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was used because it has a larger opening and permits a more rapid transfer of the sample. In this way it is possible to distribute a sample equally among several slides. If the count at a particular level is exceptionally high, not all of the slides need be counted since each slide is one tenth of the total sample.

This dilution method was compared to a count obtained by examination of the whole sample and the examination of individual slides was found to compare very favorably.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to Michael W. Hager, a junior biology major at Grinnell College, for his able assistance.

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A Guide to the Common Lichens of Boone and Story Counties, Iowa[1]

LOIS H. TIFFANY AND KAREN K. JUHL

Abstract. A key to the common lichens of Boone and Story Counties, Iowa is presented with brief descriptions of the genera and common species.

The lichens comprise a comparatively inconspicuous portion of the flora of Iowa. They are, however, widely distributed on trees, rocks and soil, and some are large and showy. Many technical treatments of the lichens as a group and excellent monographs of individual genera are available. The majority of these discussions are rather difficult for a beginner to use satisfactorily. Requests for a limited simplified treatment of the more common lichens that occur in central Iowa have motivated the authors to prepare this paper.

The lichen vegetative body or thallus is a composite structure of fungal and algal cells. The fungal cells compose the bulk of the thallus, with the chlorophyll-containing algal cells concentrated in particular areas. The thallus is a structure completely different from that which either organism would form growing alone. There is a great variation in thallus organization. A typical

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lichen thallus (Fig. 3) has an upper cortex of vegetative fungus filaments (hyphae) often specially oriented and compressed, an algal layer of loosely interwoven hyphae with scattered algal cells or clumps of algal cells, a medulla of loosely packed hyphae, and the lower cortex with appendages called rhizines which may attach to the substrate. The lower cortex is lacking in some lichens.

Several thallus structures thought to act as vegetative propagative structures have been used as taxonomic characters in the lichens. Isidia are minute, corticate coralloid outgrowths of the upper thallus which are easily broken from the thallus. Soredia are microscopic bodies of a few algal cells accompanied by hyphae, and are formed singly or in powdery clumps (soralia).

Sexual fruiting bodies of the fungus member of the lichen are of basic importance in identification of many lichens. Temperate zone lichens have fungus members which produce their sexual spores (ascospores) in saclike structures known as asci. Typically eight ascospores are produced in each acus, although the number may vary from one to many. Groups of asci are produced in sexual fruiting bodies (ascocarps) of various kinds. An open disk or cup-like ascocarp (Fig. 2) with a layer (hymenium) of asci and sterile hyphae (paraphyses) is an apothecium. A surrounding wall of hyphal tissue, the proper exciple, may form a margin around the apothecium. An outer rim of tissue like the thallus, the thalloid exciple, may extend around the apothecium. Both of these tissues may be well developed, or either one may be present without the other. A perithecium (Fig. 5) is a flask-shaped ascocarp lined with a layer of asci and paraphyses or containing a basal clump of asci. Perithecia typically have an apical opening (the ostiole) and are immersed completely in the thallus, while apothecia may be seated directly in or on the thallus or elevated above it on a stalk.

Flask-shaped structures (pycnidia) in which are formed free asexual spores, are also produced by some lichen fungi. The pycnidia are immersed in the lichen thallus and open by a pore at the surface of the thallus.

A foliose lichen thallus (Fig. 4) is typically lobed and leaf-like and is attached to the substrate by rhizines. Less commonly a foliose thallus may be attached in a single central area. Most crustose and squamulose lichen thalli (Fig. 6) have an indefinite thallus edge, with the thallus very closely adhering to the substrate and often composed of numerous small portions. The fruticose or shrubby lichens (Fig. 10) are erect or pendulous, with growth occurring at the tips of the branches.

The lichen species included in this discussion have been collected in Boone and Story counties. They do not represent the

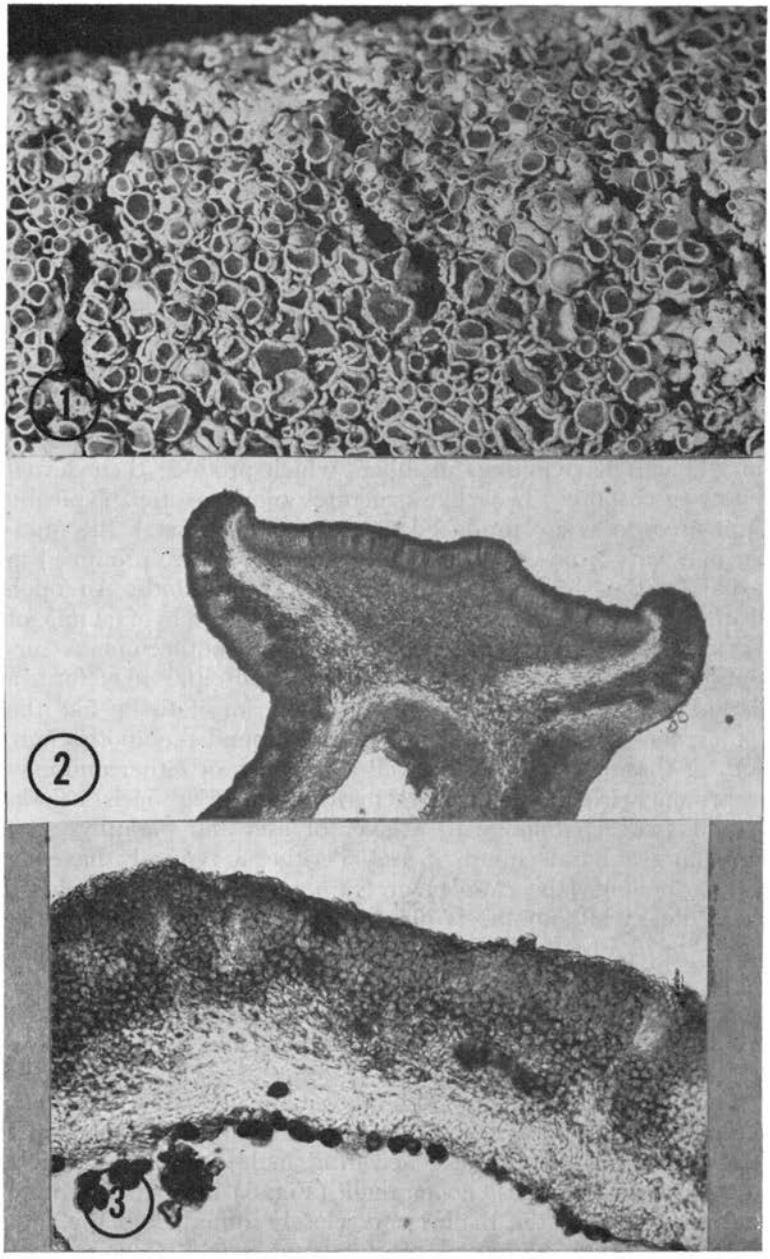

Figure 1. Thallus and apothecia of *Physcia stellaris*. Fig. 2. Section through an apothecium of *Physcia stellaris*. Fig. 3. Section of thallus of *Physcia stellaris*.

complete lichen flora, but rather a selection of the larger, more obvious forms plus those smaller ones that are common or distinctive enough to be frequently collected.

1. Thallus of two distinctly different portions, a primary crustose or squamulose thallus which often disappears and a permanent secondary thallus of erect branches, slender or trumpet-like ..... 1. *Cladonia*
1. Thallus usually of one type ..... 2.
2. Fruiting structures unknown, thallus mealy in texture, composed of loose clusters of algal cells with hyphae ..... 2. *Crocynia*
2. Fruiting structures formed on older thalli; not always present on all collections, thallus not mealy ..... 3.
3. Thallus erect and anchored at the base, or thallus foliose with rhizines on underside ..... 4.
3. Thallus completely in contact with substrate, often breaking into separate chunk-like portions in older thalli, no definite thallus edge, rhizines absent ..... 13.
4. Thallus erect and branched or single, anchored at the base, common on soil or with mosses ..... 1. *Cladonia*
4. Thallus foliose and lobed, usually with rhizines on underside ..... 5.
5. Thallus gelatinous or shiny; black, dark brown or slate-blue, usually in moist places; algal member a blue-green alga scattered throughout the central area ..... 6.
5. Thallus dull, ashy gray, gray-blue, orange, yellow-green or brown; algae in thin layer just below upper cortex ..... 7.
6. Thallus gelatinous, dull black or brown, upper cortex absent or poorly developed ..... 3. *Collema*
6. Thallus shiny, typically slate-blue, upper cortex distinct and cellular, often at bases of large trees in woods or with mosses on shaded rocks ..... 4. *Leptogium*
7. Thallus sometimes attached in the central area only, otherwise foliose to squamulose clusters; perithecia buried in the thallus, evident as black dots on upper side of thallus ..... 5. *Dermatocarpon*
7. Thallus not centrally attached, foliose to squamulose, with or without rhizines, lower side with or without a cortex ..... 8.
8. Thallus orange to orange-red to yellow, purple-red when in contact with KOH solution ..... 6. *Xanthoria*
8. Thallus ashy-gray, blue-gray, yellow-green, or brown, if yellow-green, no purple-red reaction with KOH solution ..... 9.
9. Under side jet-black to brown, with or without rhizines ..... 10.
9. Under side white, tan, or buff, with rhizines ..... 11.
10. Rhizines few, black or brown, usually branched, or none; medulla white or rarely pale yellow ..... 7. *Parmelia*
10. Rhizines numerous, black with light tips; medulla usually white ..... 8. *Physcia*
11. Thallus foliose, ashy to blue-gray or brown ..... 12.
11. Thallus foliose to squamulose, orange yellow to yellow green ..... 9. *Candelaria*
12. Thallus large, brown apothecia present along tips of lobes, underside veined, lacking a cortex, common on soil and mosses ..... 10. *Peltigera*
12. Thallus smaller; apothecia, if present, on upper surface of thallus, cortex present ..... 8. *Physcia*
13. Ascocarps at maturity containing an amorphous mass of ascospores and paraphyses ..... 14.
13. Ascocarps containing a more or less distinct layer of asci and paraphyses ..... 15.
14. Ascocarps stalked ..... 11. *Calicium*
14. Ascocarps sessile ..... 12. *Cyphelium*
15. Ascocarps elongate, situated in the thallus; thallus light gray to whitish, on tree bark, not appearing raised from the bark ..... 16.
15. Ascocarps flask-shaped, buried in thallus ..... 18.

16. Ascocarps with true paraphyses; unbranched, like long lines in the thallus ..... 17.
16. Ascocarps with branched and anastomosing paraphyses; ascocarps linear, but rather broad and short ..... 13. *Opegrapha*
17. Ascospores colorless, with several septa (cross walls) ..... 14. *Graphis*
17. Ascospores brown when mature, with septa ..... 15. *Phaeographis*
18. Ascocarps more or less separate in individual segments of the thallus, ostiole visible at surface of thallus as a dark dot ..... 19.
18. Ascocarp an apothecium, cup-like or flattened ..... 20.
19. Ascospores 8 per ascus, thin walled, small ..... 16. *Verrucaria*
19. Ascospores usually less than 8 per ascus, often 1 or 2, thick walled, large ..... 17. *Pertusaria*
20. Ascospores polarilocular (Fig. 19) ..... 21.
20. Ascospores not polarilocular ..... 23.
21. Ascospores brown, apothecia with a proper or a thalloid exciple ..... 22.
21. Ascospores colorless, apothecia with a thalloid exciple ..... 18. *Caloplaca*
22. Apothecia with a proper exciple only ..... 19. *Buellia*
22. Apothecia with a thalloid exciple only ..... 20. *Rinodina*
23. Asci with many small 1-celled ascospores ..... 21. *Acarospora*
23. Asci typically with 1 to 8 ascospores per ascus ..... 24.
24. Ascospores muriform (cross walls in both planes), brown ..... 22. *Diploschistes*
24. Ascospores non-septate or with septa in one plane only, hyaline ..... 25.
25. Ascospores without cross walls, rarely with a single septum ..... 26.
25. Ascospores with one to several transverse septa ..... 23. *Bacidia*
26. Ascospores usually less than 8 per ascus, large, ellipsoid, with a thick wall (Fig. 13), ascocarp immersed in the thallus ..... 17. *Pertusaria*
26. Ascospores 8 per ascus, small, with a thin wall ..... 27.
27. Young apothecia with a thalloid exciple ..... 24. *Lecanora*
27. Young apothecia with a proper exciple only ..... 25. *Lecidea*

1. *Cladonia*

Primary thallus of squamules, persistent or soon lost, upright and foliose or horizontal and crustose, becoming rough; secondary thallus of upright portions (podetia) arising from the primary thallus or from other old upright portions; podetia cyclindrical, trumpet-shaped, or variously irregular, with or without branching, with or without cups, with or without squamules, often bearing secondary and tertiary podetia; apothecia scarlet or brown of various sizes, forms and arrangement, terminal on the podetia or on their cups or branches or on short apothecial stalks; asci with 8 ascospores; ascospores hyaline, ellipsoid, non-septate, 6-24 x 2-4.5 microns.

Species of *Cladonia* are the common conspicuous erect lichens with white to greenish-white thalli occurring on soil, in mixed stands with mosses, and on well weathered wood.

Cladonia furcata (Huds.) Schrad. (Fig. 10) has a regularly or radiately branched erect secondary thallus. The primary thallus of ascending or flat lobed squamules rarely persists. *C. furcata* commonly occurs with mosses on soil.

Cladonia pyxidata (L.) Fr. (Fig. 7) has a persistent primary thallus of lobed flat upright squamules from which the trumpet-shaped erect secondary branches arise. Neither *C. furcata* nor *C. pyxidata* commonly form apothecia.

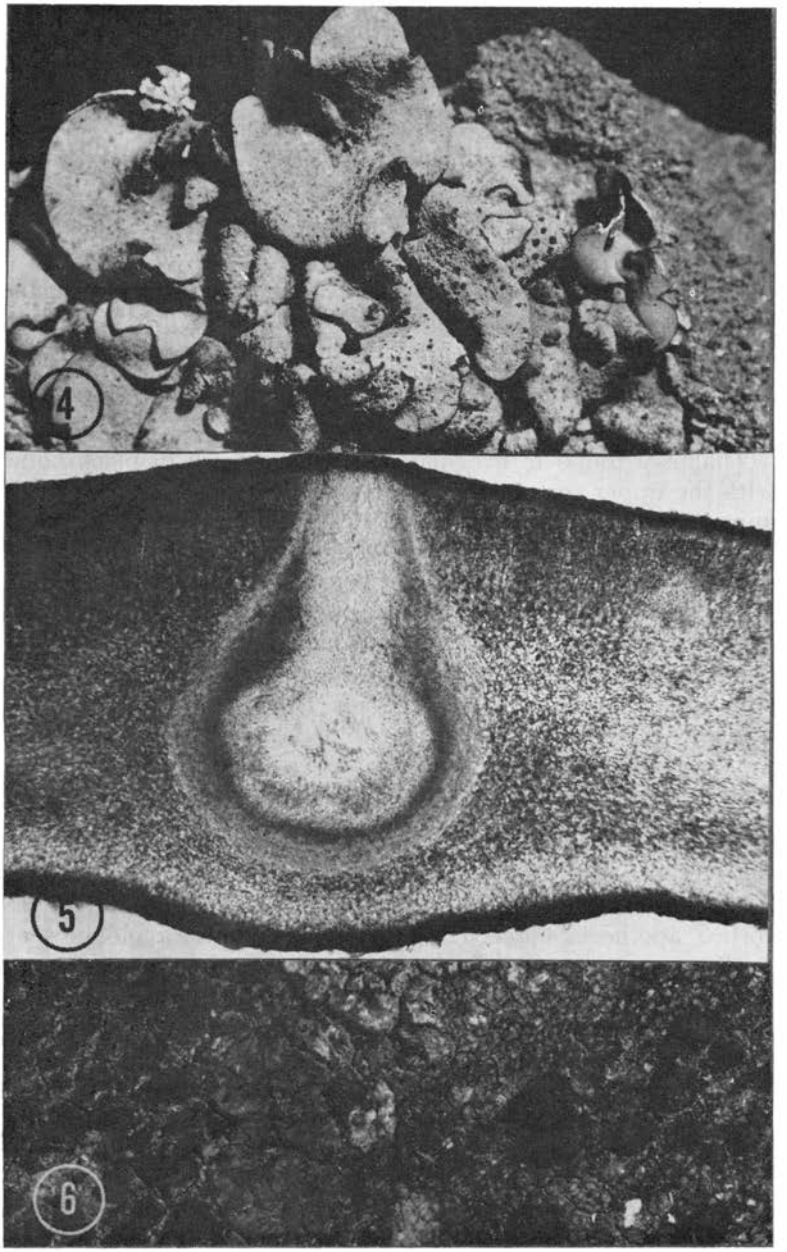

Figure 4. Thallus of *Dermatocarpon miniatum*. Fig. 5. Section through a perithecium and thallus of *Dermatocarpon miniatum*. ig. 6. Crustose thalli and apothecia of *Caloplaca* sp. and *Buellia* sp. on sandstone.

Cladonia cariosa (Ach.) Spreng. has a primary thallus of clustered squamules. The secondary thallus consists of grooved

stalks that terminate in convex, brown to reddish-brown apothecia. A number of erect stalks, sometimes branched, occur in clusters.

2. *Crocynia*

Thallus a tangled mass of hyphae, with no differentiation into cortex and medulla, with enclosed algal cells forming a greenish-gray to whitish, mealy mass; occurring in moist places; ascocarps unknown.

Crocynia membranacea (Dicks.) Zahlbr. (Fig. 12) occurs on soil, the bases of trees, and on rocks in moist sheltered places. It is one of the most widely distributed lichens in our area, and also one of the most nondescript.

3. *Collema*

Thallus a round to irregular or lobed greenish to black body with the upper cortex absent to poorly developed, gelatinous in appearance; apothecia immersed in the thallus to sessile, flesh-colored to brown; thalloid exciple variable; paraphyses straight, commonly enlarged and brown at apices; asci clavate; ascospores 8 per ascus, hyaline, transversely and longitudinally septate. Algal member *Nostoc*, a blue-green alga.

Species of Collema intergrade and are difficult to identify. The only common species here, *Collema tenax* (Sw.) Ach. has an irregular thallus, dark, with thin folded lobes; apothecia 0.5 to 2 mm. across; ascospores with 3 transverse and one longitudinal septation, 16-24 x 8-11 microns. It occurs on moist, shaded sandstone outcrops, and on moist, shaded areas near streams.

4. *Leptogium*

Thallus of irregular foliose lobes with an upper and lower cortex; apothecia immersed to sessile, thalloid exciple present to disappearing; asci clavate with 8 ascospores; ascospores hyaline, transversely and longitudinally septate. Algal member *Nostoc*, a blue-green alga.

Leptogium thalli are typically foliose and slate-blue, with a well developed upper cortex. *Leptogium chloromelum* (Sw.) Nyl. (Fig. 9) has been collected in mosses and on soil at the bases of large trees in wooded areas. It has a lobed, slate-gray thallus; apothecia 0.4 to 1 mm., yellowish-brown to brownish-red; ascospores (Fig. 17) with 3 to 5 transverse septations and 1 longitudinal septation, 18-32 x 8-13 microns.

5. *Dermatocarpon*

Thallus foliose, irregularly lobed and attached by an umbilicus or thallus of an irregular cluster of lobes; upper cortex thin, lower cortex better developed, with algal and medullary layers;

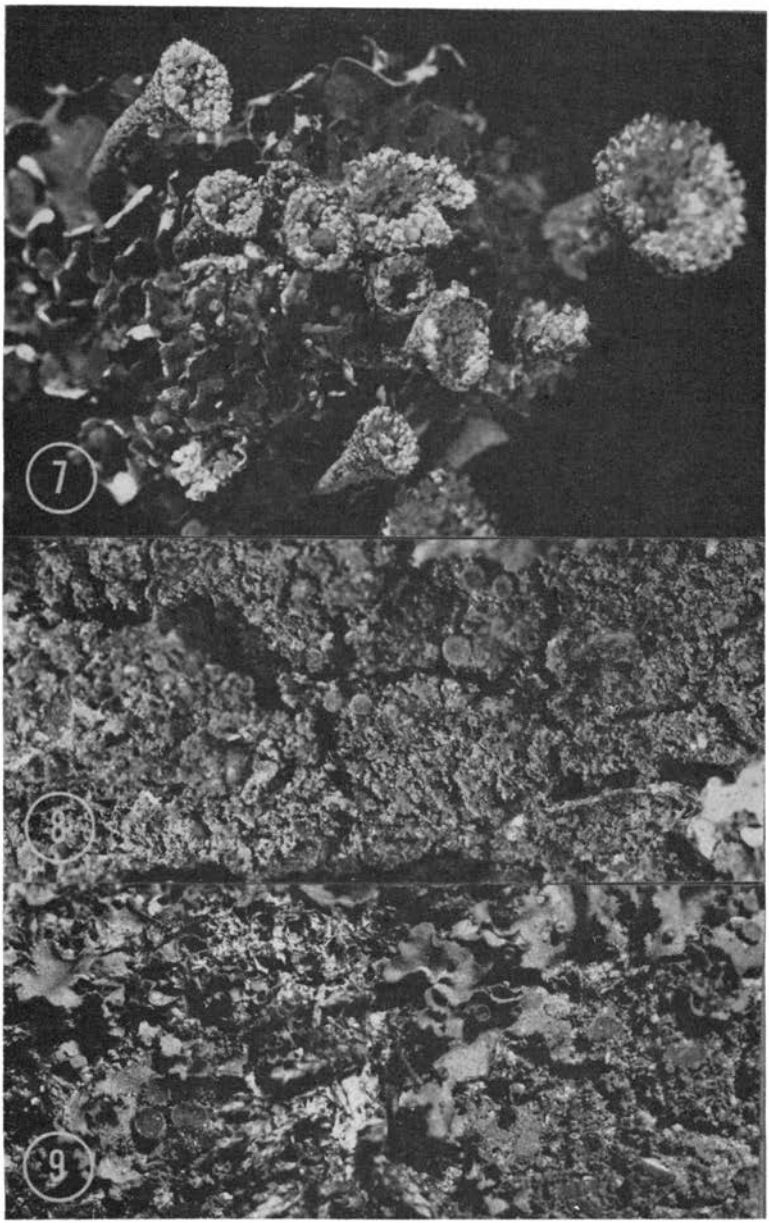

Figure 7. Primary and secondary thalli of *Cladonia pyxidata*. Fig. 8. Thallus and apothecia of *Candelaria concolor*. Fig. 9. Thallus and apothecia of *Leptogium chloromelum*.

perithecia small, ostiole visible as dark dot on thallus; ascospores usually 8 per ascus, hyaline, non-septate, subglobose to oblong *ellipsoid*.

Dermatocarpon miniatum (L.) Mann. (Fig. 4) occurs on rock, commonly on sandstone in this area. The gray-brown to dusty brown irregularly lobed thallus is usually centrally attached with numerous dark ostioles visible, scattered in the lobes. The ascospores are ellipsoid, 9-16 x 5-8 microns.

6. *Xanthoria*

Thallus foliose, orange-red to orange to greenish-yellow; upper cortex, algal layer, medulla and lower cortex with rhizines present, usually reacting to KOH solution with formation of a purple-red color; apothecia yellow or orange with a thalloid exciple; asci with 8 ascospores; ascospores hyaline, two-celled, polarilocular.

Xanthoria fallax (Hepp.) Arn. is one of the common lichens on elm bark. The dark yellow to orange thallus with soredia along the margins and on the under side of the lobes in soralia often covers large areas. The underside of the thallus is pale with scattered light-colored rhizines. Apothecia are not commonly formed. *X. fallax* often occurs on elm bark intermingled with *Candelaria concolor* and various species of Physcia.

7. *Parmelia*

Thallus typically foliose, more or less lobed, smooth or with soderia or coralloid branches, well developed upper cortex, algal layer, medullary layer, and lower cortex, usually with rhizoids, lower surface commonly jet-black; apothecia brown, surrounded by a thalloid exciple colored like the thallus; asci with 8 ascospores; ascospores ellipsoid to ovoid-ellipsoid, non-septate.

Parmelia has the largest thalli of the foliose lichens, and occurs most commonly on the bark of deciduous trees. It is a large genus with many species that form apothecia only rarely, thus thallus characters such as the presence of soredia or isidia, width of the lobes, and reactions of certain portions of the thallus to chemical reagents such as KOH solution have been extensively used in taxonomic treatments of the genus. *Parmelia borreri* (Sm.) Turn. and *Parmelia caperata* (L.) Ach. are in the species group with large thalli, the individual lobes 8 to 20 mm. wide, a black under surface sometimes shading into tan at the margins, and rhizines. Both *P. borreri* and *P. caperata* produce soredia; however *P. caperata* has a yellowish-green thallus with soredia produced over the surface of the lobes, while *P. borreri* has a mineral gray thallus with soredia over the surface of the lobes and along the margins of the lobes also. *Parmelia reducta* Ach. has a medium sized thallus, with individual lobes 1 to 3 mm. in width, and isidia.

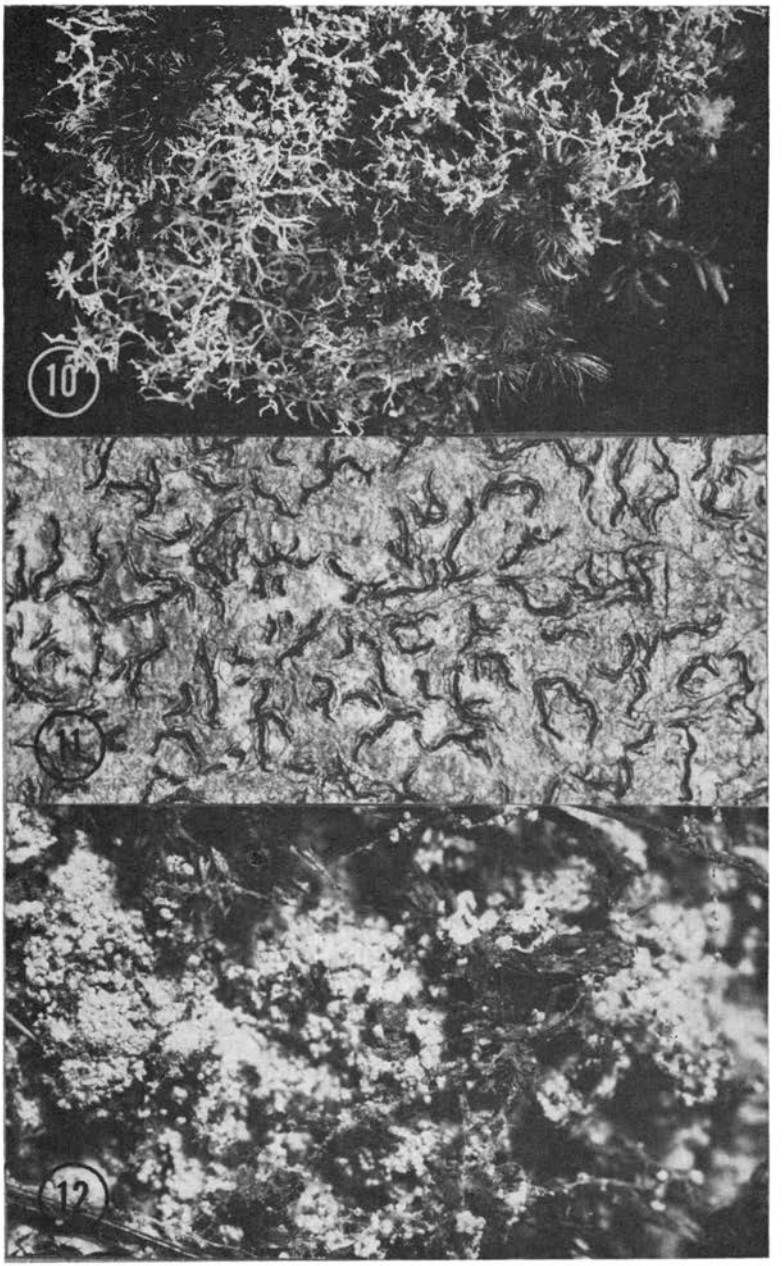

Figure 10. Secondary thallus of *Cladonia furcata* intermingled with mosses. Fig. 11. Thallus and apothecia of *Graphis scripta*. Fig. 12. Thallus of *Crocynia membranacea* growing over mosses.

8. *Physcia*

Thallus foliose orbicular (rounded), lobes appressed to ascending, mainly attached to the substrate by rhizines; upper cortex, algal layer, medulla and lower cortex well developed, lower side usually pale in color; apothecia sessile or short stalked, brown to black or pruinose (with a powdered appearance); asci with 8 ascospores; ascospores (Fig. 16) brown, usually 2-celled, spore walls variously thickened; pycnidia immersed in the thallus; conidia short, cylindrical and straight or long, thin and curved.

Species of Physcia are commonly found on the limbs and trunks of deciduous trees. Apothecia are more commonly produced than by Parmelia species, and the light lower surface also serves to separate them from the small Parmelias. Chemical tests are used in separating species, but are not too successful on some of the smaller thalloid forms where it is difficult to get a large enough area of medulla for an accurate test.

Physcia stellaris (L.)Nyl. (Fig. 1) is the most prevalent species in our area. It occurs usually on trees, its whitish-gray to bluish-gray thallus growing close to the substrate. No soredia or isidia are formed, while apothecia are usually present over the thallus. Pycnidia are common, with straight, small (3-5 microns) conidia. The lower surface is pale with numerous rhizines. The other common species with a whitish-gray thallus, *P. millegrana* Degelius, has granular soredia and commonly forms apothecia over the thallus.

Two smaller species with gray-brown to greenish-brown thalli, black under sides and dark rhizines also occur on bark quite commonly. *P. ciliata* (Hoffm.) DuRietz has light gray-brown to dark brown thalli with lobes 1 to 2 mm. broad, no soredia, usually no isidia, and apothecia typically with a ring of rhizines projecting around each apothecium from the thalloid exciple. *Physcia orbicularis* (Neck.) Thomson has small olive-gray to greenish-brown thalli which often coalesce over large areas. Soredia occur on the upper surface, and one variety of this species has a characteristic reddish-orange medulla.

9. *Candelaria*

Thallus foliose, commonly yellow, more or less irregularly lobed, differentiated into an upper cortex, thin algal layer, medulla, and lower cortex with short rhizoids; apothecia sessile, paraphyses somewhat enlarged at apices; asci with 16 to 32 ascospores; ascospores hyaline, ellipsoid, non-septate to becoming 1-septate.

The common species *Candelaria concolor* (Dicks.) Arn. (Fig. 8) occurs on the bark of decidious trees, especially on elms. The

greenish-yellow to yellow thallus has many small, scattered or clustered sorediate lobes. The apothecia are 0.5 to 1.5 mm. across, upper surface yellow to brownish, with a wavy thalloid exciple. Ascospores become 1-septate, and are 6-11 x 3-5 microns.

10. *Peltigera*

Thallus large, lobed, loosely attached to substrate by rhizines, differentiated into an upper cortex, an algal layer and a medulla to which the rhizines are attached, lower surface more or less veined; apothecia marginal, often with sides reflexed, horizontal or vertical, exciple lacking; asci with 8 ascospores; ascospores; fusiform or broader at one end, sometimes curved, 3-9 septate.

Peltigera canina (L.)Willd. is common on soil, around rotten logs and at the bases of trees. The thallus is quite variable, slate gray to a greenish-brown or brown and up to 30 cm. or more across. The under surface has a network of raised white to brown, veinlike areas with rhizoids. The apothecia are upright on lobes of the thallus, 6 to 10 mm., with a redidsh-brown to darker surface. Apothecia are not uncommon, but are not always present.

11. *Calicium*

Thallus usually smooth, inconspicuous and sometimes disappearing, rarely with margins lobed; apothecia black or lightly pruinose, proper exciple present, no thalloid exciple; well developed stalks; asci disintegrating readily, with 8 ascospores; ascospores brown, often constricted at the cross wall, 1-septate.

Calcium lenticulare (Hoffm.) E. Fries occurs on tree bark and on old wood. The thallus is ashy to white, the apothecia and stalks brownish-black to black, apothecia 0.2 to 0.4 mm., ascospores 5-7 x 3-5 microns.

12. *Cyphelium*

Thallus smooth to rough to warty, sometimes with lobed margins; apothecia usually superficial or immersed in thallus, thalloid exciple present and sometimes proper exciple also; asci disintegrating readily, with 8 ascospores; ascospores brown, 1-septate, usually constricted at the cross wall.

Cyphelium tigillare Ach. occurs on wood. The yellowish-green thallus is roughened to warty; apothecia often immersed, 0.3 to 0.5 mm., upper surface dull black, proper exciple black; ascospores 14-24 x 7-11 microns.

13. *Opegrapha*

Thallus crust partly or wholly within the substrate, not differentiated into layers; apothecia linear to ellipsoid or rarely almost circular in outline, rarely branched, superficial to immersed,

inner surface usually black; paraphyses interwoven and branched; asci with 8 ascospores; ascospores hyaline commonly,' but sometimes becoming brownish, several septate, oblong to ellipsoid or fusiform.

Opegrapha pulicaris (Hoffm.) Nyl. resembles *Graphis scripta* in thallus color, and also occurs on bark. The apothecia of *Opegrapha pulicaris* are rather short and wide (0.4-2 x 0.16-0.4 mm.), and are often quite widely open exposing the black inner surface. Ascospores (Fig. 15) are hyaline to finally brownish, fusiform to oblong-ellipsoid, usually 3- to 5-sepate, 18-30 x 5-8 microns.

14. *Graphis*

Thallus forms a thin, usually smooth crust upon substrate, partly within substrate, no differentiation into layers; apothecia linear, curved, somewhat immersed, often branched, inner surface black when apothecia open, black proper exciple often surrounded by a thalloid exciple; paraphyses unbranched; asci with 8 ascospores, hyaline, 3- to many-septate, cells lenticular (Fig. 14).

Graphis scripta (L) Ach., (Fig. 11) the so-called script lichen, occurs on tree bark. The thin greenish-gray to white thallus with long narrow (1-5 x 0.1-0.25 mm.) immersed black apothecia are readily recognized. Ascospores (Fig. 14) are 5 to 11 septate, hyaline, 20-50 x 6.5-12 microns.

15. *Phaeographis*

Thallus forms a thin, usually smooth crust, partly or wholly within the substrate, not differentiated into layers; apothecia linear, curved, often branched, inner surface black, proper exciple black, thalloid exciple usually present; paraphyses unbranched; asci commonly with 8 ascospores; ascospores brown, oblong-ellipsoid to longer, 3- to many septate, cells lenticular.

Phaeographis inusta (Ach.)Mull. Arg. can be distinguished from *Graphis scripta* by its dark brown ascospores primarily, also by its greenish-gray to olive-brown thallus. Ascospores are brown, oblong-ellipsoid, 5- to 7-septate, 20-36 x 6-9 microns.

16. *Verrucaria*

Thallus crustose, partly or wholly within substrate, warty to areolate; well developed hypothallus, no differentiation into layers; perithecia immersed, 1 to several in each segment of thallus, ostiole small and inconspicuous; asci clavate, with 8 ascospores; ascospores hyaline to rarely brownish ,non-septate.

Verrucaria nigrescens Pers. is common on rocks. The chunky to areolate grayish-brown to darker thallus is not very conspicuous however. Ascospores are hyaline, ellipsoid, 15-26 x 7-11 microns.

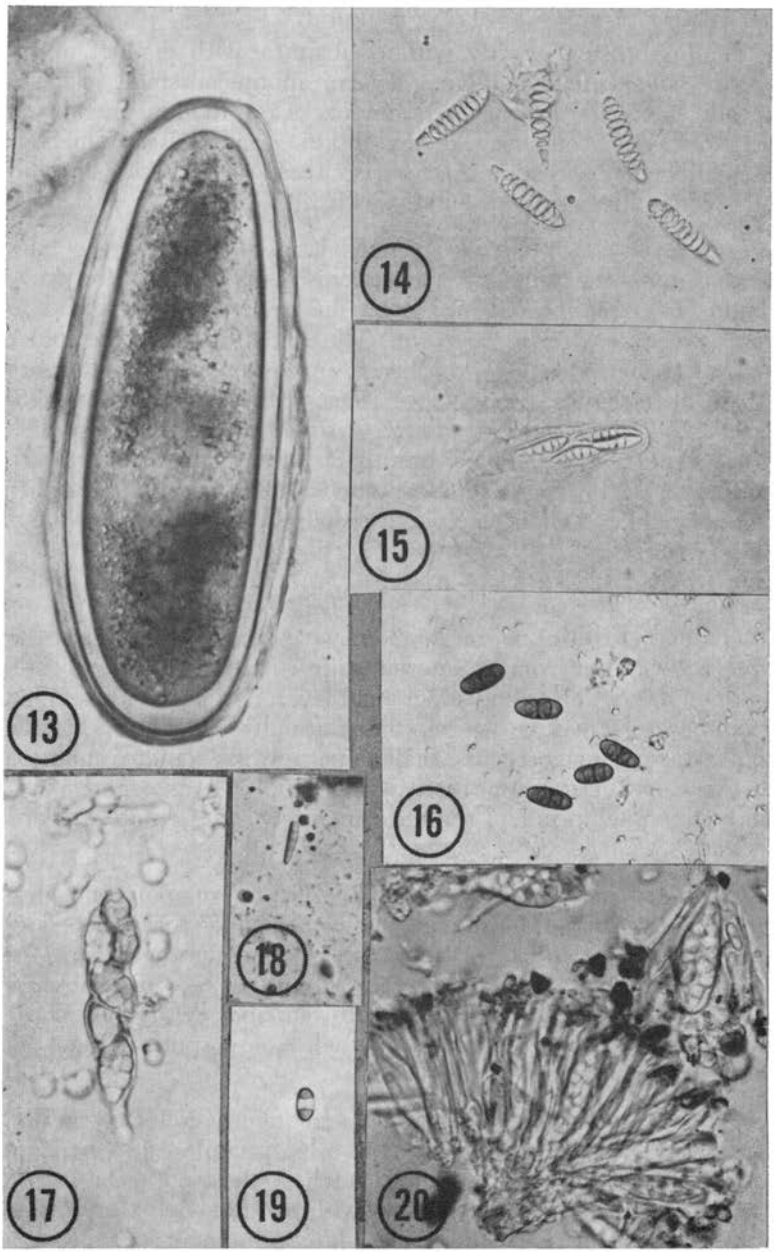

Figure 13. Ascospore of *Pertusaria multipuncta*. Fig. 14. Ascospores of *Graphis scripta*. Fig. 15. Ascospores of *Opegrapha pulicaris*. Fig. 16. Ascospores of *Physcia stellaris*. Fig. 17. Ascus and ascospores of *Leptogium chloromelum*. Fig. 18. Ascospores of *Bacidia trisepta*. Fig. 19. Ascospores of *Caloplaca cinnabarina*. Fig. 20. Asci and paraphyses of *Caloplaca cinnabarina*.

17. *Pertusaria*

Thallus crustose, partly within substrate, with distinct upper cortex, algal and medullary layers; apothecia small, one to several immersed in wartlike segments of the thallus, opening at first small but becoming wide and disklike; paraphyses branched; asci with 1 to 8 ascospores per ascus; ascospores hyaline, ellipsoid or oblong-ellipsoid, non-septate, with thick wall.

Pertusaria multipuncta (Turn.) Nyl. is common on the bark of various trees. The ashy to greenish-gray smooth to warty thallus has apothecia 0.3-0.6 mm., one to several immersed in each wartlike thallus segment. The areas around the older apothecia become powdery heaps. Ascospores (Fig. 13) are single in the ascus, rarely 2 per ascus, with each ascospores 75-170 x 25-65 microns. *Pertusaria pustulata* (Ach.)Duby which also occurs on deciduous tree bark, has a greenish-gray to yellowish or brown thallus; apothecia 0.15-0.4 mm., a rather thick irregular thalloid exciple; ascospores 2 per ascus, 50-135 x 25-56 microns.

18. *Caloplaca*

Thallus crustose or rarely somewhat foliose, granulose to areolate, varying from no internal differentiation to a poorly developed upper cortex, indistinct algal layer, and poorly developed medulla and lower cortex; apothecia usually adnate and sessile, thalloid exciple colored like thallus; paraphyses septate, enlarged at the apices; asci with 8 ascospores (Fig. 20); ascospores hyaline, oblong-ellipsoid, 1-septate, or rarely non-septate, polarilocular.

Caloplaca cinnabarina (Ach.) Zahlbr. is common on sandstone in this area. The orange thallus is chinky to areolate and sometimes with lobed scattered areas. The apothecia are 0.2 to 0.7 mm., adnate, numerous to the extent that they may obscure much of the thallus, dark orange to cinnabar with the exciple somewhat the same color as the thallus, ascospores (Fig. 19) 7-13 x 5-7 microns.

Caloplaca ulmorum (Fink)Fink is frequently collected on elm bark. The thallus is greenish-gray to ashy, granulose to verrucose and irregularly spread in small patches; the apothecia 0.2 to 1.3 mm., sessile, dull waxy-yellow with a roughened to pruinose surface surrounded by an ashy white prominent exciple; the ascospores 8-18 x 5-10 microns.

Caloplaca camptidia (Tuck.)Zahlbr. has been collected on bark of deciduous trees, especially on cottonwood bark. The thallus is ashy to brownish-gray, smooth to chunky; apothecia

0.2 to 1 mm., reddish-brown to darker and white-pruinose with the exciple gray like the thallus; ascospores 10-14 x 5-8 microns.

19. *Buellia*

Thallus crustose, granulose to areolate, mainly above the substrate; apothecia hard, sessile, commonly black (Fig. 6) with a black proper exciple which may disappear; paraphyses branched, usually enlarged and brownish toward the apices; asci usually with 8 ascospores; ascospores brown to rarely smoky, 1-septate, ellipsoid to oblong-ellipsoid, polarilocular.

Buellia parasema (Ach.)DeNot. collected on the bark of various deciduous trees has a smooth to roughened and chunky greenish-gray to ashy thallus commonly bordered by a black line; apothecia 0.3 to 0.8 mm., black; ascospores 10-22 x 5-10 microns. *Buellia punctata* (Hoffm.)Mas., has been reported on wood and rocks, and has a greenish-gray to ashy, scurfy to rough often disappearing thallus; apothecia 0.1 to 0.6 mm., black; ascospores 7-16 x 4-7.5 microns.

20. *Rinodina*

Thallus crustose, granulose to areolate to sometimes lobed, differentiated into poorly developed upper cortex, thin algal layer, and a somewhat developed medullary layer; apothecia immersed to sessile, brown to black or pruinose; thalloid exciple colored like thallus, irregular, sometimes disappearing; paraphyses straight; asci usually with 8 ascospores; ascospores brown, usually 1-septate, polarilocular.

Rinodina milliaria Tuck. is common on bark of deciduous trees, especially on shagbark hickory. The thallus is thin, finely granulose, greenish-gray to green with black apothecia 0.15 to 0.3 mm. and surrounded by a thin thalloid exciple. Ascospores are oblong-ellipsoid, slightly constricted at the single septum, 9-15 x 5-8 microns.

21. *Acarospora*

Thallus squamulose, forming areoles toward the center and frequently lobed toward the margin, some species becoming whitened with age; apothecia usually immersed, 1 to 3 or more in each areole, thalloid exciple frequently differentiated; asci thick walled with numerous ascospores; ascospores minute, non-septate.

Acarospora smaragdula (Wahl.)Mass., one of the crustose lichens on rocks, has a yellowish-brown to chestnut thallus which varies from a lobed to a scattered aerolate to squamulate condition. Apothecia are 0.3 to 0.8 mm., usually 1 to 3 per areole, immersed to becoming superficial, reddish-brown, with

the entire thalloid exciple disappearing with age. Ascospores are many per ascus, 3-5 x 1.5-3 microns.

22. *Diploschistes*

Thallus crustose, thick, areolate, with a poorly developed upper cortex, more or less distinct algal and medullary layers; apothecia immersed to adnate, surrounded by a thick irregular proper exciple of the same color as the upper apothecial surface, usually with a thin thalloid exciple; asci with 2 to 8 ascospores; ascospores brown, ellipsoid to oblong-ellipsoid, muriform. *Diploschistes scruposus* (Schreb.)Norm. occurs on sandstone. Thallus is composed of uneven gray to ashy-white wartlike areoles. The apothecia are 0.3 to 1 mm., black or grayish pruinose with a thin black proper exciple and a thick swollen thalloid exciple; ascospores 4 to 8 per ascus, brown, muriform, 20-34 x 10-15 microns.

23. *Bacidia*

Thallus crustose, granulose, to warty ,sometimes inconspicuous and even disappearing, not differentiated; apothecia usually adnate with upper surface flesh-colored to darker or even black and an exciple of the same color; asci with 8 ascospores; ascospores hyaline with several septa which are often indistinct.

Bacidia trachona (Ach.)Lett. is one of the rather obscure crustose forms occurring on rocks. The greenish-gray to ashy thallus is scurfy or granulose. The apothecia are 0.4 to 0.8 mm., brownish-black to black, initially with a black proper exciple, and the ascospores are 3-septate, 12-19 x 2.5-5.5 microns.

Bacidia trisepta (Naeg.)Zahlbr. occurs on the bark of various deciduous trees. The thallus is obscure, thin, grayish to brownish. The apothecia are less than 0.2 mm., black with a rapidly disappearing black exciple, and the ascospores (Fig. 18) are 3-septate, 14-21 x 3.5-5 microns.

24. *Lecanora*

Thallus crustose to rarely foliose, crustose forms not differentiated into layers or poorly so, foliose forms with well-developed upper cortex, algal and medullary layers, and poorly developed lower cortex; apothecia immersed to sessile with a thalloid exciple colored like the thallus; asci with usually 8 ascospores; ascospores hyaline, non-septate.

Lecanora iowensis Fink has been collected on sandstone. The thin greenish-gray to ashy, granular to warty thallus has small flat sections with a few lobes toward the margins. The apothecia are 0.25 to 0.7 mm., 1 to 2 per thallus segment, upper surface brown to black with a pruinose cover, with an exciple colored like the thallus. Ascospores are 10-14 x 5-8 microns.

25. *Lecidea*

Thallus crustose, granulose to warty, not differentiated into layers; apothecia immersed to sessile, proper exciple present but usually disappearing; asci with 8 ascospores; ascospores hyaline, non-septate usually, oblong or ellipsoid.

Lecidea is a very common genus with many species.

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