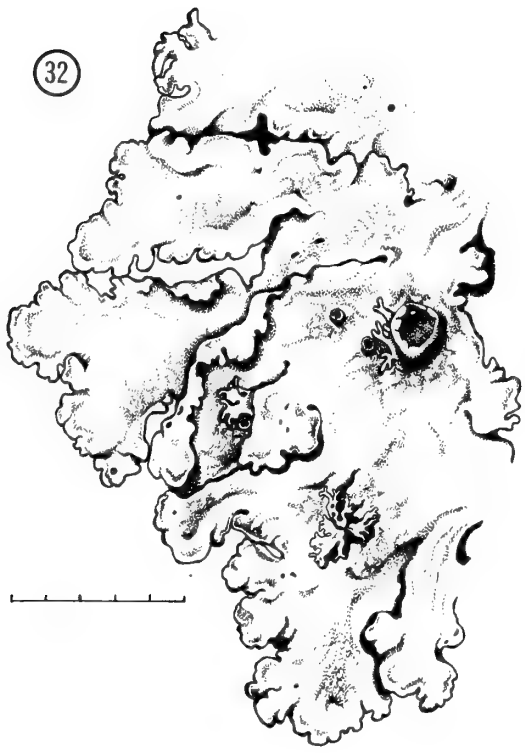
5. Thallus bright lemon- to yolk-yellow when dry . . . . . 6.
5. Thallus shades of yellow-green or greenish yellow . . . . . 8.

6. Medulla bright lemon yellow; lobes 1-3 mm broad, round; margins of lobes bordered with fine, powdery, yellow soredia. On wood, bark, or twigs of conifers and birch, rarely on rocks, often in bogs . . . . Cetraria pinastri
6. Medulla white; lobes finely divided (less than 1 mm across) . . . . . 7.

7. Lobes often with yellow granules or soredia all along margins; thallus sometimes becoming reduced to a yellow granular crust. Common on roadside trees, elm, ash, etc. . . . . Candelaria concolor
7. Lobes not sorediate or granular. Rare . . . . . Candelaria fibrosa

8. Medulla KOH+ yellow becoming red; soredia absent. On rocks . . . . . 9.
8. Medulla KOH-; soredia of some kind present. On tree bark or wood, or rarely on rock . . . . . 12.





Figures 31-32. -31. *Xanthoria fallax*; -32. *Parmelia cumberlandia*. Scale: each unit = 1 mm.

9. Thallus covered with isidia . . . . . 10.
9. Thallus with no isidia on surface . . . . . 11.

10. Undersurface of thallus jet-black except for the edges which are dark brown. Infrequent . . . . . Parmelia conspersa
10. Undersurface of thallus pale to medium brown throughout. Frequent . . . . . Parmelia plittii

11. Medulla KOH+ yellow turning blood-red, PD+ deep yellow or orange (salazinic acid); thallus loosely attached to the rock, often growing over itself; lobes usually narrow, 1-3 mm across. Common . . . . . Parmelia taractica
11. Medulla KOH+ yellow (sometimes becoming red), PD+ orange to red-orange (stictic and nonstictic acids); thallus usually closely attached to the rock, forming a single layered, circular plant; lobes often broader than 3 mm across. Common . . . . . (Figure 32) Parmelia cumberlandia

12. Lobes very narrow, 0.5-1.5 mm, divided, closely appressed to the substrate; soralia in large, hemispherical, powdery masses; medulla C-, KOH-, PD-. Fairly common on conifer bark or wood . . . . . Parmeliopsis ambigua
12. Lobes broader than 1.5 mm, not finely divided . . . . . 13.

13. Soredia in irregular, coarsely granular masses on the thallus surface, rarely on the margins; lobes very broad, up to and sometimes exceeding 6 mm across, forming circular thalli . . . 14.
13. Soredia marginal, becoming crescent-shaped, at least in part; lobes 2-4 mm across; medulla PD- . . . . . 15.

14. Lobes with conspicuous round to irregular white spots (pseudocyphellae) on the upper surface; medulla C+ red, PD-, KC+ red (lecanoric acid). Rare; on tree bark . . . . . Parmelia flaventior
14. Lobes lacking white spots on the upper surface; medulla C-, PD+ orange-red, KC+ pink (protocetraric acid). Very common, especially on tree bark but occasionally also on rocks . . . . . Parmelia caperata

(Note: A very similar, coarsely pustulate to almost isidiate species, *P. baltimorensis*, is found on rock in eastern U.S. and parts of southern Ontario. It is probably also in the Ottawa region.)

15. Thallus with few rhizinae on undersurface; margins of lobes covered with fine powdery soredia; lobes long and narrow; medulla C-. On bark (usually conifers) and old wood; common . . . . . Cetraria oakesiana

15. Rhizinae common on undersurface; some soredia on the surface of the lobes (laminal) as well as on the margins; lobes rounded, not elongated; medulla C+ bright red (lecanoric acid). Rare, on bark . . . . . Parmelia soredica

16. Thallus, when wet, appearing translucent and gelatinous, dark brownish green or blue-green; when dry, thallus is brown-grey to slate-grey or black; algae distributed throughout thallus (Figures 33, 35) . . 17.

16. Thallus never gelatinous when wet; algae confined to a definite algal layer (see Figure 65) . . . . . 37.

17. Lower surface covered with long, fine, white hair (tomentum); thallus grey, isidiate. Rare . . . Leptogium burnetiae var. hirsutum

17. Lower surface smooth, not hairy or tomentose . . . . . 18.

18. Thallus steel grey; lobes thin, (1-)2-8 mm across; cortex present on upper and lower surfaces of thallus (Figure 35) . . . . . 19.

18. Thallus shades of brown, olive, green or black (or rarely grey in *Leptogium lichenoides*); thallus with or without cortices . . . . . 22.

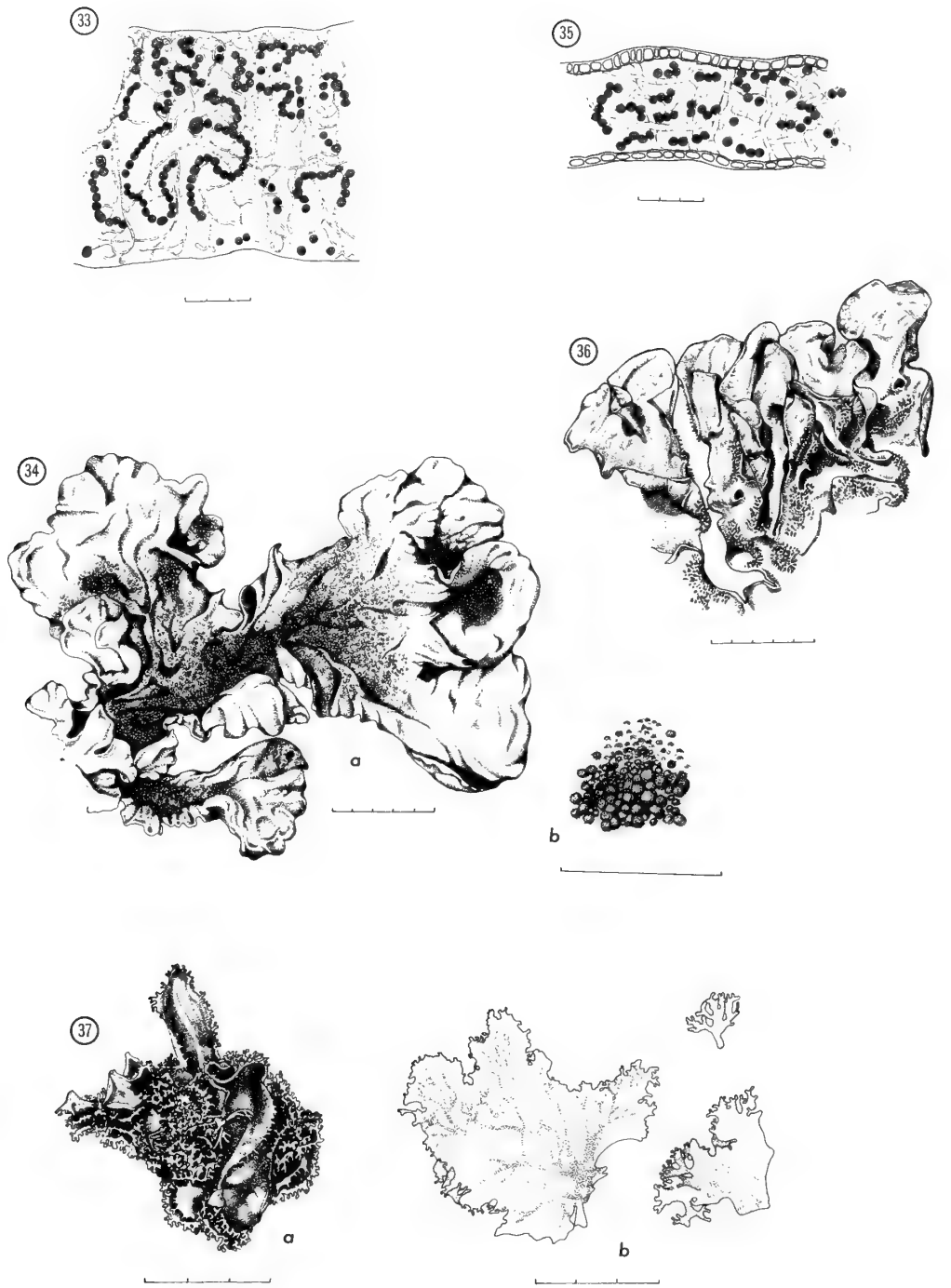
19. Thallus surface (and sometimes the margins) covered with cylindrical to flattened isidia . . . . . 20.

19. Thallus without isidia. Rare . . . . . 21.

20. Apothecia abundant, flat; lobes dark grey to olive, 1-4 mm across. Rare; on calcareous rocks . . . . Leptogium dactylinum

20. Apothecia absent or rare; lobes steel-grey, thin. Common on tree bases and mossy rocks . . . (Figure 36) Leptogium cyanescens

21. Thallus lobes 1.2-2.4 mm across, sometimes with small regeneration lobules; apothecia very common, 0.3-0.7 mm across; on tree bases, rocks, and soil . . . . Leptogium juniperinum



Figures 33-37. -33. *Collema*, vertical section of thallus; -34. *Collema subflaccidum*, (a) habit, (b) granular isidia; -35. *Leptogium*, vertical section of thallus; -36. *Leptogium cyanescens*; -37. *Leptogium lichenoides*, (a) dry thallus, (b) moistened and flattened lobes. Scale: -36, 35: each unit = 10μm; -34, 36, 37: each unit = 1 mm.

21. Thallus lobes 2-8 mm across, very thin; apothecia can be common, 0.5-2 mm across. On bark . . . . . Leptogium azureum
(Note: Like *L. cyanescens*, but without isidia.)

22. Thallus uniformly brown to red-brown (or rarely grey); lobes 1-3 mm across, more or less erect, fringed with lacy, finely divided, isidia-like projections; corticate on upper and lower surfaces (Figure 35). On limestone rock, bark, usually partially buried in moss; frequent . . . . . (Figure 37) Leptogium lichenoides

22. Thallus olive- to greenish-black, occasionally brownish in part, but if brown, then lobes are thick and not fimbriate; thallus not corticate (Figure 33) . . . . . 23.

23. Lobes erect, 7-10 mm high, thick and tongue-like, somewhat divided, with ultimate lobes 0.7-1.5 mm across, often with tiny granules or granular isidia on surface; thallus black; phycobiont is *Gloeocapsa*. Rare; growing on limestone . . . . . Thyrea pulvinata

23. Lobes more or less prostrate, not erect; at least in part greenish or olive-coloured; phycobiont is *Nostoc* . . . . . 24.

24. On bark. Lobes very broad, 5-15 mm across . . . . . 25.

24. On limy rock or soil. Foliose, with lobes usually 0.5-4 mm across; or subcrustose . . . . . 26.

25. Lobes more or less smooth, at most somewhat folded; covered with tiny granular isidia. Very common . . . . . (Figure 34) Collema subflaccidum

25. Lobes ridged, wrinkled and pustulate on upper and lower surfaces; isidia cylindrical at least in part. Infrequent. . . . . Collema furfuraceum

26. Thallus sterile, without any apothecia . . . . . 27.

26. Thallus fertile; apothecia with broad or punctiform openings . . . . . 29.

27. Thallus distinctly brownish to red-brown, with granular to spherical isidia; lobes up to 4 mm broad, very thick. Rare; on limestone . . . . . Collema sp.

27. Thallus olive to blackish . . . . . 28.

28. Thallus lobes plicate, with conspicuously thickened or swollen margins; isidia inconspicuous or absent; lobes usually prostrate, but sometimes becoming narrow and more or less ascending. Over soil and moss covering limestone; infrequent . . . . . Collema tenax

28. Thallus lobes more or less thin, not swollen or plicate, usually ascending, divided, curled up (like "corn flakes"), more rarely prostrate; covered with large, spherical isidia. Usually growing directly on limestone rock; frequent . . . . . Collema tuniforme

29. Spores entirely, or almost entirely non-septate; thallus subcrustose, usually membranous; apothecia very small (under 0.5 mm across) . . . . . 30.

29. Spores 2- or more-celled to muriform; thallus clearly lobed or foliose . . . . . 31.

30. Apothecia open by a small ostiole and resemble perithecia; spores non-septate, subspherical to ellipsoid, hyaline, thick-walled. Rare; on moss and earth . . . . . Lempholemma myriococcum

30. Apothecia open broadly, disk-like; spores ellipsoid to subfusiform, sometimes 1-septate, 22-26 x 6-8 μm, thin-walled. Rare; on earth and moss . . . . Cfr. Lempholemma sp.

31. Spores 1-septate, 8 per ascus; thallus lobes swollen along the margins, often imbricate, swollen lobules sometimes appearing like spherical granules; apothecia common, with large, red-brown disks and thick margins. Uncommon . . . . . Collema cfr. coccophorum

31. Spores 3(-4)-septate or muriform . . . . . 32.

32. Spores 3(-4)-septate when mature . . . . . 33.

32. Spores mostly muriform or submuriform when mature . . . . 34.

33. Lobes not, or only slightly swollen at the margins, with or without globular isidia or granules; lobes becoming divided, erect, abundantly fertile with small, flat apothecia often

raised on short, lateral or marginal lobes; apothecial margins thin, smooth. Infrequent . . . . . Collema polycarpon

33. Lobes distinctly swollen along the margins, not deeply divided and erect; lacking isidia or granules; apothecia infrequent, embedded in thallus or closely attached, broad, often convex. Infrequent . . . . . Collema tenax

34. Thallus lobes divided, not plicate, often with thicker lobes curled up like "corn-flakes", more or less covered with globular isidia; apothecia infrequent; spores 8 per ascus. Frequent; on limestone rock . . . . . Collema tuniforme

34. Thallus lobes appressed, clearly plicate, older portions often becoming somewhat membranous; apothecia abundant with large disks . . . . . 35.

35. Thallus membranous to disappearing and replaced with scattered swollen lobes; apothecia large, crowded, usually with thin, even margins; spores 4 per ascus, submuriform to muriform, 25-34 x 10-13 µm. Mostly on soil and moss over limestone . . . . . Collema limosum

35. Thallus lobes distinct for the most part, although sometimes becoming membranous on the old portions; spores 8 per ascus, submuriform . . . . . 36.

36. Spores 20-26 x 6.5-9.0 µm; apothecial margin smooth and even; apothecia usually dispersed and sparse. Infrequent; on soil and sometimes on rock . . . . . Collema tenax

36. Spores 25-34 x 9.0-13 µm; apothecial margins thick, crenulate to lobate; apothecia abundant, crowded. Frequent on limestone and soil over limestone . . . . Collema bachmanianum

37. Algal layer appearing dark blue-green when exposed; lobes 5 mm or more across except for *Pannaria* species which are squamulose. Mostly growing on the ground or on mossy logs, stumps, and shaded rocks . . . . . 38.

37. Algal layer appearing grass-green when exposed; lobes as narrow as 0.3 mm across, never squamulose . . . . . 54.

38. Soredia or isidia present . . . . . 39.

38. Soredia and isidia absent . . . . . 45.

39. Soredia or isidia mostly marginal . . . . . 40.
39. Soredia or isidia laminal, not marginal; lower surface white to black, felt-like (without a cortex) . . . . . 43.

40. Lower surface of thallus felt-like (without a cortex) . . 41.
40. Lower surface of thallus with a cortex, tan, smooth. Rare; in shady woods on rocks or logs, occasionally on tree bark . . . . . Nephroma parile

41. Margins with abundant, granular, blue-grey soredia; thallus subsquamulose to foliose. Very rare; on mossy tree base . . . . . Pannaria ahlneri
41. Margins with flattened, lobulate "isidia", no soredia; thallus broadly foliose. On the ground . . . . . 42.

42. Lower surface black, with few interspersed white spaces mostly at margins; upper surface shiny, or sometimes scabrous to pruinose, at least at margins. Infrequent. . . . . Peltigera elizabethae
42. Lower surface pale, with branched, raised veins; upper surface dull, tomentose close to margins. Rare . . . . . Peltigera praetextata

43. Thallus small, with lobes not more than 5-8 mm across . . . . . 44.
43. Thallus very large, lobes broad (commonly over 15 mm across), flat, covered with tiny, loosely attached, cylindrical to almost globular isidia or granules. Over soil in shaded habitats . . . . . Peltigera evansiana

44. Thallus with distinct, circular, pale grey patches of soredia; lobes deeply concave. On soil; uncommon . . . . . Peltigera spuria
44. Thallus with small, brown, scale-like isidia scattered on upper surface; soredia absent; lobes generally flat. On exposed soil; rare . . Peltigera lepidophora

45. Thallus consisting almost entirely of scale-like lobes, more or less overlapping (imbricate squamulose). Infrequent; on rocks in shaded habitats . . . . . Pannaria leucophaea

45. Thallus distinctly foliose . . . . . 46.

46. Lower surface corticate, tan or buff, with or without a tomentum; lobes 2-6 mm broad; usually fertile with large, disk-like, red-brown apothecia on *undersurface* of lobe tips . . . . . 47.
46. Lower surface without a cortex (appearing felt-like); lobes 4-15 mm broad; if fertile, then apothecia on upperside of special lobe tips . . . . . 48.

47. Undersurface smooth, without tomentum or warts; lobes 2-4 mm across, often overlapping. Infrequent . . . . . Nephroma bellum
47. Undersurface tomentose with a short, white tomentum and scattered warts; lobes 3-6 mm across. Rare . . . Nephroma resupinatum

48. Undersurface of thallus mostly brown, with scattered white patches which are sometimes restricted to the younger portions of the lobes; veins or vein-like ridges not evident . . . 49.
48. Undersurface of thallus mostly white, with distinct white or brown veins or vein-like ridges . . . . . 52.

49. Undersurface with few white patches, and these are mostly restricted to lobe margins; margins and cracks in thallus often having small lobules or squamules; apothecia round, not on stalked lobes; spores 3-septate, under 45 µm long. Infrequent . . . . . Peltigera elizabethae
49. Undersurface with conspicuous white patches between a network of flat, brown areas that coalesce at the thallus centre; thallus lacking lobules or squamules . . . . . 50.

50. Spores fusiform, 3-4-septate; apothecia dark red-brown, almost circular, flat, not erect or revolute. Rare . . . . . Peltigera horizontalis
50. Spores needle-shaped (acicular), 3-9-septate, over 45 µm long; apothecia elongate, erect, saddle-shaped . . . . . 51.

51. Lobes mostly 6-12 mm across; apothecia 2-4 mm long, black, at lobe margins or on very short lobes; lobe tips often becoming somewhat pruinose. Frequent, in shady woods . . . Peltigera neckeri

51. Lobes 10-22 mm across, apothecia 3-6 mm long, dark red-brown, usually terminating finger-like lobes; lobes never pruinose. Rare . . . . . Peltigera polydactyla s.s.

52. Thallus lobes with a tomentum over surface, particularly near lobe tips . . . . . 53.

52. Thallus with a rough or crusty surface (scabrose), not tomentose, appearing very dull; lobes generally very rounded and broad. Infrequent . . . . . Peltigera scabrosa

53. Lobe margins distinctly thickened, and curled back when dry. In dry habitats on soil; common . . (Figure 38) Peltigera rufescens

53. Lobe margins not thickened or conspicuously curled back. In moist or shaded habitats over moss, logs, or humus. Common . . . . . Peltigera canina

54. Growing on submerged or occasionally submerged rocks in or at the edge of flowing water. Thallus greenish when wet, brown when dry, consisting of small, crowded lobes; undersurface smooth or sometimes ridged. Common . . . . . (Figure 39) Dermatocarpon weberi

54. Not growing on submerged or occasionally submerged rocks . . . . . 55.

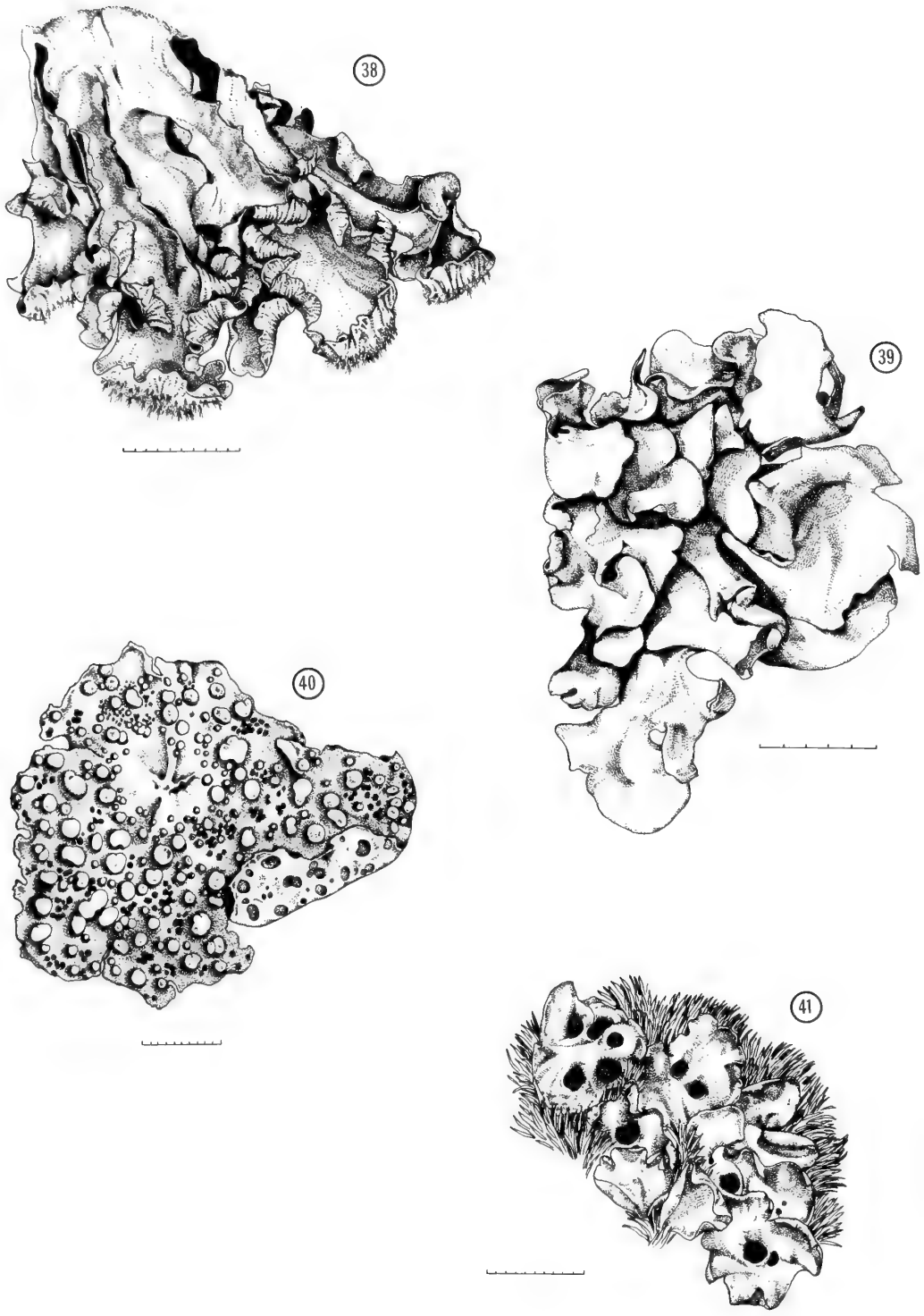
55. Thallus more or less circular, unlobed, attached to the substrate at a single, central point (umbilicate); brown to brown-grey. On rocks . . . . . 56.

55. Thallus attached to substrate over the greater portion of its lower surface, or with ascending, narrow branches forming small, almost fruticose cushions . . . . . 61.

56. Thallus distinctly pustulate with each wart on the upper surface having a corresponding depression on the lower surface; undersurface smooth (without rhizinae). Infrequent. . . . . (Figure 40) Lasallia papulosa

56. Upper thallus surface more or less smooth, not pustulate . . . . . 57.

57. Upper surface finely granular-isidiate; thallus extremely thin and brittle, almost black. Infrequent . . . . . Umbilicaria deusta



Figures 38-41. -38. *Peltigera rufescens*; -39. *Dermatocarpon weberi*; -40. *Lasallia papulosa*; -41. *Solorina saccata*. Scale: each unit = 1 mm.

57. Upper surface not granular or isidiate . . . . . 58.

58. Lower surface perfectly smooth, tan, without rhizinae or plates; thallus grey to tan; upper surface with tiny black dots revealing the presence of buried perithecia. Generally on limestone of some kind; infrequent . . . . . Dermatocarpon miniatum

58. Lower surface covered with a mat of rhizinae or plates, never smooth; black dots on the surface, if present, are due to pycnidia, not perithecia. On "hard rock", e.g., granite . . . . . 59.

59. Undersurface with overlapping, reticulate, plate-like tissues radiating from attachment point; rhizinae absent or very sparse; black fruiting bodies (apothecia) with irregular ridges and furrowed surfaces usually conspicuous. Common . . . . . Umbilicaria muehlenbergii

59. Undersurface covered, for the most part, with a thin but dense mat of black rhizinae, with plates of tissue sometimes also present; apothecia absent . . . . . 60.

60. Thallus pale grey to pale grey-brown, very thick and stiff (something like cardboard, but brittle). Infrequent. . . . . Umbilicaria vellea

60. Thallus uniform brown to dark brown, relatively thin. Common . . . . . Umbilicaria mammulata

61. Thallus lobes having large (up to 4 mm diameter) brown disks of apothecia sunken into depressions. On mosses and soil over limestone rock. Rare . . . . . (Figure 41) Solorina saccata

61. Thallus lobes without apothecia sunken into depressions . . . . 62.

62. Thallus inflated and hollow; undersurface black, without rhizinae of any kind; marginal cilia absent . . . . . 63.

62. Thallus solid. (If lobe *tips* are inflated, then the undersurface is white and long marginal cilia are present.) . . . . . 64.

63. Lobe tips bursting and revealing granular soredia in hood-shaped structures. Very common on tree bark, twigs, and wood . . . . . (Figure 42) *Hypogymnia physodes*

63. Soredia, if present, in patches on the thallus surface; thallus with holes penetrating the upper surface. Rare; on bark . . . . . *Menegazzia terebrata*

64. Thallus with granular or powdery soredia, or isidia (not lobules) . . . . . 65.

64. Thallus without soredia or isidia, but sometimes with lobules . . . . . 99.

65. Lobes very broad, usually 8-30 mm across; thallus covered with a network of depressions and ridges, with soredia and/or isidia confined to ridges; lower surface pale tan with a fuzzy tomentum, no true rhizinae. Infrequent; on trees usually in shaded, rich woods . . . . . (Figure 43) *Lobaria pulmonaria*

65. Lobes 0.5-6 mm across, or, if broader, without a network of ridges and depressions . . . . . 66.

66. With more or less cylindrical, sometimes branched isidia, never with soredia . . . . . 67.

66. With soredia or coarse granular isidia which dissolve into soredia with age . . . . . 72.

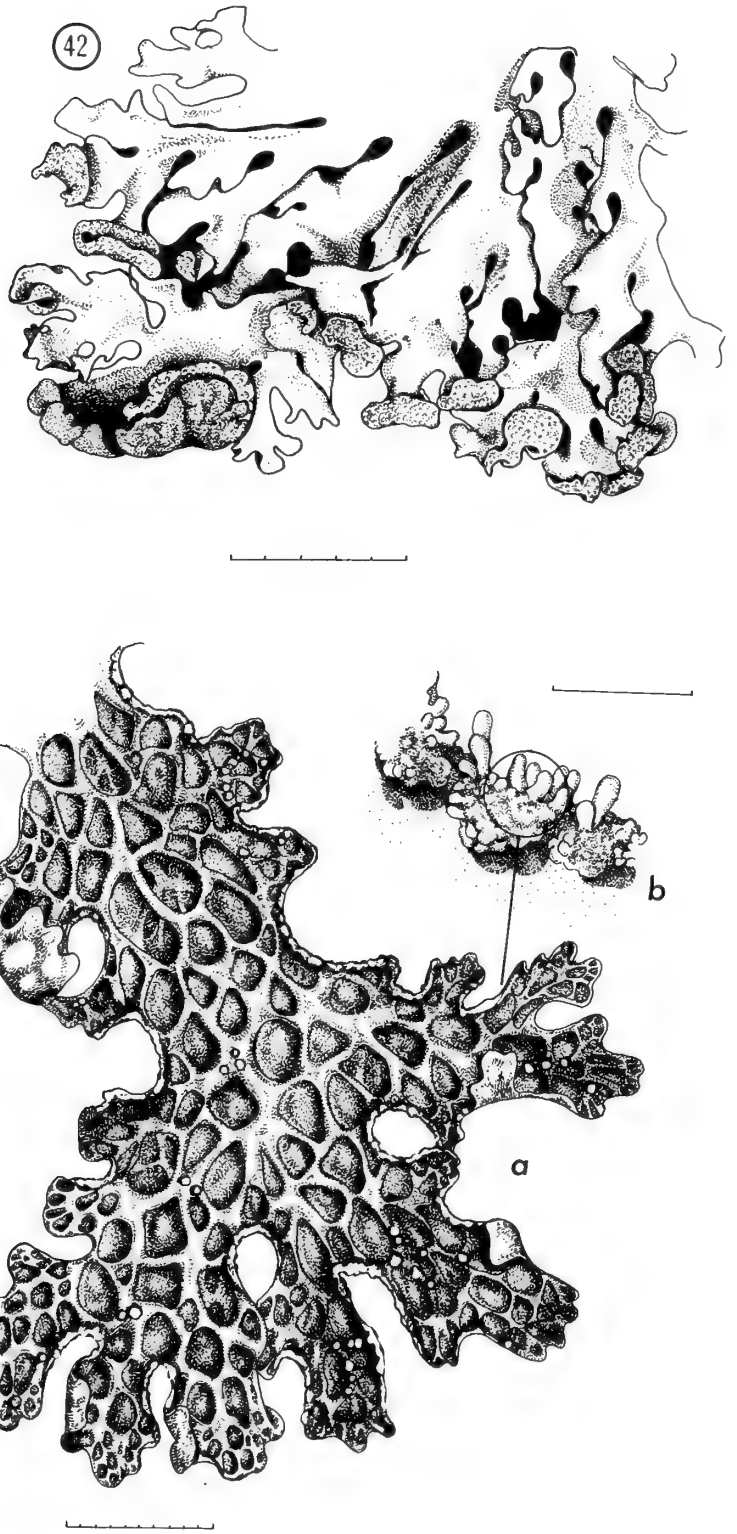
67. Thallus brown or olive-brown when dry; isidia more or less swollen, spoon- or club-shaped; medulla C-, KOH-, PD- . . . . . *Parmelia exasperatula*

67. Thallus grey or grey-green, never olive-brown . . . . . 68.

68. Upper surface of thallus lobes with scattered tiny white dots (pseudocyphellae); undersurface pale tan; medulla C+ red, KOH-, PD- (lecanoric acid). Very common; on trees or wood, sometimes on rock . . . . . *Parmelia rudecta*

68. Thallus without conspicuous white dots; medulla C-, KOH+ yellow or red, PD+ yellow or orange . . . . . 69.

69. Lobes small, not more than 1.5 mm across; undersurface pale brown, shiny; forming small circular thalli often on dry, hard, conifer wood or bark; thallus cortex and medulla KOH+



Figures 42-43. -42. *Hypogymnia physodes*; -43. *Lobaria pulmonaria*, (a) habit, (b) isidiate soralia. Scale: each unit = 1 mm.

bright yellow, PD+ orange (thamnolic acid). Infrequent
. . . . . *Parmeliopsis aleurites*

69. Lobes generally more than 2 mm across; undersurface black in center (brown at edges) . . . . . 70.

70. Lobes broad and round, 6-15 mm across, often with black, hair-like cilia extending out from margins; undersurface with a naked zone (i.e., a zone without rhizinae) at margins; medulla KOH+ yellow (not changing to red), PD+ yellow (stictic acid). Rare; on bark . . *Parmelia crinita*

70. Lobes narrow and "squared", with a net-like system of ridges over the surface; rhizinae extend out to the margins; medulla KOH+ yellow changing to blood red, PD+ yellow (salazinic acid) . . . . . 71.

71. Rhizinae squarrose (Figure 65). Very common, especially on tree bark . . . . . *Parmelia squarrosa*

71. Rhizinae simple (unbranched) or dichotomously branched. Rare; usually on rock . . . . . *Parmelia saxatilis*

72. Soredia mostly on lobe margins or tips . . . . . 73.

72. Soredia mostly in patches or on ridges on thallus surface, but occasionally on the margins as well . . . . . 89.

73. Medulla mustard-yellow or bright orange . . . . . 74.

73. Medulla white or very pale yellow . . . . . 75.

74. Thallus "frosted" white with white powdery pruina, sometimes only at the lobe tips; medulla mustard-yellow; lobes 1-2 mm broad; soredia entirely marginal. Infrequent; on tree bark in mature deciduous woods . . . . . *Pyxine sorediata*

74. Thallus without pruina; medulla mostly bright orange (but some lobes can have a white medulla); lobes less than 1 mm broad; soredia marginal and laminal. Common on tree bark of all kinds
. . . . . (Figure 44) *Phaeophyscia rubropulchra*

75. Thallus pruinose, although sometimes only at lobe tips; soredia entirely marginal; undersurface black; rhizinae squarrose; medulla and cortex KOH- . . . . . 76.

75. Thallus entirely without pruina; medulla KOH+ or KOH- . . . . . 77.

76. Medulla white, KOH-. Common; especially on roadside elms and poplars, rarely on rocks . . . . . Physconia detersa

76. Medulla and soredia pale yellowish, KOH+ yellow (sometimes faint). Infrequent; on roadside trees . . . . . Physconia cfr. enteroxantha

(Note: Doubtfully distinguished from *Ph. detersa*.)

77. Lobes broad, over 3 mm across, rounded; medulla C+ red or pink; white dots (pseudocyphellae) on thallus surface . . . . . 78.

77. Lobes narrower than 3 mm across, not rounded; medulla C- . . . 79.

78. Soredia entirely restricted to thallus margins; undersurface with a broad naked zone at margins. Frequent; over mossy, partially shaded rocks, especially cliffs . . . . . Cetrelia olivetorum

78. Soredia on thallus surface (laminal) as well as on the margins; rhizinae on the lower surface extend nearly to the lobe margins. Rare; on tree bark . . . . Parmelia borreri

79. Thallus mineral grey or grey-green; upper cortex KOH+ yellow (atranorin) . . . . . 80.

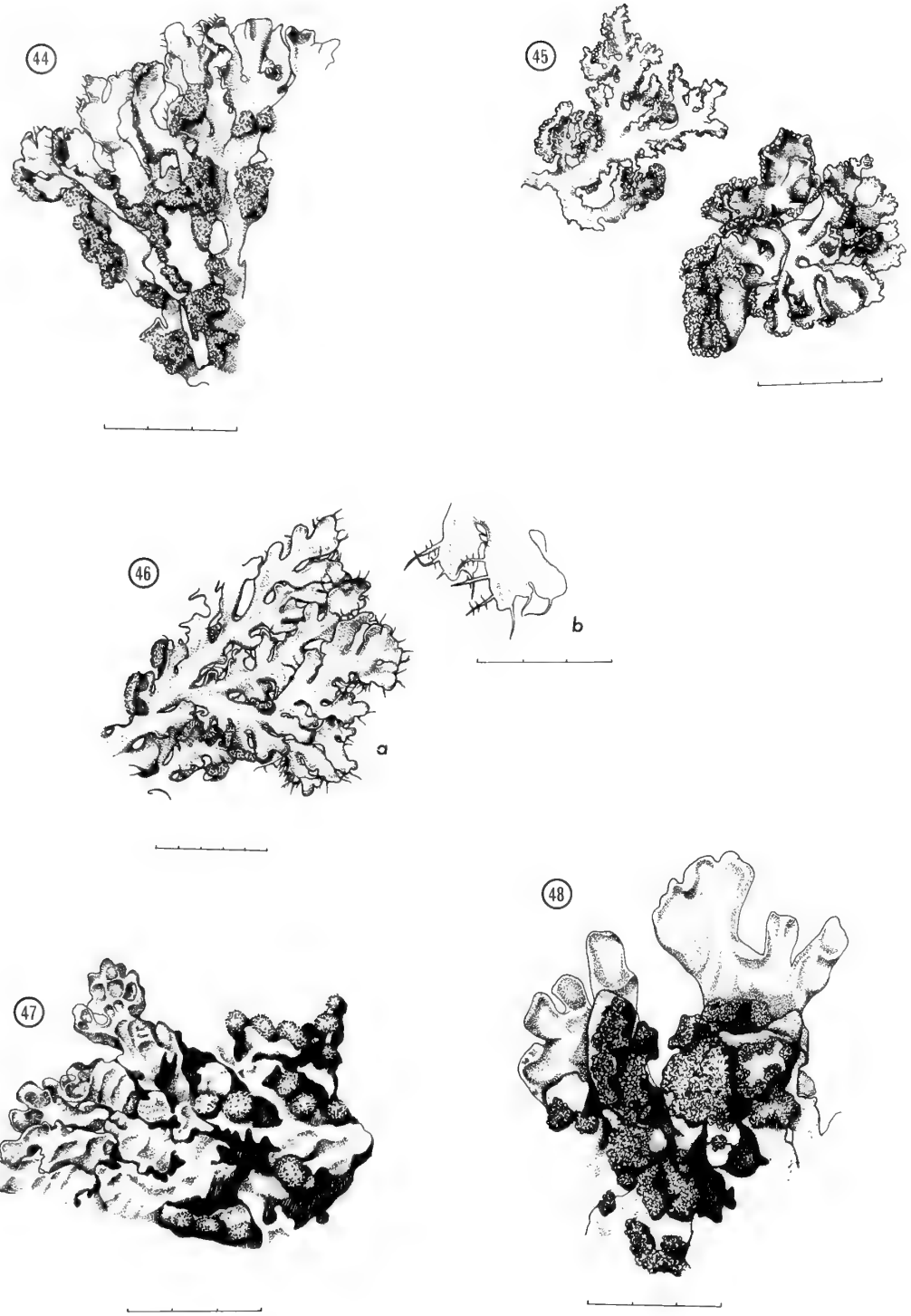
79. Thallus olive-brown, grey-brown, or dark grey-green (mineral grey only in *Physcia chloantha*); upper cortex KOH- . . . . . 83.

80. Tips of lobes forming distinct hood- or helmet-shaped structures filled with granular soredia; cilia usually conspicuous at tips of lobes. Common, especially on roadside trees, as well as on limestone rocks . . . . . Physcia adscendens

80. Tips of lobes more or less flat, not hood- or helmet-shaped . . . . . 81.

81. Soredia coarse, grading into granules, mostly confined to the edges of the lobes; lobes finally divided. Very common; on tree bark, especially that of elm, poplar and ash and occasionally on rock . . . . . (Figure 45) Physcia millegrana

81. Soredia fine and powdery, formed almost entirely on the undersurface of the slightly broadened tips of the lobes (labriform); lobes not finely divided . . . . . 82.



Figures 44-48. -44. *Phaeophyscia rubropulchra*; -45. *Physcia millegrana*, two morphotypes; -46. *Heterodermia speciosa*, (a) habit, (b) marginal cilia; -47. *Parmelia sorediosa*; -48. *Parmelia disjuncta*. Scale: each unit = 1 mm.

(Note: *Parmeliopsis hyperopta*, often with soredia on the *upper* surface of lobe tips, may key out here. See couplet 97.)

82. White or tan branched rhizinae or rhizine-like cilia often extending beyond the lobe margins. Infrequent; on tree bark . . . . . (Figure 46) Heterodermia speciosa

82. Marginal, branched, rhizine-like cilia absent. Infrequent; usually on rocks, but occasionally on roadside trees . . . . . Physcia dubia

83. Undersurface white; soralia mostly labriform and farinose, some marginal; lobes 0.4-0.7 mm across. Infrequent; mostly on bark, rarely on rock . . . . . Physcia chloantha

83. Undersurface black; soralia marginal or terminal, not labriform . . . . . 84.

84. Lobes rather broad, concave at tips, commonly 0.8-3 mm across; soralia round, capitate, marginal to submarginal and laminal; rhizinae long and projecting beyond lobe margins. Rare; usually on bark . . . . . Phaeophyscia hispidula

84. Lobes narrow, less than 1.5 mm across; soralia not submarginal or laminal; rhizinae long or short . . . . . 85.

85. Young lobes and apothecial margins often bearing tiny colourless (i.e., translucent) hairs; soredia coarsely granular, strictly marginal. Infrequent; usually on rock, rarely on bark . . . . . Phaeophyscia cernohorskyi

85. Lobes and apothecial margins without colourless hairs . . . . 86.

86. On rock (sometimes mossy rock) . . . . . 87.

86. On bark or wood. Soralia in dark olive or yellow-black, almost spherical, farinose patches more or less elevated on short lobe tips; lobe margins and apothecia often ciliate or with fringes of rhizinae. Frequent . . . . . Phaeophyscia pusilloides

87. Thallus dark brown to olive-brown; soralia round to subspherical, often raised on short, lateral or terminal lobes; soredia greenish, fine powdery. Infrequent; on granite or other hard rocks in sunny habitats . . . . . (Figure 47) Parmelia sorediosa

87. Thallus greyish brown to olive; soredia never raised or in subspherical patches; soredia very coarse to isidioid . . . . . 84.

88. Thallus lobes 0.15-0.5 mm across, flat or convex; dark isidioid-soredia abundant, often in terminal or marginal clumps. Rare; normally, found only on rocks . . . . . Phaeophyscia sciastra

88. Thallus lobes 0.6-1.5 mm across, concave at tips (as in *Phaeophyscia hispidula*), rather shiny and smooth. Frequent . . . . . Phaeophyscia adiastola

89. Thallus subcrustose, extremely tightly appressed to substrate; rhizinae almost absent; lobes very small, less than 0.4 mm across, brownish grey; cortex KOH-. Rare; on tree bark . . . . . Physciopsis adglutinata

89. Thallus foliose, loosely attached (easily freed from substrate); lobes over 0.5 mm across . . . . . 90.

90. Thallus brown to olive-brown when dry . . . . . 91.

90. Thallus mineral grey or occasionally brownish at margins . 93.

91. Thallus lobes flat, thin; soredia in very irregular patches, developing from isidia-like granules; medulla C+ red (lecanoric acid). Common; on tree bark . . . Parmelia subaurifera

91. Thallus lobes narrow, sometimes convex, usually thick; soredia limited to distinct rounded heaps; medulla C- or C+ yellowish. On rocks . . . . . 92.

92. Soredia actually on short, ascending lobe tips and therefore appearing to be slightly raised, fine and powdery. Infrequent . . . . . (Figure 47) Parmelia sorediosa

92. Soredia not raised, clearly laminal, arising from coarsely granular, black, isidia-like granules. Rare . . . . . (Figure 48) Parmelia disjuncta

93. Lobes broad, over 4 mm across; medulla C+ red; soredia also on margins (see couplet 78) . . . . . Parmelia borreri

93. Lobes narrower than 4 mm across; medulla C- . . . . . 94.

94. Soredia along net-like ridges over thallus surface; medulla white, KOH+ yellow becoming red. Extremely common on trees of all kinds, wood, and occasionally rocks . . . . . (Figure 49) Parmelia sulcata

94. Soredia in circular or irregular patches . . . . . 95.

95. On tree bark or wood . . . . . 96.

95. On rock . . . . . 98.

96. Lobes under 2 mm broad; medulla white; small circular patches of soredia over the thallus surface; thallus very closely attached to the substrate . . . . . 97.

96. Lobes more than 2 mm broad; thallus grey, without white spots; soredia in irregular patches; medulla pale yellow, especially close to the algal layer. Common; on tree bark . . . . . Parmelia aurulenta

97. Undersurface light to dark brown, shiny; soredia fine (farinose), white to greenish black, developing from eroded patches, often close to the lobe tips; spores colourless, non-septate. Rare; on conifer twigs and dead wood . . . . . Parmeliopsis hyperopta

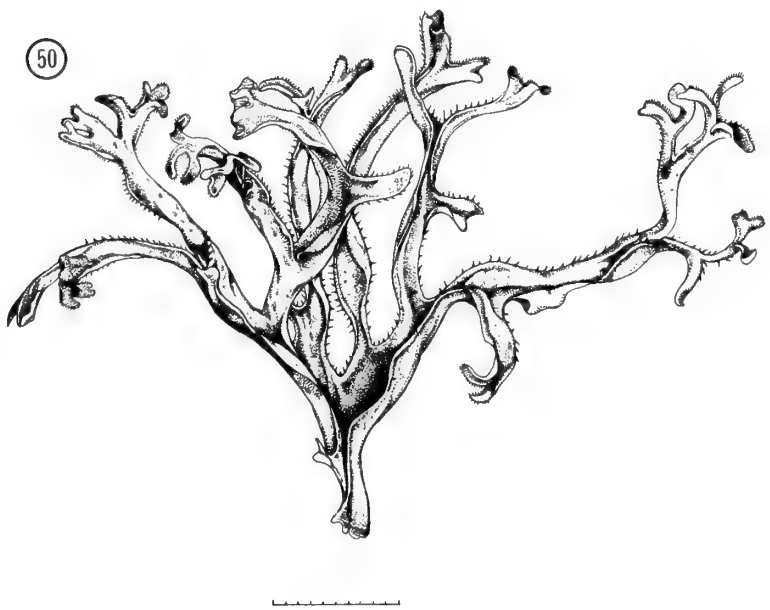
97. Undersurface white to pale creamy buff, dull; soredia coarsely granular, white to bluish grey, erupting in circular patches through upper cortex, sometimes becoming confluent, never near the lobe tips; spores brown, 1-septate. Rare; bark of deciduous trees . . . . . Physcia tribacoides

98. Medulla KOH+ yellow; thallus blue-white or grey, white-spotted, with distinct, hemispherical, white patches of soredia. Infrequent; usually on limestone or associated with bird perches . . . . . Physcia caesia

98. Medulla KOH-; thallus mineral grey; lobes less than 0.5 mm across. Rare; usually on HC1- rock . . . . . morphotype of Physcia dubia

99. Growing on the ground . . . . . 100.

99. Growing on rock, tree bark, or wood . . . . . 102.



Figures 49-50. -49. *Parmelia sulcata*; -50. *Cetraria arenaria*.
Scale: each unit = 1 mm.

100. Lobes over 20 mm broad; upper surface with scattered, small, flat, brown cephalodia; undersurface felt-like, without a cortex. Usually in moist, mossy habitats . . . 101.
100. Lobes narrow (less than 5 mm broad), ascending, dichotomously branched, forming subfruticose cushions; brown to olive brown. Infrequent; on dry, thin, rocky soil . . . . . (Figure 50) Cetraria arenaria

101. Lower surface more or less uniform brown-black with veins indistinct or absent; lower surface of apothecia entirely corticate. Frequent . . . . . Peltigera aphthosa
101. Lower surface with distinct, brown to black veins; lower surface of apothecia with scattered, corticate areoles. Rare . . . . . Peltigera leucophlebia

102. Thallus brown, olive-brown, or dark green-grey, rarely pale mineral-grey; upper surface KOH- . . . . . 103.
102. Thallus grey-white, mineral-grey, or blue-grey; upper surface KOH+ yellow . . . . . 113.

103. Margins of lobes giving rise to numerous small, flattened lobules (which are sometimes somewhat cylindrical, appearing like isidia) . . . . . 104.
103. Thallus lobes without lobules of any kind . . . . . 106.

104. Thallus strongly pruinose throughout, especially on lobules; undersurface entirely white or very pale buff, not blackening; apothecia common, with apothecial margins becoming expanded in the form of radiating lobules. Infrequent; on tree bark or, rarely, mossy rocks . . . . . Physconia pulverulacea
104. Thallus without pruina, or somewhat scabrose, or with spots of scattered pruina at lobe tips; undersurface white at margins but always blackening toward the center of the thallus; apothecial margins, if lobulate, then not radiating . . . . . 105.

105. Thallus lobes long, more or less linear, with elongate, sometimes almost cylindrical lobules (see Figure 65) along margin and on thallus surface; thallus usually brownish

or dark olive; rhizinae squarrose on well-developed specimens. Infrequent; on trees or, sometimes, mossy rocks . . . . . *Anaptychia palmulata*

105. Thallus lobes rounded, irregular, somewhat imbricate, with rounded or irregular, marginal, imbricate lobules; thallus usually grey or greenish grey, but can be slightly brownish; rhizinae never squarrose. Infrequent; on mossy rocks, or very rarely, on tree bases . . . . . *Phaeophyscia imbricata*

106. Apothecia or pycnidia present, along or close to the margins of the thallus lobes (see Figure 51); rhizinae sparse. Usually on conifer, alder, or birch twigs and bark . . . . . 107.

106. Apothecia or pycnidia present or absent, not marginal; rhizinae abundant. On various substrates . . . . . 109.

107. Thallus large, 2-4 cm across; apothecia produced on the undersurface of the lobe tips which then turn upwards making it appear as if the apothecia are on the upper surface . . . . 108.

107. Thallus very small, under 2 cm across; apothecia originating on the upper surface of the lobes. (Look for young apothecia.) Infrequent . . . . . *Cetraria sepincola*

108. Medulla C-, KC+ pink, with a bright white ultraviolet light fluorescence. Frequent . . . . (Figure 51) *Cetraria halei*

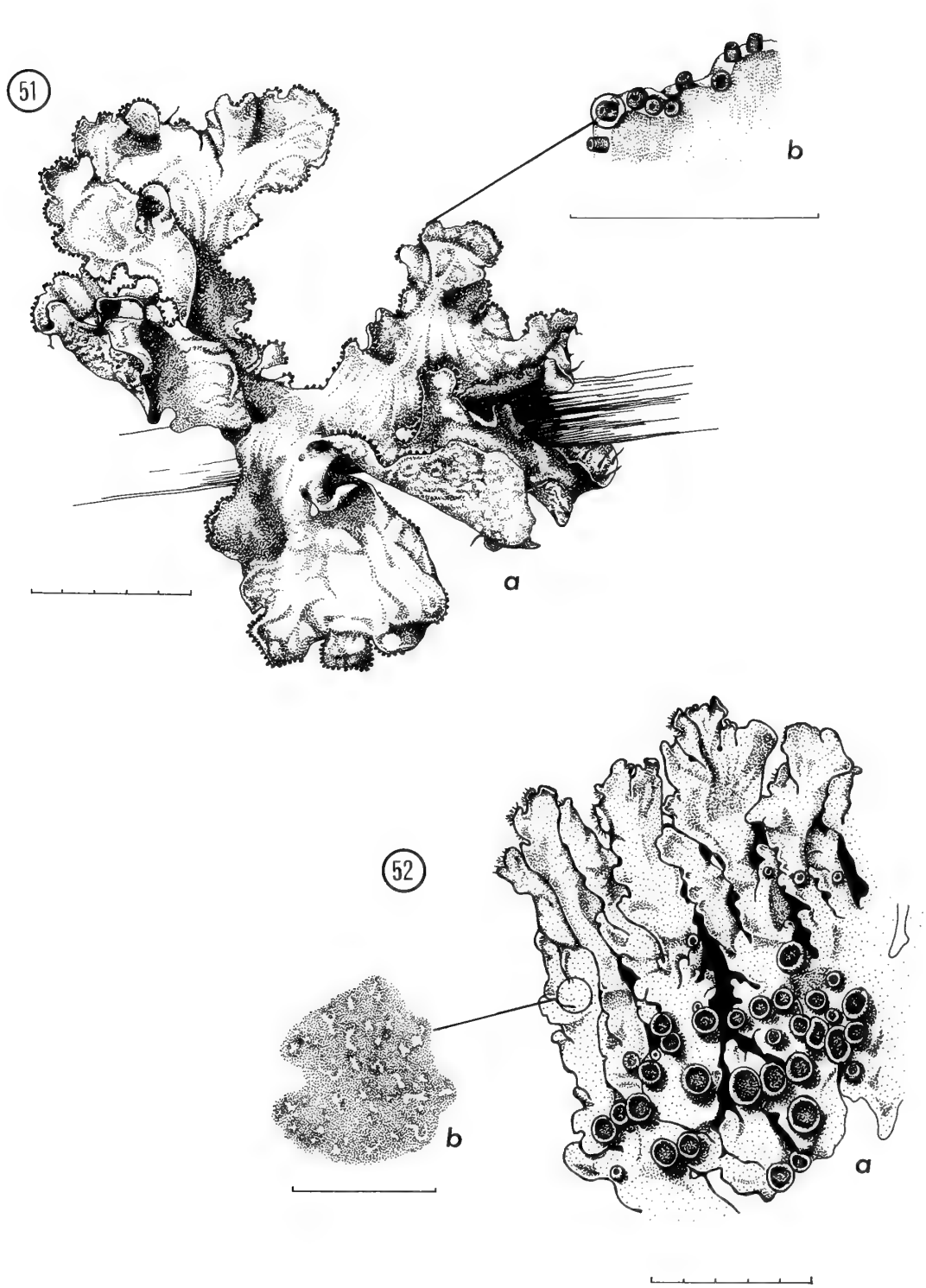
108. Medulla C+ pink, KC+ red, UV-. Rare . . . . . *Cetraria ciliaris*

109. Thallus lobes 2-5 mm across, loosely attached; undersurface brown, shiny; colour when dry usually brownish olive, more or less shiny; medulla PD+ red. On bark . . . . . 110.

109. Thallus lobes 0.5-2 mm across; undersurface black, dull; thallus dark brown to grey-brown, dull; closely appressed to substrate; medulla PD- . . . . . 111.

110. Thallus smooth, pseudocyphellae absent or very sparse; apothecia flat when mature, with a thin, smooth, disappearing margin. Infrequent . . . *Parmelia septentrionalis*

110. Thallus rough, wrinkled; pseudocyphellae usually conspicuous, especially on apothecial margins; apothecia cup-like, with a persistent, often crenulate margin. Infrequent . . . . . *Parmelia olivacea*



Figures 51-52. -51. *Cetraria halei*, (a) habit, (b) pycnidia; -52. *Physcia aipolia*, (a) habit, (b) white spots (maculae) on surface. Scale: each unit = 1 mm.

111. Growing on rock. Lobes slender, less than 0.6 mm across, usually dark brown; not verrucose; usually sterile. Rare . . . . . *Phaeophyscia decolor*

111. Growing on bark or wood (very rarely on rock). Lobes broader, 0.4-1.5 mm across; thallus dark grey-green to brownish grey, often verrucose; usually fertile, with rhizinae growing from base of apothecial margin . . . . . 112.

112. Fine, colourless, erect hairs growing from at least some lobe tips and apothecial margins. Frequent . . . . . *Phaeophyscia hirtella*

112. Hairs absent . . . . . *Phaeophyscia ciliata*

113. Lower surface "fuzzy" (tomentose) with or without sparse rhizinae, pale tan; medulla C+ pink (gyrophoric acid), especially under the algal layer; thallus very large, often 12-15 cm in diameter; lobes commonly over 10 mm across; large, brown apothecia usually abundant; pseudocyphellae and lobules absent. Infrequent; in rich forests or near bogs, on tree bark . . . . . *Lobaria quercizans*

113. Lower surface either with rhizinae or entirely naked, not tomentose; medulla C- . . . . . 114.

114. Thallus bulky, deeply pitted, ridged, and wrinkled; lower surface almost entirely without rhizinae, shiny white, brown, and black mottled. Infrequent; on conifer wood or bark . . . . . *Platismatia tuckermanii*

114. Thallus more or less flat, not ridged or wrinkled; lower surface with a uniform colour (i.e., not mottled) . . . . 115.

115. Undersurface black at center, dark brown at edges; medulla usually pale yellow, at least close to algal layer, KOH+ dark yellow to orange. Common; on tree bark . . . . . *Parmelia galbina*

115. Undersurface pale tan to white throughout . . . . . 116.

116. Pseudocyphellae usually conspicuous on the surface of young lobes; black dots (the tips of pycnidia which are buried in the thallus) are commonly seen on the thallus surface; undersurface brown, shiny, entirely corticate; main lobes broad, 2-5 mm across, but tiny

lobules are common over the entire thallus; large, chestnut-brown, shiny, deeply concave apothecia common; medulla KOH-. Rare; on tree bark . . . . . *Parmelia bolliana*

116. Pseudocyphellae and pycnidia absent; undersurface at least partly white and lacking a cortex; lobes mostly narrow, 1-3 mm across, slightly flaring at tips . . . . . 117.

117. Lobules frequent on lobe margins and apothecial margins; apothecia frequent, deeply concave, not pruinose; medulla KOH+ light yellow. Rare . . . . . *Heterodermia hypoleuca*

117. Lobules absent; apothecia 1-2 mm in diameter, flat to slightly concave, dark brown to almost black, often frosted with pruina . . . . . 118.

118. Medulla KOH-; upper surface more or less uniform grey, without spots. Frequent; on roadside trees, especially elms . . . . . *Physcia stellaris*

118. Medulla KOH+ yellow; upper surface conspicuously white-spotted (see Figure 52b) . . . . . 119.

119. Very common; on tree bark, especially elms and poplars. Thallus white to grey-white . . . . . (Figure 52) *Physcia aipolia*

119. Infrequent; on rocks. Thallus blue-grey to violet-grey . . . . . *Physcia phaea*

FRUTICOSE SPECIES

Synopsis

1. Stalks or branches clearly hollow . . . . . 2.
1. Stalks or branches solid, but the medulla is sometimes loose and cottony . . . . . 49.

2. Podetia highly branched, forming shrub-like cushions or clumps . . . . . 3. (p. 99)
2. Podetia not at all, or at most once or twice branched, never "shrubby" in appearance . . . . . 8.

8. Podetia ending in bright red fruiting bodies (apothecia) . . . . . 9. (p. 101)
8. Podetia either with brown apothecia or lacking apothecia altogether . . . . . 14.

14. Podetia with more or less distinct cups, or flat, saucer-like tiers . . . . . 15. (p. 102)
14. Podetia without cups of any kind, either ending in points or fruiting bodies . . . . . 33.

33. Podetia without soredia or granules . . . . . 34. (p. 105)
33. Podetia more or less covered with soredia or granules . 40. (p. 106)

49. Branches or stalks growing vertically upward, often from a granular or powdery crust . . . . . 50. (p. 107)
49. Branches or stalks growing outward from a vertical surface, or hanging downward, never originating from a basal crust of any kind . . . . . 53.

53. Branches almost perfectly circular in cross-section; more or less filamentous . . . . . 54. (p. 108)
53. Branches distinctly flattened or very irregular in cross-section, at least at the base . . . . . 58. (p. 110)

General Key

1. Stalks or branches clearly hollow . . . . . 2.
1. Stalks or branches solid, but the medulla is sometimes loose and cottony . . . . . 49.

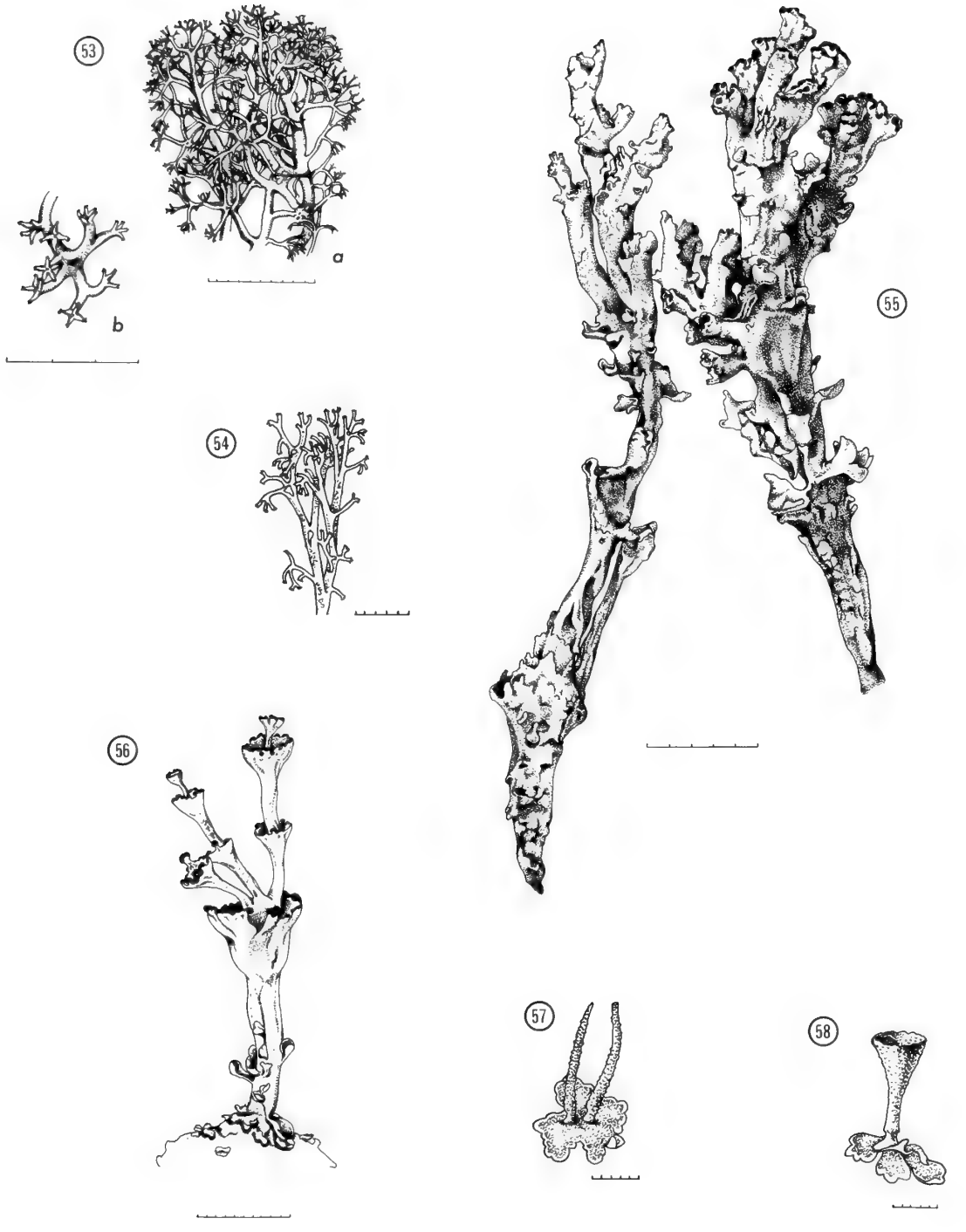
2. Stalks (podetia) highly branched, forming shrub-like cushions or clumps (see Figures 53, 54) . . . . . 3.
2. Podetia not at all, or at most once or twice branched, never "shrubby" in appearance (see Figures 55-58) . . . . 8.

3. Podetia having few to many squamules, particularly close to the base; PD+ red . . . . . 4.
3. Podetia having no squamules at all . . . . . 5.

4. Podetia usually abundantly branched; entirely without soredia. Infrequent; usually on shaded ground (where it is dark grey-green), but occasionally exposed (where it is brownish green) . . . . . Cladonia furcata
4. Podetia sparsely branched, especially in upper half; tips of branches with coarse, granular soredia. Infrequent; on ground and logs . . . . . Cladonia scabriuscula

5. Thallus is silver- or blue-grey, with the extreme tips of the branches usually browned and drooping more or less in one direction; surface KOH+ yellow, PD+ red. Common; in exposed habitats on thin soil, over rocks, and among mosses . . . . . Cladina rangiferina (true reindeer lichen)
5. Thallus is distinctly yellowish green or green-grey (never silvery grey); surface KOH-, PD- . . . . . 6.

6. Thallus growing into tightly branched, rounded tufts 2.5-5.0 cm across, with the tip of each branch ending in a star-shaped whorl of 4 or 5 tiny branches around a central hole. Infrequent; in exposed situations on the ground . . . . . (Figure 53) Cladina stellaris
6. Thallus not growing into rounded tufts or having whorled branch tips . . . . . 7.



Figures 53-58. -53. *Cladina stellaris*, (a) habit, (b) close view of branch tip; -54. *Cladina mitis*; -55. *Cladonia phyllophora*; -56. *Cladonia cervicornis* subsp. *verticillata*; -57. *Cladonia coniocraea*; -58. *Cladonia chlorophaea s.l.* Scale: each unit = 1 mm.

7. Surface of podetia smooth and shiny, very yellowish; tips divergent and erect, sharply pointed. Common; on exposed soil or over rock . . . . . Cladonia uncialis

7. Surface of podetia uniformly dull, usually greenish or slightly yellowish; tips divergent but often drooping. Common; over ground or in moss mats, usually exposed . . . . . (Figure 54) Cladina mitis

8. Podetia ending in bright red fruiting bodies (apothecia) . . 9.

8. Podetia either with brown apothecia, or lacking apothecia altogether . . . . . 14.

9. Podetia covered with soredia . . . . . 10.

9. Podetia not covered with soredia of any kind. Very variable: the podetia can be unbranched or slightly branched, covered with squamules or without squamules, yellowish or perfectly grey. Very common; on soil, logs, tree bases, etc. . . . . (Figure 66) Cladonia cristatella (British soldiers)

10. Podetia ending in distinct cups, with the red apothecia located at the cup margins; KOH- . . . . . 11.

10. Podetia without cups, ending in blunt or sharp points . . 13.

11. Podetia KOH+ bright yellow, PD+ orange. Uncommon; on soil or wood (see couplet 15) . . . . . Cladonia digitata

11. Podetia KOH-, PD- . . . . . 12.

12. Cups often elongate, somewhat split longitudinally; soredia powdery, very fine. Infrequent; on ground and logs . . . . . Cladonia deformis

12. Cups goblet-shaped, not split; soredia coarse, mealy. Frequent; on soil . . . . . Cladonia pleurota

13. Podetia KOH+ deep yellow, PD+ orange; usually stout and robust. Infrequent; on soil, logs, and rock . . Cladonia macilenta

13. Podetia KOH-, PD-; usually slender. Common; on ground, logs, and tree bases . . . . . Cladonia bacillaris (pin lichen)

14. Podetia with more or less distinct cups, or flat, saucer-like tiers . . . . . 15.

14. Podetia without cups or tiers of any kind; either ending in points or fruiting bodies . . . . . 33.

15. Podetia KOH+ bright yellow; covered with fine, powdery soredia; cup margins often inrolled and sometimes split. Infrequent; on logs or soil . . . . . *Cladonia digitata*
15. Podetia KOH- or ± dingy brown; sorediate or not sorediate . . . 16.

16. Podetia distinctly yellowish (usually pale yellowish green); sorediate; PD- . . . . . 17.
16. Podetia without a yellowish tint; PD- or PD+ red . . . . . 18.

17. Soredia coarse, granular, or mealy; cups goblet-shaped, not split. Frequent; on soil . . . . . *Cladonia pleurota*
17. Soredia fine, powdery; cups often elongate, somewhat split longitudinally. Infrequent; on logs and soil . . . *Cladonia deformis*

18. Cups perforate or opening into podetia through a gaping hole . . . . . 19.
18. Cups entirely closed, not perforate . . . . . 24.

19. Podetia covered with powdery soredia, without squamules; very pale, almost white, with margins of cups somewhat inrolled; KOH-, PD-. Frequent; on ground and logs . . . . . *Cladonia cenotea*
19. Podetia not sorediate at all . . . . . 20.

20. Thallus PD-, brightly fluorescent in long wave ultraviolet light (UV+) . . . . . 21.
20. Thallus PD+ red, UV-; podetia without squamules, or having squamules which are often lobed, but are not finely divided . . . . . 22.

21. Podetial surface (cortex) discontinuous, patchy, forming abundant, small, finely divided squamules less than 2 mm long which almost cover the podetia; cups single, often stunted (occasionally broad and proliferating). Frequent; usually in partially shaded habitats, on logs or on mossy soil . . . . . *Cladonia squamosa*
21. Cortex continuous, smooth, rarely covered with squamules; cups usually proliferating at the margins to give rise to

successive tiers of cups. Infrequent; on the ground, usually in the open . . . . . Cladonia crispata

22. Basal squamules very large and ascending, often more than 6 mm long; podetia dark green, with very irregular cups which are often longitudinally split. Infrequent; on soil . . . . . Cladonia turgida
22. Basal squamules small, rarely more than 3 mm long . . . . 23.

23. Podetia usually with easily distinguished cups which are perforated; cortex of older portions of the podetia is smooth and uniformly darkened. Frequent; on soil . . . . . Cladonia multiformis
23. Podetia with irregular cups, often with squamules at the margins, with irregular perforations and lacerations; cortex of old portions of the podetia becomes broken up into small white patches showing up on a black background. Common; on soil . . . . . (Figure 55) Cladonia phyllophora

24. Podetia sorediate . . . . . 25.
24. Podetia not sorediate; PD+ red . . . . . 29.

25. Cups very narrow or abruptly expanding at the tip of a slender podetium, shallow, sometimes disappearing altogether and leaving a pointed podetium . . . . . 26.
25. Cups narrow or broad, more or less deep, usually gradually expanding from podetium; podetia never pointed . . . . . 27.

26. Soredia very fine, abundant; podetia stocky, rarely slender, originating from the centers of large, usually unlobed basal squamules; cup margins not proliferating; PD+ red. Very common; on wood, tree bases, and sometimes soil . . . (Figure 57) Cladonia coniocraea (powder horn lichen)
26. Soredia granular, dispersed; podetia very slender, with lobed or finely divided basal squamules; cups often developing marginal proliferations and giving a "star-like" appearance; PD+ red or PD-. Common; especially on exposed soil . . . . . Cladonia rei

27. Soredia fine, powdery; PD+ red . . . . . 28.

27. Soredia coarse, granular, covering podetia; cups broad, deep; PD- or PD+ red. Very common; on soil, logs, and tree bases . . . . . (Figure 58) Cladonia chlorophaea (mealy pyxie-cup lichen)

(Note: Four "micro-species", distinguished mainly on the basis of thallus chemistry, will key out here: *Cladonia merochlorophaea* containing merochlorophaeic acid, *C. grayi* containing grayanic acid, *C. cryptochlorophaea* containing cryptochlorophaeic acid and *C. chlorophaea* s.s. containing none of these substances. Except for occasional specimens of *C. grayi*, all these species contain fumarprotocetraric acid and are PD+ red. *C. chlorophaea* in the strict sense is most common.)

28. Podetia entirely covered with soredia; cups narrow, "trumpet-shaped". Common; on soil, logs, and tree bases . . . . . Cladonia fimbriata

28. Podetia only sorediate on upper 1/3; cups broad, deep. Frequent; on soil and logs . . . . . Cladonia conista

29. Cups very irregular, distorted; podetia often split; commonly covered with squamules (see couplet 23). Common; on soil . . . . . (Figure 55) Cladonia phyllophora

29. Cups distinct, regular . . . . . 30.

30. Cups deep, containing small, scale-like areoles; podetia with the cortex largely fallen away (decorticate) leaving scattered green areas on a blackened surface; basal squamules thick, unlobed, convex . . . . . 31.

30. Cups very shallow to flat, usually proliferating from the cup margins or from the center of the cup; podetial cortex largely intact and smooth . . . . . 32.

31. Thallus dark grey-green to brownish green; KOH-; cup margins rarely squamulose. Common; on bare soil or over rock . . . . . Cladonia pyxidata (true pyxie-cup lichen)

31. Thallus mineral grey to brownish grey, KOH+ yellow (atranorin); cup margins often squamulose. Infrequent; on thin soil in open areas . . . . . Cladonia magyarica

32. Proliferating from the center of the cup, sometimes forming several tiers. Common; on exposed soil . . . (Figure 56) Cladonia cervicornis subsp. verticillata (ladder lichen)

32. Proliferating from the cup margins; occasionally forming more than one tier. Common; on exposed soil or moss patches . . . . . Cladonia gracilis

33. Podetia without soredia or granules; cortex KOH+ pale yellow (atranorin) . . . . . 34.
33. Podetia more or less covered with soredia or granules . . . . . 40.

34. Podetia PD+ bright yellow (psoromic acid) . . . . . 35.
34. Podetia PD- or PD+ red . . . . . 36.

35. Basal squamules large, narrow (4-6 mm long, 2-3 mm broad), ascending and curled back revealing the white undersurface; podetia corticate in thick, cracked plates, often slit or perforate; apothecia common, small, numerous on each podetium. Rare; on thin, calcareous soil . . . . . Cladonia dahliana
35. Basal squamules and podetial squamules small, less than 2-3 mm long; podetia largely decorticate, with small, almost granule-size patches scattered over the surface; podetia often branched at tip, slit and irregular; apothecia infrequent. Infrequent; on soil . . . . . Cladonia norrlinii

36. Podetia 1-1.5(-2.5) mm tall, entirely ecorticate, arising from the margins of branched, finely lobed squamules; thallus PD+ red (fumarprotocetraric acid), KOH-. Rare; on bark or wood . . . . . Cladonia caespiticia
36. Podetia 2 mm or more tall, at least partially corticate, arising vertically from the substrate level, usually from the centers of basal squamules . . . . . 37.

37. Thallus KOH- (atranorin absent). Usually on wood, occasionally on soil . . . . . 38.
37. Thallus (i.e., undersurface of squamules) KOH+ yellow (atranorin). On soil . . . . . 39.

38. Thallus PD-; podetia 2-5 mm tall, terminated by large, pale or yellowish-brown apothecia; basal squamules minute, more or less dispersed over substrate. Rare; on lignum or, rarely, peaty soil . . . . . Cladonia botrytes
38. Thallus PD+ red (fumarprotocetraric acid); podetia 7-12 mm tall, terminated by very large brown apothecia; basal squamules small, thick, crowded. Rare; on soil or lignum . . . . . Cladonia capitata

39. Basal squamules very large and ascending, often more than 6 mm long; podetia dark green, irregular, often longitudinally split, surface smooth and uniform; usually without apothecia. Rare; on exposed soil . . . . . Cladonia turgida

39. Basal squamules small, not more than 3 mm long; podetia grey-green, warty, without squamules, often split or "lacerate" longitudinally, terminating in one or more large brown apothecia. Common; on exposed soil . . . . . Cladonia cariosa

40. Podetia KOH+ bright yellow, PD+ orange (thamnolic acid . . . . . 41.

40. Podetia KOH-, KOH+ pale yellow, or KOH± dull brownish-yellow; PD-, PD+ bright yellow, or PD+ red . . . . . 42.

41. Podetia and the edges of the basal squamules covered with coarse granules; podetia always tipped with large, brown apothecia. Rare; on logs or soil . . . . . Cladonia parasitica

41. Podetia covered with fine, powdery soredia, without apothecia. Infrequent; on soil, logs and rocks . . Cladonia macilenta

42. Soredia fine, powdery . . . . . 43.

42. Soredia coarse, granular; podetia slender, PD+ red or PD- . 45.

43. Podetia PD-, very slender, almost white, with fine, powdery soredia; podetia sometimes somewhat thicker at tip (i.e., "club-shaped"); basal squamules small, lobed, or finely divided. Common; on logs, soil, or tree bases . . . . . Cladonia bacillaris (pin lichen)

43. Podetia PD+ red, usually dark olive-green to slightly yellowish green or brownish (never white) . . . . . 44.

44. Podetia short, stocky, usually under 20 mm tall, tapering evenly to a point; basal squamules large, normally unlobed or with shallow lobes and undivided, with podetia arising from the center; soredia generally covering 2/3 or more of podetia. Very common; on soil or soil over rock, logs, and tree bases. . . . . (Figure 57) Cladonia coniocraea (powder horn lichen)

44. Podetia usually over 30 mm tall; basal squamules small, divided and lobed; soredia in patches mostly on upper half of podetia. Rare; on logs and ground . . . . Cladonia cornuta

45. Podetia PD+ yellow, KOH+ pale yellow (psoromic acid and atranorin) (see couplet 35) . . . . . Cladonia norrlinii

45. Podetia PD- or PD+ red, KOH+ brownish (atranorin absent) . . . 46.

46. Podetia under 5 mm tall, cylindric, with very coarse granules at the base grading into almost farinose soredia at the tips; basal squamules divided and lobed, sometimes sorediate; PD+ red (fumarprotocetraric acid and grayanic acid). Infrequent; on wood and tree bases . . . . . Cladonia cylindrica

46. Podetia over 5 mm tall, somewhat irregular to branched at the tips . . . . . 47.

47. Podetia often over 30 mm tall, branched at tips with open axils; usually squamulose, PD+ red. Infrequent; on ground and logs . . . . . Cladonia scabriuscula

47. Podetia usually less than 30 mm tall, unbranched or with proliferations at tips but no open axils . . . . . 48.

48. Podetia slender, with decorticate areas which are opaque; PD- or PD+ red. Common (see couplet 26) . . . . . Cladonia rei

48. Podetia stout, very irregular; decorticate areas are translucent (pellucid); PD+ red. Rare; on rotting wood . . . . . Cladonia anomaea

49. Branches or stalks growing vertically upward, often from a granular or powdery basal crust . . . . . 50.

49. Branches or stalks growing outward from a vertical surface, or hanging downward, never originating from a basal crust of any kind . . . . . 53.

50. Stalks very short (never more than 12 mm high), unbranched, naked, growing from a greenish white, verrucose to areolate basal crust becoming sorediate in patches, terminated by a light brown fruiting body (apothecium); KOH+ yellow, PD+ orange (stictic acid). Rare; on shaded rock or soil . . . . . (Figure 60) Baeomyces rufus

(Note: Another species of *Baeomyces, B. roseus*, although common from the Gaspé eastward, has only been collected once

close to this region: north of Ottawa in Parc de la Vérendrye. It has a white, continuous to verruculose thallus which is PD+ yellow, KOH+ yellow (baeomycesic acid), and has short podetia terminated by very large, pink apothecia. It grows on disturbed, often sandy soil, frequently along roadsides.)

50. Stalks highly branched, more or less ascending or spreading as a prostrate cushion; stalks over 25 mm tall, covered with granule-like or scale-like lobes; KOH+ yellow . . . . 51.

51. Cephalodia absent; "podetial" scales (phyllocladia) broad and lobed; "podetia" generally more or less flattened close to the substrate and having clearly distinguishable upper and lower surfaces; thallus PD- or PD+ pale yellow (atranorin). Very common; growing directly on acid rocks and boulders usually in very sunny habitats . . . . . (Figure 59) Stereocaulon saxatile

51. Cephalodia present; phyllocladia broadened or finely divided; "podetia" mostly erect, without distinguishable upper and lower surfaces; thallus PD+ pale orange (stictic acid). Rare; usually on soil . . . . . 52.

52. Cephalodia large, blue-grey, tumor-like, very conspicuous on "podetia"; phyllocladia finely divided . . . . . Stereocaulon dactylophyllum

52. Cephalodia small, black, buried in thick, fuzzy, grey tomentum on "podetial" surface; phyllocladia thick, lobed, but not finely divided . . . . . Stereocaulon tomentosum

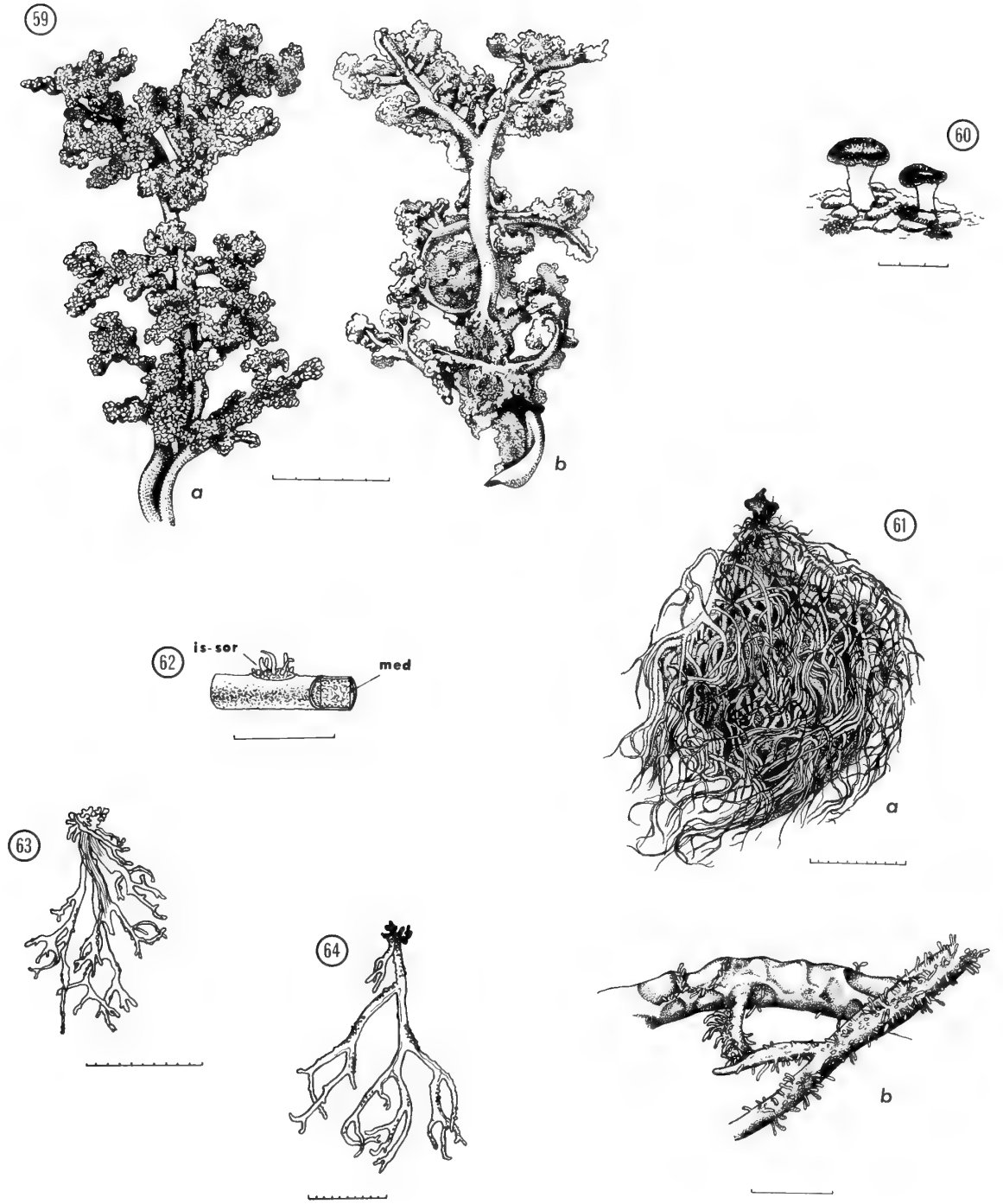
53. Branches almost perfectly circular in cross section, more or less filamentous . . . . . 54.

53. Branches distinctly flattened or very irregular in cross-section, at least at base . . . . . 58.

54. Thallus yellow-green; filaments with a cartilaginous, elastic central strand (Figure 67b) . . . . . 55.

54. Thallus brown to almost black; filaments lacking a central, cartilaginous strand (Figure 62) . . . . . 57.

55. Thallus short and shrubby, not long and pendent . . . . . 56.



Figures 59-64. -59. *Stereocaulon saxatile*, (a) "upper" surface, (b) "lower" surface; -60. *Baeomyces rufus*; -61. *Usnea hirta*, (a) habit, (b) branches showing scrobiculate surface and isidia; -62. *Bryoria furcellata*, portion of branch showing uniform medulla and isidiate soralium; -63. *Ramalina intermedia*; -64. *Evernia mesomorpha*. Scale: each unit = 1 mm.

55. Thallus distinctly pendent; main branches usually darker than secondary branches; isidiate. Rare; on trees . . . . . Usnea filipendula

56. Filaments somewhat "dented" and angular, especially close to the base (Figure 61b); surface of main stems without tiny bumps (papillae); young branches with abundant isidia, without soredia of any kind. Infrequent; on trees . . . . . (Figure 61) Usnea hirta

56. Filaments never dented or angular at all; at least main stems with papillae; young branches often with soredia mixed with isidia. Frequent; on trees . . . . . (Figure 67) Usnea subfloridana

57. Thallus shrubby, irregularly branched, about as broad as it is long; branches having scattered, elliptical patches of soredia mixed with tiny but conspicuous spine-like isidia (Figure 62); sorediate patches and thallus are PD+ red. Frequent; especially on coniferous trees . . . . . Bryoria furcellata

57. Thallus more or less pendent, much longer than broad; branching regular or irregular; entirely lacking soredia or isidia; medulla or inner cortex PD+ red (sometimes hard to detect). Rare; on conifer trees . . . . . Bryoria trichodes subsp. trichodes

58. Branches angular and uneven, occasionally becoming flattened; thallus very soft and pliable; surface of branches dull, coarse, with granular soredia scattered over much of the surface. Frequent; on trees . . . (Figure 64) Evernia mesomorpha

58. Branches distinctly flattened, quite stiff at least at base; surface of branches shiny and smooth (although often ridged); soredia present or absent, but, if present, in distinct patches or structures . . . 59.

59. Thallus with soredia . . . . . 60.

59. Thallus without soredia . . . . . 61.

60. Branches quite narrow, generally less than 1.5 mm across, often becoming long; soredia in conspicuous elliptical patches along the margins of the branches; fruiting

bodies rare. Infrequent; on rock walls
. . . . . (Figure 63) Ramalina intermedia

60. Branches usually short and broad, 1.5-4 mm across; soralia in large, often hood-like patches, especially near the tips of branches. Rare; on rocks or bark . . . Ramalina obtusata

61. Branches broad, up to 3 mm across, sometimes more, solid, flattened throughout; large, yellow, disk-shaped apothecia common on margins or close to tips of branches. Frequent; on trees . . . . . Ramalina americana

61. Branches narrow, under 3 mm across, flattened only at base, somewhat hollow and tube-like (fistulose) and perforated with pits or holes. Rare; on trees . . . . . Ramalina dilacerata

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GLOSSARY

Acicular. Needle-shaped, i.e., slender and pointed at both ends.

Aeruginose. Bluish green.

Algal layer. Layer of algal cells in a lichen thallus (Figure 65).

Amphithecium. The portion of a lecanorine apothecium external to the exciple (Figure 70b), usually containing algae; the thalline margin.

Amphithecial cortex. The outermost protective layer of an amphithecium.

Apothecium. A disk- or cup-shaped ascocarp (Figures 65, 70).

Areolate. Broken up into small, irregular, usually angular patches (areoles), often appearing tile-like. (Figures 1, 2a, 68).

Ascocarp. The fruiting body of an Ascomycete; the structure which bears the asci which in turn contain the ascospores.

Ascohymenial. Pertaining to a type of ascocarp having true paraphyses and unlayered ascus walls; characteristic of the subclass Ascomycetidae.

Ascolocular. Pertaining to a type of ascocarp in which the asci (generally with layered walls) arise within a uniform fungal tissue mass and are separated in maturity, not by true paraphyses, but by pseudoparaphyses; characteristic of members of the subclass Loculoascomycetidae.

Ascospore. A spore produced in an ascus (Figure 72).

Ascus (asci). The sac-like structure in Ascomycetes in which the ascospores are formed. (Figure 71).

Basal squamules. Small, scale-like lobes forming the basal or "primary" thallus of *Cladonia* species (Figure 66).

Biseriate. Spores in two rows within the ascus. (Figure 71a).

Calcareous rock. Rock containing lime and producing vigorous bubbling (CO_2) in the presence of a strong acid.

Capitate. Referring to a type of rounded, almost hemispherical soralium usually found at the tip of a lobe or branch (e.g., see Figure 47).

Carbonaceous. Opaque black, and usually brittle; individual cells in the tissue not usually distinguishable.

Cephalodium (cephalodia). A small gall-like growth occurring within the tissues or on the surface of some lichens; containing blue-green algae.

Chlorococcales. An order of green algae having taxa with spherical, individual cells.

Cilia. Hair-like thalline appendages occurring at the thallus or apothecial margins of many foliose and fruticose lichens (Figure 46b).

Continuous. Thallus unbroken, or broken very little by cracks (Figure 69).

Coralloid. (a) Having or being composed of minutely branched cylindrical outgrowths. (b) A type of isidium having this form.

Cortex. The outer protective layers of a lichen thallus or apothecium, completely fungal in composition; often cellular in appearance (paraplectenchymatous), but may have other forms as well (Figure 65).

Corticate. Having a cortex.

Corticolous. Growing on bark.

Crenulate. Having a margin with rounded teeth or minute lobes.

Crustose. A thallus type which is generally in contact with the substratum at all points and lacks a lower cortex; cannot be removed intact from its substrate without removing a portion of the substrate as well (Figure 73).

Decorticate. Having had a cortex which has now fallen away or decomposed.

Dichotomous. Branching into two equal parts, as in the letter "Y" (e.g., see Figure 50).

Dorsi-ventral. With recognizable upper and lower surfaces.

Ecorticate. Never having had a cortex.

Effigurate. Referring to the lobed margin of a thick, basically crustose thallus (e.g., see Figure 22).

Effuse. Pertaining to a thallus having no clearly defined margins.

Endolithic. Growing "within" a rock, i.e., under and around the rock crystals, often with little or no thallus visible on the outer rock surface.

Epilithic. Growing on a rock surface with little or no penetration between and under the rock particles.

Epispore. A transparent gelatinous covering, often irregular in thickness, surrounding the ascospores of many lichens; often called a "halo" (Figure 72a).

Epithecium. The uppermost portion of the hymenium formed by the expanded tips of paraphyses; usually pigmented and sometimes inspersed with tiny granules (Figure 70).

Epruinose. Lacking pruina.

Erumpent. Emerging through the thallus surface, visibly pushing aside some thallus tissue as it appears.

Exciple. An area in an apothecium external to and below the hypothecium, forming the apothecial margin in lecideine apothecia (Figure 70a) and internal to the amphithecium in lecanorine apothecia (Figure 70b).

Excipulum. As used in this key, refers to the wall enclosing a perithecium, i.e., the perithecial wall. (See Figure 26: the pale wall; Figure 74c: the black wall).

Farinose soredia. Very fine, powdery soredia.

Foliose. Pertaining to a more or less "leafy" lichen thallus, distinctly dorsi-ventral, and varying in its attachment to the substrate from almost completely adnate to umbilicate (Figures 31-52).

Fruticose. Pertaining to a lichen thallus which is stalked, pendent, or shrubby, normally with no clearly distinguishable upper and lower surfaces (Figures 53-64).

Fusiform. Narrow, tapering toward both ends, usually with pointed ends; spindle- or cigar-shaped.

Glabrous. (a) Having a more or less smooth, shiny surface. (b) With no trace of tomentum.

Gloeocapsa. Blue-green alga consisting of small groups of spherical cells (2-8) enclosed within a thick gelatinous matrix, with the individual cells having their own gelatinous sheaths.

Granular. (a) Having granules or granule-like particles. (b) Pertaining to soredia, composed of particles large enough to be easily distinguished under a dissecting microscope, presenting a coarse appearance, not powdery as in farinose soredia.

Granule. A spherical or nearly spherical corticate particle.

Halo. See *epispore*.

Hyaline. Colourless.

Hymenium. The fertile layer of an ascocarp, consisting of asci and paraphyses or pseudoparaphyses (Figure 70).

Hypophloedal. Corticolous lichens in which most or all of the thalline tissue is below one or more layers of cork.

Hypothecium. The tissue just below the hymenium but above the exciple (Figure 70a); often difficult to distinguish from the exciple.

Imbricate. Pertaining to scales or squamules which overlap in a shingle-like fashion (e.g., see Figure 21).

Inflated. Swollen and hollow.

Involucrellum. The exposed covering or cap external to the excipulum present on many perithecia; usually black and carbonaceous (Figure 26).

Involute. With margins rolled inward.

Isidium (isidia). A minute, cylindrical, or coralloid thalline outgrowth which is corticate and contains algae; apparently functions as a vegetative reproductive body (a propagule) (Figure 65).

Isthmus (isthmi). The narrow canal between the two locules of a polaribilocular spore (Figure 72d); refers to the distance between the two locules.

Labriform. (a) Lip shaped. (b) Pertaining to soralia, generally formed by a revolute thallus margin or a bursting hollow thallus lobe, sorediate on

the lower or inside (i.e., exposed) surface, as in *Hypogymnia physodes* (see Figure 42).

Laminal. On the upper surface of a thallus.

Lax. Loose; not compact.

Lecanorine. Pertaining to an apothecium having a distinct amphithecium, usually containing algae, as in the genus *Lecanora* (Figure 70b).

Lecideine. Pertaining to an apothecium in which there is no distinguishable amphithecium and, therefore, in which the exciple forms the apothecial margin (i.e., the proper margin), as in the genus *Lecidea* (Figure 70a).

Leprose. Composed almost entirely of loosely organized granules or soredia.

Lignicolous. Growing on bare wood (lignum), as on a decorticate log or a wooden fence.

Lobule. A small, often scale-like lobe growing from a foliose thallus either along its margin or from the surface, sometimes also appearing along apothecial margins, generally of the same colour and character as the parent thallus (Figure 65).

Locule. The cell cavity in an ascospore.

Mazaedium. A mass of ascospores and paraphyses formed by the disintegration of the asci of a special type of ascocarp, as in *Chaenotheca*.

Medulla. The internal region in a thallus or lecanorine apothecium which is generally composed of loosely packed fungal tissue (Figure 65).

Muriform. Having both longitudinal and transverse septa, with the cells thus appearing like a brick wall (Figure 72a, b).

Nostoc. A genus of blue-green algae found in many lichens; producing bead-like chains or filaments when free-living, but, when lichenized, may be single- or few-celled (see Figures 33, 35).

Ostiole. The small, round, apical pore in various types of ascocarps (Figure 74).

Paraphysis (paraphyses). A sterile fungal filament, sometimes branched, associated with asci in the hymenium of a member of the Ascomycetidae.

Paraplectenchymatous. Pertaining to fungal tissue which appears cellular in section due to short cells and highly branched, irregularly oriented fungal filaments.

Peltate. Attached at the center of the lower surface; umbrella-like.

Perithecium. A flask-shaped ascocarp (Figures 69, 74c, 26, 27): may be sessile or, more commonly, sunken partially or completely into the thallus tissue.

Phycobiont. The algal component (symbiont) in a lichen thallus.

Phyllocladium (phyllocladia). A minute, often lobed or scale-like outgrowth on the branches of some members of the genus *Stereocaulon* (see Figure 59).

Plicate. Folded into more or less longitudinal ridges or furrows.

Podetium. A stalk formed by a vertical extension of apothecial tissues (usually the hypothecium and stipe); the stalk usually becomes secondarily invested with an algal layer and cortex (as in *Cladonia*) and can be either short and unbranched, or quite tall and highly branched (Figures 53-58, 66).

Polaribilocular. Pertaining to spores having two cell cavities (lumina) separated by a relatively thick septum through which a narrow canal or isthmus passes (Figures 72d, 14, 15); characteristic of members of the Teloschistaceae.

Primary squamule. The scale-like component of the primary thallus of a *Cladonia* species. (See *basal squamule*.)

Primary thallus. The thallus of a *Cladonia* species exclusive of the podetia, composed of leafy scales or squamules.

Proper margin. See *exciple*.

Prothallus. The non-assimilative lower portion of a lichen seen around the outer edge of many crustose species as a white or pigmented margin, and often visible as a mat between the areoles or granules of other crustose species (Figure 68).

Pruina. White or grey "frost-like" particles on a surface.

Pruinose. Having a frosted appearance (usually white or grey).

Pseudocyphella (pseudocyphellae). A tiny white dot or pore seen in large numbers on the upper and sometimes the lower thallus surfaces of many foliose species; caused by a break in the cortex and the extension of medullary hyphae to the surface (Figure 65).

Pseudoparaphyses. The remains of fungal tissue found between the asci in ascolocular ascocarps; often is highly branched and anastomosing.

Pulverulent. Powdery.

Pycnidium (pycnidia). A globular or flask-shaped body, usually very small, in which spore-like conidia are formed; often closely resembling a perithecium in external appearance (Figure 51b).

Revolute. Pertaining to margins which are rolled backward or downward.

Rhizine (rhizinae). A purely hyphal extension of the lower cortex, which generally serves to attach a foliose thallus to its substrate; of various lengths, thicknesses, colours, and degrees of branching (Figure 65).

Rimose. Having a minutely cracked appearance (e.g., see Figure 2b).

Saxicolous. Growing on rock, stone, pebbles, concrete, or brick.

Scabrose. Having a minutely roughened, almost crusty surface.

Septum (septa). A cross-wall in a fungal filament or spore.

Sessile. Without a stalk of any kind.

Simple. Unbranched; nonseptate.

Soralium (soralia). A body or area in which soredia are produced; can be in many forms (Figure 65).

Soredium (soredia). A vegetative reproductive body of a lichen consisting of a few algal cells entwined and surrounded by a layer of fungal filaments; entirely ecorticate; generally produced in localized masses called soralia, or covering large diffuse areas in a thallus.

Spore. A single- or few-celled reproductive body capable of giving rise to a new plant; as used here, refers specifically to an ascospore.

Squamule. A small, scale-like lobe or areole, generally at least partially ascending (e.g., see Figure 21).

Squarrose. With short, stiff, perpendicular branches; having the general appearance of a bottle-brush, as in certain types of rhizinae (Figure 65).

Stichococcus. A small, unicellular green alga having short, cylindrical (rod-shaped) cells.

Sub- (a) Partially. (b) Incompletely. (c) Approaching. (d) Under.

Terricolous. Growing on soil or sand.

Thalline. Pertaining to the lichen thallus; similar to the thallus in appearance or structure.

Thalline margin. See *amphithecium*.

Thallus. In lichens, the vegetative plant body consisting of both algal and fungal components.

Tier. A platform-like expansion on the podetia of several species of *Cladonia* (e.g., *Cladonia cervicornis*) at which point one or more new branches arise (see Figure 56).

Tomentose. Having a downy or woolly appearance.

Tomentum. A covering of fine "hair" or fuzz.

Trebouxia. A genus of single-celled green algae. Its distinctive, single, disk-shaped chloroplast almost fills the cell, and has a lobed or crenate margin. It is the most common green phycobiont in lichens. It is here used in the old sense, including *Pseudotrebouxia*.

Trentepohlia. A genus of filamentous green algae found in many crustose lichens; when lichenized, the alga often produces only very short filaments or is single-celled. The orange-red pigmented globules, common in the cells of unlichenized individuals, are more infrequent or absent in lichenized individuals.

Umbilicate. Attached from a single, central point (an umbilicus) on the lower surface of the thallus.

Umbilicus. A solitary, short, thick, stem-like, purely fungal attachment organ present on various foliose and subfoliose lichens, especially species of *Umbilicaria*.

Uniseriate. Spores occurring in one row within the ascus.

Vein. In lichens, broad or narrow ridges or thickenings, often pigmented, on the lower surface of some species of *Peltigera* (see Figure 38).

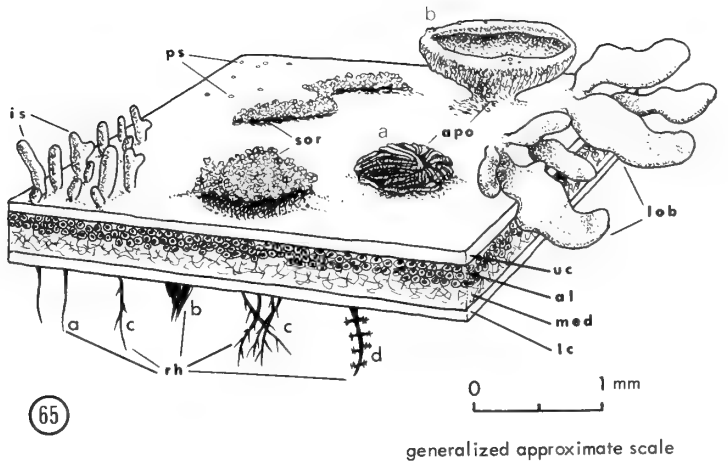
Vermiform. Shaped like a worm; i.e., elongate, curved, gradually tapering to a point at each end.

Verruca (verrucae). A conspicuous, wart-like thalline protuberance (e.g., see Figure 24).

Verrucose. Covered with rounded, wart-like protuberances (e.g., see Figure 7).

Verruculose. Minutely verrucose.

Figures 65-74. Morphological features of lichens. -65. Composite, semi-schematic drawing of a foliose thallus: *al*, algal layer; *apo*, apothecia (a) as in *Umbilicaria*, (b) as in *Parmelia, Physcia*, etc.; *is*, isidia; *lc*, lower cortex; *lob*, lobules; *med*, medulla; *ps*, pseudocyphellae; *rh*, rhizines (a) simple, (b) tufted as in *Peltigera*, (c) dichotomously branched, (d) squarrose; *sor*, soralia with soredia; *uc*, upper cortex. -66. *Cladonia cristatella* podetium: *apo*, apothecium; *bsq*, basal squamules; *pod*, podetium; *sq*, podetial squamules. -67. *Usnea subfloridana* (a) young thallus, (b) portion of a branch: *cor*, cortex; *med*, medulla; *st*, central cartilaginous strand. -68-74. Crustose lichens. -68. Areolate thallus from above, and from side: *ar*, areole; *apo*, apothecium; *pth*, prothallus; *sub*, substrate. -69. Continuous, smooth thallus containing embedded perithecia (*per*). -70. Apothecia (a-b) in vertical section; (c-d) external appearance. (a, c) lecideine, (b, d) lecanorine: *al*, algae; *amph*, amphithecium; *epi*, epithecium; *exc*, exciple; *hym*, hymenium; *hyp*, hypothecium. -71. Asci containing spores, (a) *Lecanora* and *Lecidea* type, (b) *Sarcogyne* (polysporous), (c) *Pertusaria*. -72. Ascospores: (a) muriform, with a transparent, gelatinous "halo", from *Rhizocarpon lavatum*, (b) muriform, without a halo, from *Polyblastiopsis*, (c) simple (one-celled or non-septate) from *Lecanora*; (d) polaribilocular, from *Caloplaca*; (e) kidney-shaped (slightly curved), one-septate, from *Lecania dimera*; (f) thread-like, from *Conotrema*; (g) fusiform, with cylindrical cells, from *Opegrapha pulicaris*; (h) fusiform, with lens-shaped cells, from *Graphis scripta*; (i) from *Mycocalicium*; (j) from *Calicium*; (k) one-septate with unequal cells, from *Catillaria laureri*; (l) one-septate, with spore walls even in thickness, from *Buellia*; (m) one-septate, with spores walls uneven in thickness, from *Rinodina*; (n) thick, channelled spore walls, from *Pertusaria macounii*. -73. Crustose thallus in section: *al*, algae; *cor*, cortex; *med*, medulla; *sub*, substrate. -74. Fruiting bodies (ascocarps) in section: (a) biatorine, *Lecidella stigmatea*; (b) *Pertusaria macounii*: *"ost"*, ostiole-like opening of apothecium, (c) perithecium of *Pyrenula*: *ost*, ostiole; (d) *Diploschistes scruposus*.



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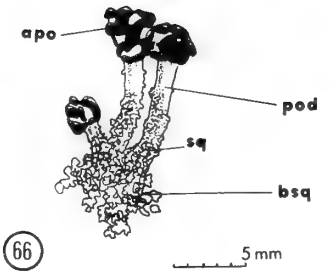
generalized approximate scale



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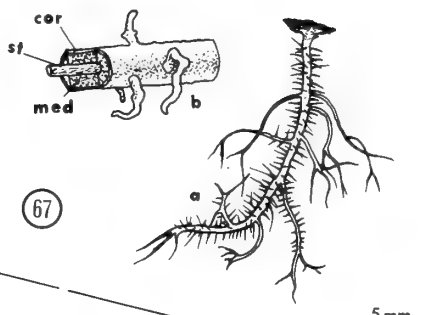

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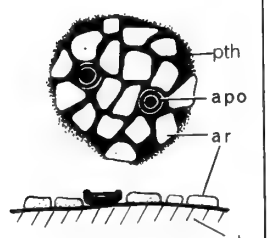

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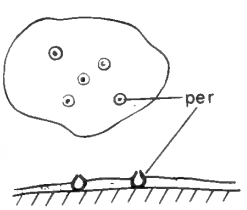

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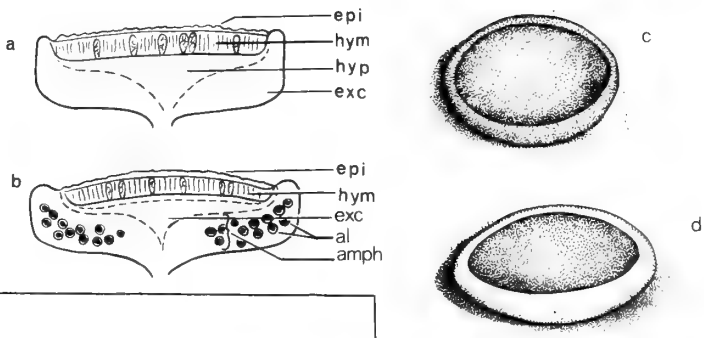

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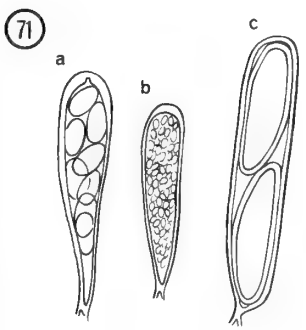

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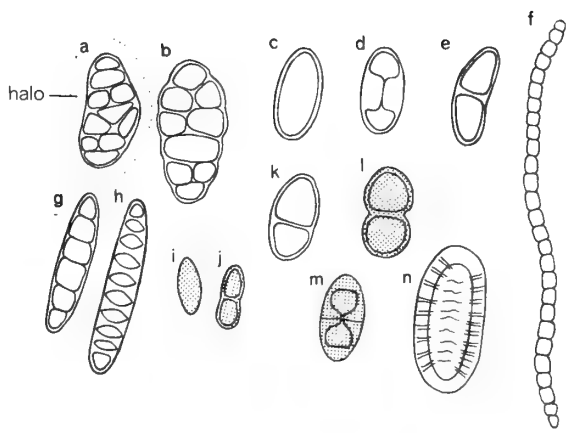

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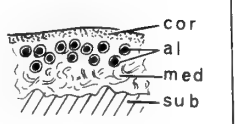

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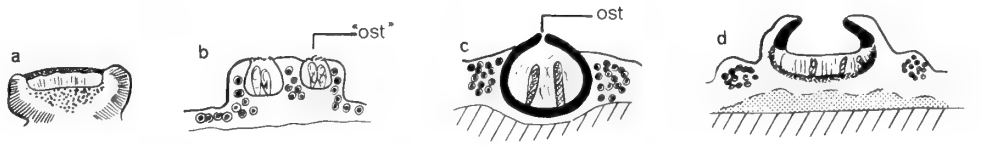

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CHECKLIST AND INDEX TO LICHEN TAXA

In the following list, only very recent synonyms have been cross-referenced. These synonyms are written in italics. The taxa in square brackets are not known with certainty from the Ottawa region, but might be expected to occur there. The presence of the taxa on the Ontario or Quebec side of the Ottawa River is indicated by the abbreviations ON and QU, respectively, following each epithet. Page references are made for all points in the text mentioning the taxa; page numbers in italics refer to illustrations.

pinastri (Scop.) S. Gray	ON	QU	71
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