

The Genera *Lecidea*, *Lecidella* and *Huilia* (Lichens) in Japan I. *Lecidea**

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Introduction

Lecidea (s. lat., sensu Zahlbruckner 1926) is one of the largest lichen genera. It has been distinguished from other lichens by its crustose to effigurate or squamulose thallus containing protococcoid algae, lecideine or biatorine sessile apothecia, and colorless simple spores which are small- to medium-sized. However, the genus seems to be heterogeneous as R. Santesson (1952) has pointed out, in that some groups of species in the genus are more closely related to other genera in view of our modern knowledge. In recent years a very important series of papers, notably by Hertel (1967, etc.), Hertel & Leuckert (1969), V. Wirth & Vežda (1972), Schneider (1979), and Swinscow & Krog (1981) have radically altered the taxonomic concept of the genus. For example, they have separated the genera *Lecidea* (s. str.), *Lecidella*, *Huilia*, *Fuscidea*, *Psora*, and *Phyllopsora* in a modern sense from the heterogeneous *Lecidea* in a broad sense.

In the present paper an attempt is made to revise the Japanese species of *Lecidea* (s. str.), *Lecidella*, and *Huilia* on the basis of modern principles. These three genera are not especially closely related to each other taxonomically, as will be discussed below. They could well be placed in independent families, when the taxonomy of species belonging to *Lecidea* (s. lat.) and the other genera of Lecideaceae (sensu Zahlbruckner 1926) are treated monographically. Further studies will be required, of course, to segregate *Lecidea* (s. lat.) into more natural genera and to establish their most reasonable taxonomic position.

1. Brief history of the genera

1) *Lecidea*

The genus *Lecidea* was proposed by Acharius (1803), who ascribed great importance to apothecial structure visible to the naked eye as a diagnostic character, stating, "Apothecium e propria substantia compositum, nec a thallo ullo modo formatum. Apothecia aperta; patellulae concavae, planae vel convexiusculae.

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Thallus varius.” However, the 99 species of the genus recognized by him are now placed in various genera in the families Lecideaceae, Buelliaceae, Umbilicariaceae, and others.

In his microscopic examination, Massalongo (1852) emphasized the importance of spore characters in the classification of *Lecidea*: “sporidia ovoidea vel elliptica, semper diaphana, nonnunquam aetate protracta, fusciscentia, homogenea monolocularia.” The category of *Lecidea* recognized by him was narrower than that of Zahlbruckner (1926), and *Biatora* Fr. and *Psora* (Hall.) were treated as autonomous. Körber (1855) reached the same conclusion. Furthermore, Körber (1861) first divided the genus into 6 stirps: *Lecidea fumosae*, *L. confluentis*, *L. platycarpae*, *L. sarcogynoidis*, *L. Juranae*, and *L. hydrophicae*.

Th. Fries (1874) subdivided the genus *Lecidea* (s. lat.) into 4 subgenera, and described the species known from Scandinavia at that time, using microscopic characters as well as macroscopic features. This work is even now accepted as an indispensable reference. His subdivision is: A. *Psora* (Hall.) Th. Fr.; B. *Biatora* (Fr.) Th. Fr.; C. *Mycoblastus* (Norm.) Th. Fr.; and D. *Eulecidea* Th. Fr.

Later Zahlbruckner (1926) modified Th. Fries' classification slightly; he excluded *Mycoblastus* from the genus and considered it an autonomous genus belonging to the Lecideaceae. Zahlbruckner's concept of *Lecidea* has been followed by many authors such as Lowe (1939), Magnusson (1952), and Grumman (1963).

Vainio (1934) proposed a different subgeneric division of *Lecidea* (s. lat.), in which he recognized the subgenera *Protoblastenia* (Zahlbr.) Vain., *Psora* (Hall.) Th. Fr., and *Eulecidea* Th. Fr. emend Lynge in Vain. (incl. *Biatora*). This work is one of the important contributions for clarifying the Finnish flora of *Lecidea* (s. lat.), but no one has accepted this system of classification. Vainio's contribution is also very useful in recognizing the “true species,” that is, he examined many original specimens (syntypes) available at that time in the Acharian Herbarium, the Nylander Herbarium, and others, to which he had ready access.

Most of the authors mentioned above agreed that “the simple colorless spore” was one of the basic diagnostic characters of the genus *Lecidea* (s. lat.). Nylander (1857a, 1861, etc.) and Vainio (1890, 1909), however, rejected this spore character in the diagnosis of *Lecidea* (s. lat.). For example, Vainio (1890) included 11 subgenera under the genus: *Toninia* (Mass.) Vain., *Bacidia* (De Not.) Vain., *Thalloidima* (Mass.) Vain., *Bilimbia* (De Not.) Vain., *Lopadium* (Körb.) Vain., *Bombyliospora* (Mass.) Vain., *Psorothecium* (Mass.) Vain., *Catillaria* (Mass.) Vain., *Psora* (Hall.) Th. Fr., *Biatora* (Fr.) Th. Fr., and *Eulecidea* Th. Fr. in which some had simple spores, some 1-septate spores, and the others multi-septate or muriform spores.

On the other hand, Magnusson (1925, 1931, 1945) studied monographically a few of the natural groups belonging to *Lecidea* (s. lat.) such as the *Lecidea rivulosa* group which comprises the nucleus of the current genus *Fuscidea* V. Wirth & Vězda, the *Lecidea armeniaca*-*L. elata* group which comprises the nucleus of

Lecidea sect. *Elatae* Jatta, and the *Lecidea goniophila* group which comprises the nucleus of the current genus *Lecidella* Körb. emend Hertel & Leuckert. Poelt (1961) also studied the *Lecidea goniophila* group in central Europe, and presented a key to the European species of *Lecidea* subg. *Lecidella* (Poelt 1969).

Recently, Hertel (1967) limited the genus *Lecidea* in the sense of *Lecidea* D. *Eulecidea* Th. Fr. (1874), and subdivided it into the following five subgenera: Subg. *Lecidea*, Subg. *Lecidella* (Körb.) Stitz. emend Hertel, Subg. *Haplocarpon* (Choisy) Hertel, Subg. *Carbonea* Hertel, and Subg. *Cephalophysis* Hertel. In a later work (Hertel 1977), he restricted the genus to subg. *Lecidea* on the basis of anatomical characters of apothecia, such as excipulum, paraphyses, and apical ascus structure.

2) *Lecidella*

The genus *Lecidella* was established by Körber in 1855. He distinguished the genus from *Lecidea* mainly by the difference in hypothecial coloration: in *Lecidella* the hypothecium was "simplex carnosum-grumosum," while in *Lecidea* "simplex carbonaceum." Only a few lichenologists, such as Stein (1879) and Sydow (1887), followed him without introducing any major modifications. On the other hand, the genus was recognized as a subgenus under *Lecidea* by Stitzenberger (1862), Müller, J. A. (1894) and Jatta (1900, 1911). Most lichenologists, however, have ignored this genus because Th. Fries (1874) reduced it to a synonym of *Lecidea* D. *Eulecidea* Th. Fr. and Zahlbruckner (1926) followed Fries in compiling the Lichenes in "Die Natürlichen Pflanzenfamilien."

At any rate, no further noteworthy contributions on *Lecidella* appeared until 1950, when Choisy resurrected and delimited the genus, using the character pycnospores, "pycnoconidies aciculaires, le plus souvent courbes," in addition to Körber's original delimitation. Hertel (1967) attempted to treat the genus on the basis of modern information, and recognized it as *Lecidea* subgenus *Lecidella* (Körber) Stitz. emend Hertel. Two years later, however, Hertel & Leuckert (1969) raised it again to an autonomous genus, as here accepted. More recently Ahti et al. (1973), R. Anderson (1974), Hawksworth et al. (1980), and Poelt & Vězda (1981) accepted the genus *Lecidella* in their respective treatments of lichens from Canada, America, England, and Europe.

3) *Huilia*

Huilia was established by Zahlbruckner (1930) erroneously as a member of the Pannariaceae. No further information on the genus appeared until 1975 when Hertel (1975b) referred to it.

Choisy (1936) proposed the genus *Haplocarpon* independent of Zahlbruckner's 1930 contribution. He distinguished it from *Lecidea* by spore characters, "Sporae magnae vel mediocres, versimiliter plurinucleatae, saepe halonae." The genus *Haplocarpon* was later accepted by a few authors such as Vězda (1972) and V. Wirth (1972). Before the contributions by Vězda and V. Wirth, the genus *Haplocarpon* was reduced by Hertel (1967) to a subgenus of *Lecidea* and

subdivided into three sections on the basis of structural differences in the excipulum: Sect. *Haplocarpon*, Sect. *Ypocritae* Hertel, and Sect. *Juranae* (Körb.) Jatta. Later Hertel (1975b) recognized that *Haplocarpon* Choisy (excl. Sect. *Juranae**; this was regarded as a synonym of *Tremolecia* Choisy 1953 by Hertel 1977) was a synonym of Zahlbruckner's *Huilia*, as here delimited.

2. Contributions so far made on Japanese species of *Lecidea* (s. lat.)

The lichen flora of Japan, treated in several publications, includes the following species of *Lecidea* (s. lat.).

Müller, J. A. (1879): *Lecidea albocaerulescens* Ach., *L. coarctata* β *elachista* Th. Fr., *L. exigua* Chaub., and *L. inexpectata* n. sp.

Nylander & Crombie (1884): *L. albuginosa* Nyl., *L. enteroleuca* (Ach.) Nyl., *L. enteroleucella* n. sp., and *L. Maingayensis* n. sp.

Nylander (1890): *L. albocaerulescens* Ach., *L. apochroella* Nyl., *L. consentiens* Nyl., *L. contigua* (Fr.), *L. derelicta* n. sp., *L. enteroleuca* (Ach.) Nyl., *L. enteroleucella* Nyl., *L. euphoriza* n. sp., *L. fuliginea* Ach., *L. furfuracella* n. sp., *L. Hiroshimita* n. sp., *L. homoeochroa* n. sp., *L. illita*, *L. inductella* n. sp., *L. insulatula* n. sp., *L. Maingayensis* Cromb., *L. meiocarpa* Nyl., *L. meiospora* Nyl., *L. mollis* (Wahlenb.) Nyl., *L. Nagasakensis* n. sp., *L. ocellifera* n. sp., *L. panaeola* Ach., *L. paupercula* Fr., *L. plana* f. *subsparsa* n. f., *L. praesparsa* n. sp., *L. sanguineoatra* Fr., *L. subrubiformis* n. sp. (= *L. rubiformella* Zahlbr. nom. nov.), *L. subrufata* n. sp., *L. subtessellata* n. sp., *L. tornoënsis* Nyl., *L. turgidula* Fr., *L. vernalis* (L.) Ach. and *L. Youmotoensis* n. sp.

Müller, J. A. (1891): *L. adpressula* n. sp., *L. angolensis* Müll. Arg., *L. granifera* (as *Lecanora*), *L. inexpectata* Müll. Arg., and *L. punctulata* Fée.

Müller, J. A. (1892): *L. albocaerulescens* Ach., *L. angolensis* Müll. Arg., *L. derelicta* Nyl., *L. parasema* Nyl., *L. personatula* Müll. Arg., *L. platycarpa* Ach., and *L. russula* Ach.

Nylander (1900): *L. aurigera* Fée, *L. meiocarpa* Nyl., *L. sphaerellifera* n. sp., *L. sylvana* Arn., *L. tornoënsis* Nyl., and *L. turgidula* Fr.

Yasuda (1915): *L. spumosula* Zahlbr. (= *Bacidia* sp.)

Zahlbruckner (1916): *L. sendaiensis* n. sp., *L. spumosula* n. sp. (= *Lecidella* sp.) nom. illegit., and *L. yezoensis* n. sp.

Vainio (1918): *L. alboflavescens* n. sp., *L. leucosoralis* n. sp., *L. olivacea* var. *euphoreoides* Vain., *L. pruni* n. sp., and *L. Tiliae* n. sp.

Vainio (1921): *L. declinella* n. sp., *L. densiflorae* n. sp., *L. kiiensis* n. sp., *L. luridopallens* n. sp., *L. olivacea* var. *caesitia* n. var., *L. olivacea* var. *euphoreoides* Vain., and *L. ocellaris* n. sp.

Yasuda (1925): *L. albocaerulescens* Ach., *L. alboflavescens* Vain., *L. olivacea* var. *euphoreoides* Vain., *L. olivacea* var. *caesitia* Vain., *L. Tiliae* Vain., *L. leucosoralis* Vain., *L. ocellaris* Vain., *L. declinella* Vain., *L. luridopallens* Vain., *L. kiiensis* Vain., and *L. densiflorae* Vain.

Zahlbruckner (1927): *L. albocaerulescens* Ach., *L. albocaerulescens* var. *flavo-caerulescens* Schaer., *L. asahinae* n. sp., *L. aurigera* Fée, *L. caesiororida* n. sp., *L. nipponica* n. sp., *L. melancheima* Tuck., and *L. rosulata* n. sp.

Sato (1936): *L. Fujikawae* n. sp. (*Lecidea* Sect. *Toniniopsis* n. Sect.).

Lamb (1938): *L. cephalophora* n. sp.

Asahina & Sato in Asahina (ed.) (1939): *L. albocaerulescens* (Wulf.) Ach., *L. vernalis* (L.) Ach.

Asahina (1953): *L. ostreata* (as *Psora*).

Asahina (1954a): *L. pseudohaematomma* n. sp.

Asahina (1954b): *L. handelii* Zahlbr. (= *L. pseudohaematomma*).

Asahina (1957a): *L. handelii* Zahlbr.

Asahina (1957b): *L. pseudohandelii* n. sp.

* The calcicolous species of the *Lecidea jurana*-group were excluded from *Tremolecia*, and were created as a new genus *Melanolecia* Hertel in Poelt & Vězda (1981).

Sato (1962): This contribution summarizes the Japanese *Lecidea* known up to 1958 with no attempt at revision and is based chiefly on Zahlbruckner's Catalogus (1925, 1931). The following species were thus introduced in the flora of Japanese *Lecidea* (the taxa in parenthesis are previously known names): *L. aeneola* Vain. (= *L. paupercula*), *L. elaeochroma* var. *caesitia* (Vain.) Zahlbr. (= *L. olivacea* var. *caesitia*), *L. elaeochroma* f. *euphoreoides* (Vain.) Zahlbr. (= *L. olivacea* var. *euphoreoides*), *L. granifera* Ach. (= *Lecanora granifera*), *L. macrocarpa* Steud. (= *L. platycarpa*), *L. minuta* (Schaer.) Nyl. (= *L. meiocarpa*), *L. ostreata* (Hoffm.) Schaer. (= *Psora ostreata*), *L. rubiformella* Zahlbr. (= *L. subrubiformis*), and *L. vulgata* Zahlbr. (= *L. enteroleuca*).

Yoshimura (1974): *L. adpressula* Müll. Arg., *L. albocaerulescens* (Wulf.) Ach., and *L. scalaris* Ach. (= *L. ostreata*).

M. Inoue (1976): *L. aeolotera* Vain., *L. albocaerulescens* (Wulf.) Ach., and *L. flavocaerulescens* Hornem.

Hertel (1977): *Fuscidea cyathoides* (Ach.) V. Wirth et Vězda, *Huilia aeolotera* (Vain.) Hertel, *H. albo-caerulescens* (Wulf.) Hertel var. *albocaerulescens*, *H. albocaerulescens* var. *polycarpiza* (Vain.) Hertel, *H. crustulata* (Ach.) Hertel, *H. flavocaerulescens* (Hornem.) Hertel, *H. macrocarpa* (DC.) Hertel, *H. yezoensis* (Zahlbr.) Hertel, *Lecidea paupercula* Th. Fr., *L. plana* (Lahm in Körb.) Nyl., *L. oreinodes* (Körb.) W. A. Weber & Hertel, *L. rosulata* Zahlbr., *L. homoeochroa* Nyl., *L. vorticosa* (Flk.) Körb., *Lecidella bullata* Körb., *L. enteroleucella* (Nyl.) Hertel, *Trapelia coarctata* (Sm. & Sw) Choisy, *Tremolechia atrata* (Ach.) Hertel, *Lecidea insulatula* Nyl., and *L. praespersa* Nyl.

Schneider (1979): *Lecidea densiflorae* Vain., *L. kiiensis* Vain., *L. handelii* Zahlbr., *L. luridopallens* Vain., *Psora nipponica* (Zahlbr.) G. Schneider, *P. rubiformella* (Zahlbr.) G. Schneider, and *Psorula rufonigra* (Tuck.) G. Schneider.

Swinscow & Krog (1981): *Phyllospora densiflorae* (Vain.) G. Schneider ex Swinscow & Krog and *P. haemophaea* (Nyl.) Müll. Arg.

M. Inoue (1981): *Fuscidea austera* (Nyl.) P. James, *F. circumflexa* (Nyl.) V. Wirth et Vězda, *F. cyathoides* var. *japonica* M. Inoue et P. James, *F. cyathoides* var. *suborientalis* (Zahlbr.) M. Inoue, *F. mollis* (Wahlenb.) V. Wirth et Vězda, *F. submollis* M. Inoue, and *F. verruciformis* M. Inoue.

In total, seventy-four species, and three varieties, of the genus *Lecidea* (s. lat.) have so far been reported from Japan. A large number of Japanese species had been reported under the generic name *Lecidea* but in Zahlbruckner's Catalogus (1925) these were listed under *Bacidia*, *Biatorella*, *Buellia*, *Catillaria*, *Rhizocarpon*, *Lecanactis*, or other genera; see Sato's "Catalogus lichenum japonicorum (ed. 2, 1962)."

3. Method of study

The external features of the specimens were studied with the aid of a wide field binocular microscope (8–60×); anatomical characters were observed with a binocular biological microscope (40–2000×), using vertical sections cut by hand. Measurements of the size of organs such as spores and the hymenium were made from material in water. Values for spores produced only at 2 or 3 per ascus were neglected because they were usually monstrous and larger than those normally produced at 8 per ascus. The staining agent for studying hyphal structure was "lactophenol cotton blue." A weak potassium hydroxide solution was applied to enhance colors of the excipulum and hypothecium.

The following solutions were used for the microchemical procedures, abbreviated as indicated in parentheses.

KOH-solution (K): A 7–8% aqueous solution of potassium hydroxide.

p-solution (P): An ethanolic solution of *p*-phenyldiamine.

C-solution (C): A saturated aqueous solution of calcium hypochlorite, commercial bleaching powder.

KC-solution (KC): A combination of the KOH-solution and C-solution. The KOH-solution is applied first, followed by the C-solution.

I-solution (I): A mixture of 30 parts of water, 0.6 parts potassium iodine, and 0.4 parts iodine.

An-solution (An): A mixture of one part anilin, 2 parts ethyl alcohol, and 2 parts glycerol.

GE-solution (GE): A mixture of 3 parts glacial acetic acid and one part glycerol.

GAW-solution (GAW): A mixture of equal volumes of glycerol, ethyl alcohol, and water.

oT-solution (oT): A mixture of one part *o*-toluidine, 2 parts ethyl alcohol, and 2 parts glycerol.

Complex caustic potash solution (KK): A mixture of equal volumes of 5% potassium hydroxide and 20% potassium carbonate.

The following solvent systems were used in TLC.

Solvent A: A mixture of 180 ml benzene, 45 ml dioxane, and 5 ml acetic acid.

Solvent B: A mixture of 130 ml hexane, 80 ml ethyl ether, and 20 ml formic acid.

The microchemical tests were made according to the procedures given by Asahina (1936). Fragments of thalli are put in a microtube (ca. 6 × 45 mm) with acetone, and then the tube is heated with an alcohol lamp. After heating, the acetone is poured on a slide glass, and after the acetone evaporates, the residue is recrystallized with solutions such as An, GE, GAW, oT, and KK.

The lichen substances were identified in most specimens by means of thin-layer chromatography (TLC) using the techniques given by Culberson & Kristinsson (1970) with a few modifications: the residue of the acetone extraction is spotted on Merck's silicagel-coated aluminium sheets (DC-Alufolien Kieselgel F 254, 8 cm long). The chromatograms were developed in two solvent systems (solvent A and solvent B). After evaporation of the solvent, the chromatograms were examined under UV light (254 nm and 366 nm), sprayed with a 10% aqueous solution of sulphuric acid, and heated at about 100–110°C for 15 minutes.

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Morphology

1. Thallus

1) *External morphology*

The formation of the thallus in *Lecidea*, *Lecidella*, and *Huilia* encompasses nearly all types of crustose thalli. Those types are found equally in each of the genera. The types of thallus in a species seem subject to relatively little variation, but the degree of development seems to be very great. The main types more frequently encountered are the epilithic thallus (crustaceous thallus) and the endolithic thallus. The latter was, however, not so prominent in the species treated in the present study.

The epilithic thallus is generally areolate (or cracked-areolate) and contiguous as in *Lecidea lithophila* and *Huilia flavocaerulescens*, or not contiguous but dispersed as in *Lecidea atrobrunnea*. The areolae are plane (or rarely slightly concave), more or less convex with perpendicular or sloping edges, or uneven with protuberances. Such differences in the areolation of the thallus afford good specific characters. Cracks between the areolae are sometimes very irregular or of different sizes, because the large areolae are occasionally divided into smaller ones through thin fissures enlarging gradually into rather wide cracks. The size of the areolae (breadth and thickness) is likewise variable and hence not so important for the taxonomy. In the description of each species I give no measurements of thallus thickness but use the terms "thin," "medium," and "thick" instead; "thin" means a thickness up to 0.2 mm, "medium" means nearly 0.2–0.6 mm or so, and "thick" means over 0.6 mm. The areolae of many species belonging to the *Lecidea atrobrunnea* group, such as *L. atrobrunnea* and *L. subleucothallina*, are more or less similar to the psoroid thallus in which the lower marginal surface slightly separates from the substrate, but the hyphal structure in the upper cortex is absolutely different from each other.

The epilithic thallus is sometimes continuous and more or less rimose as in *Lecidea speirea* and *Huilia albocaerulescens*, or verrucose with somewhat discrete

verrucae as in *Lecidea elabens*. Transitional stages to the type of cracked-areolate thallus occur occasionally, but on the whole one species belongs rather definitely to one type. The thickness of the thallus is variable as mentioned above.

The color of the thallus, diverse within the genera, is usually white, gray, or brown with various shades. A few species such as *Lecidella praespersa* are yellowish-gray or yellowish-green, *Huilia aeolotera* and *H. flavocaerulescens* are ochraceous and others are chalky-white as *L. speirea*.

Features of the surface of the thallus such as "smooth," "tartareous," "polish," and "powdery" afford a good diagnostic characters of species.

2) Internal morphology

The inner structure of the thallus is fundamentally uniform within the genera treated here. The thallus consists of an upper cortical layer, an algal layer which is clearly defined from the upper cortical layer, and a medulla. The lower cortex is not differentiated and the thallus is attached to the substratum directly by medullary hyphae. Algae are always protococcoid.

The upper cortical layer is composed of closely compacted hyphae which are arranged perpendicularly, generally 30–50 μm thick (some are thinner: 10–20 μm thick, others thicker, up to 50 μm thick). There are a few variants in regard to the degree of branching and density of hyphae, but the upper cortical layer

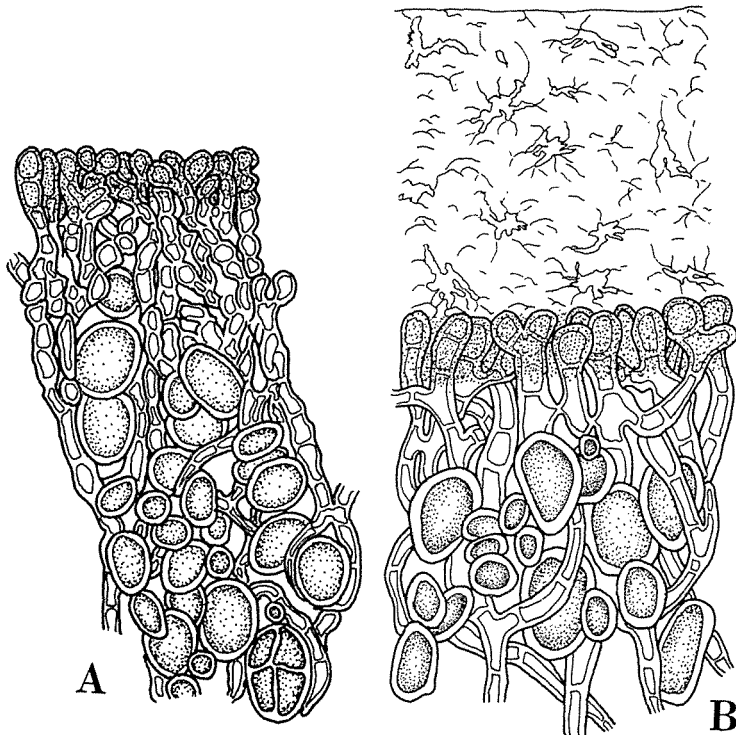


Fig. 1. Vertical thallus sections showing the upper cortical layer and algal layer in *Huilia aeolotera* (A, $\times 1080$); Epinecral layer in addition to the above tissues in *Lecidea atrobrunnea* (B, $\times 1080$).

is basically quite uniform within the genera, except for the species belonging to the *Lecidea atrobrunnea* group. In the species of the group having an "epinecral layer" (Ainsworth 1971), colorless horny dead fungal hyphae with indistinct lumina accumulate upon the upper cortical layer which has the same hyphal structure as in other species (Fig. 1). At present I do not believe that this epinecral layer has a high taxonomic value at generic level, because the upper cortical layer underlying it is not different in structure from that of other species of the same genus and the epinecral layer also occurs in species of *Buellia* among other crustose lichens.

The algal layer is rather uniform, mostly continuous and 50–100 μm thick. The medulla is composed of perpendicularly running hyphae which resemble those of the upper cortical layer in structure but is looser. As the thickness of the upper cortical layer and the algal layer does not vary greatly among species, the differences in the thickness of the thallus are due, for the most part, to the amount of medullary tissue.

2. Hypothallus

Hypothallus is here used in a wide sense, comprising both the prothallus and hypothallus (s. str.). Differences in the type or the color of the hypothallus are occasionally useful as a character for specific diagnosis.

Examples: in *Lecidea lactea*, *Lecidella elaeochroma* var. *caesitia*, etc., the hypothallus forms a narrow black or blackish-gray line at the circumference; in *Lecidea athrocarpa*, *Huilia elegantior*, etc., it is black and visible between the areolae; in *Lecidea elabens* it is white and visible between the verrucae; and in *Lecidella bullata*, *Huilia crustulata*, etc., it is not prominent or indistinct.

3. Apothecia

1) External morphology

The apothecia are mostly sessile, adnate or appressed-adnate to the thallus or hypothallus, but in a few cases they are immersed or subimmersed in the thallus as in *Lecidea athrocarpa* and *L. instratula*. The apothecia are usually slightly constricted at the base, but prominently constricted in *Lecidea auriculata* and *Lecidella bullata*. No constriction can be seen in *Lecidea advena* and *Lecidella praesparsa*. The apothecia are usually 0.5–1 mm in diameter, in extreme cases 0.15–0.5 mm (*Lecidella enteroleucella*) or reaching 1–2.5 mm (*L. auriculata*, *Huilia albocaerulescens*, and *H. macrocarpa*).

The disc varies in shape from plane to strongly convex, and occasionally divides into smaller parts. Color varies from reddish- to dark-brown to black or blue-black. A few species such as *Lecidea subleucothallina*, *Huilia albocaerulescens* and *H. aeolotera* have a whitish or ochraceous pruinose disc. We have sometimes found both naked and \pm pruinose discs in the same specimen. It is difficult to distinguish environmentally induced pruina from pruina which may be genetically controlled. However, I can not deny the taxonomic importance

of pruina, because the presence of pruina is highly constant at least in the three species mentioned above.

The apothecial margin is usually prominent and round at least in the early stages. However, a flexuose margin is seen in *Lecidea auriculata*, *L. lithophila*, etc. The size and status of the apothecia, the shape and color of the disc, the presence of pruina, and the characters of the apothecial margin are important and useful in delimiting species.

2) Internal morphology

There are differences in terminology for the apothecia tissues; the same term

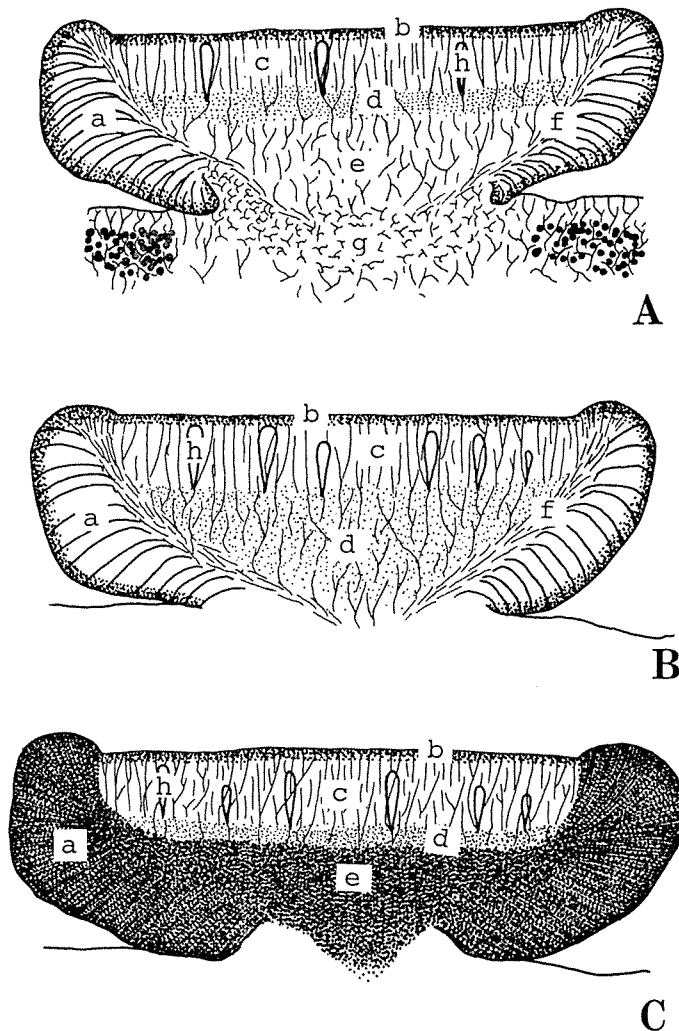


Fig. 2. Vertical sections of apothecia in *Lecidea*(A), *Lecidella*(B), and *Huilia*(C). a. Excipulum, b. Epithecium, c. Hymenium, d. Subhymenium, e. Hypothecium, f. Parathecium, g. Subhypothecial medulla, h. Ascus.

has been used in different meanings and most of the apothecial tissues have been given several names (R. Santesson 1952, Degelius 1954). Terms adopted here are represented in Fig. 2. The apothecia are composed of excipulum, epithecium, hymenium (consisting of paraphyses and ascus), subhymenium and hypothecium.

a. *Excipulum*. The excipulum, to which much attention has been paid, is of constant structure in the genera treated, as previously noted by Hedlund (1892), Vainio (1934), Lowe (1939), and Hertel (1967). In *Lecidea* and *Lecidella*, the excipulum consists of parathecium and amphithecium; the parathecium originates from the under part of hypothecium or subhymenium, running more or less parallel to the edge of the hypothecium (or of the subhymenium) and the amphithecium is derived from the parathecium running perpendicularly to the surface of the apothecia (Fig. 2: A-B). On the other hand, the excipulum of *Huilia* is derived directly from the hypothecium, and the hyphae are radially arranged (Fig. 2: C). In *Lecidea* and *Lecidella*, the excipulum is colorless or paler internally, and darker, not carbonaceous (blue-green, blackish, dark brown, or brown) externally, whereas in *Huilia*, the excipulum is usually more or less carbonaceous and brown throughout apart from differences in the degree of brightness between the inner and the outer parts. Thickness of the excipulum varies within each species. The branching pattern and direction as well as thickness of the hyphae of the excipulum are of great significance for delimiting the species, and the thickness of the hyphal wall has also an important character for distinguishing the species. Concerning the thickness of the hyphae, Frey (1936) proposed a useful terminology: leptodermatous (walls thin relative to the diameter of the lumina); mesodermatous (walls about as thick as the diameter of the lumina); and pachydermatous (walls much thicker than the diameter of the lumina).

b. *Epithecium*. The epithecium is a thin layer on the hymenial surface in which the ends of paraphyses interweave. According to Lamb (1951), brown is the only epithelial color known to occur in *Stereocaulon*, and this indicates a sharp separation from the genus *Pilophoron* in which the epithecium is aeruginose-blackish. In *Lecidea* (s. str.), *Lecidella*, and *Huilia*, this pigmentation is fairly constant within each species, but varies within the genus. Much attention is paid to the color of this tissue in my study. If the apothecia are not modified by extreme conditions, such as high humidity, or infested by insects, color may be a useful character for delimiting species. Diverse colors are observed among the species treated in the present study, but these can be divided into two major groups: various shades of green (blue-green and blackish-green), and various shades of brown (brown, dark-brown, and greenish-brown). *Lecidea plana* is very closely related to *L. lithophila*, having many similar characters, but is distinguished by having blue-green epithecium and smaller spores from *L. lithophila* which has a pale-brown to greenish-brown epithecium and

larger spores. The epithecium is not very thick in most species, but in a few species of *Huilia*, it is rather high. The height of the epithecium is included with the hymenium in descriptions of the present paper.

c. *Hymenium*. The hymenium consists of paraphyses and asci. This tissue is usually colorless but sometimes concolorous with the epithecium for the most part or a half part. An examination of extensive materials revealed that such staining is not so important. The height of the hymenium varies considerably among different species of the genera treated, from 30 μm (in *Lecidea instratula*) to 200 μm (in *Huilia aeolotera*), but in most species between 50 and 100 μm . The height is fairly so constant within each species that it may be used as a basic character for diagnosing the species.

d. *Subhymenium*. The subhymenium is a tissue from which asci and paraphyses develop (Degelius 1954). This tissue consists of ascogenous hyphae and penetrating hyphae giving rise to paraphyses. It has been treated as a part of the hypothecium by many authors, and actually it is difficult to distinguish the subhymenium from the hypothecium in many species. However, with "lactophenol cotton blue" treatment this tissue is stained deeper against the hypothecium. In the species of *Lecidea* and *Huilia* this tissue and the hypothecium are equally remarkable and well separable. However, in the species of *Lecidella*, the subhymenium is very distinct but the hypothecium not so. Hertel (1977) included this tissue in the hypothecium and mentioned that the subhymenium of *Lecidella* was not obvious. Further ontogenetic surveys will be required until a proper term is settled, but at present it is plausible to me that this tissue be called "subhymenium" because it includes ascogenous hyphae. The height of this tissue is as important as that of the hymenium. The tissue is usually colorless but sometimes pigmented as in *Lecidea auriculata* and in some species of *Lecidella*. The character unpigmented versus pigmented subhymenium is taxonomically important.

e. *Hypothecium*. The hypothecium is an underlying tissue below the subhymenium. Height is variable in a species, varying mostly with the age of the apothecium, and accordingly this character is less useful in the delimitation of the species. It varies from colorless (or rarely dirty yellowish-cloudy) to pigmented (various shades of brown). The character unpigmented versus pigmented hypothecium is usually useful for separating allied species. In the species of *Huilia* the hypothecium is always brown and carbonaceous, consisting of irregularly arranged hyphae. On the other hand, in *Lecidea* the tissue of the hypothecium differs slightly within the genus.

f. *Paraphyses*. Paraphyses are simple or branched (the branches are for the most part few in number) in both *Lecidea* and *Lecidella*, but are coherent in *Lecidea*, usually discrete in *Lecidella*. On the other hand, they are richly branched, anastomosed, and coherent in *Huilia*. These characters are fairly

constant in each genus except in a very few cases and serve to distinguish genera; paraphyses of *Lecidea athrocarpa* and *L. instratula* are richly branched and anastomosed as in *Huilia*, but not coherent. The paraphyses are, except at the apices, usually thin ($1.5\text{--}2.5\ \mu\text{m}$ thick in most species). Cells of the paraphyses are generally long and cylindrical throughout but with the tendency for a slight shortening in the apical part. In some species, such as *Huilia aeolotera*, the cells of the apical part are remarkably shorter than those of other parts and exhibit a "submoniliform" shape. Shape of apices shows variation within each genus, but it is fairly constant within a species and constitutes a useful taxonomic criterion (see drawings of individual species).

g. *Asci*. The asci are clavate in the species of the genera treated. They vary in length according to the height of the hymenium. The taxonomic importance of the apical part of the asci (apical apparatus or ascus apex) has been emphasized by many authors. In the present study, however, detailed investigation has not been made except concerning the thickness and the degree of staining with iodine in the tholus (the finger-like protrusion of the inner part of the ascus; =nasse). In species of *Lecidella* the tholus is always thick and strongly stained blue. On the contrary, it is thinner and only faintly stained in *Lecidea* and *Huilia*. This character is stable and hence taxonomically useful in *Lecidella*, as Hertel & Leuckert (1969) have pointed out (Fig. 3: A–B). Further investigations on other apical apparatusi can be expected for classifying *Lecidea* (s. lat.).

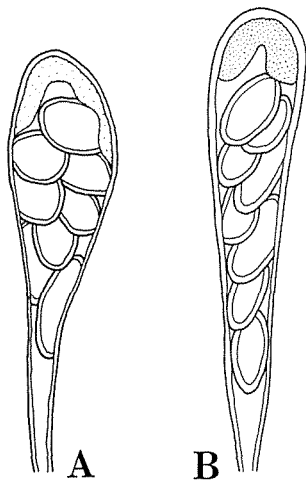


Fig. 3. Types of asci. A. Clavate ascus of *Huilia* bearing a faintly stained tholus with iodine ($\times 750$); B. Clavate ascus of *Lecidella* bearing an intensively stained tholus with iodine ($\times 750$).

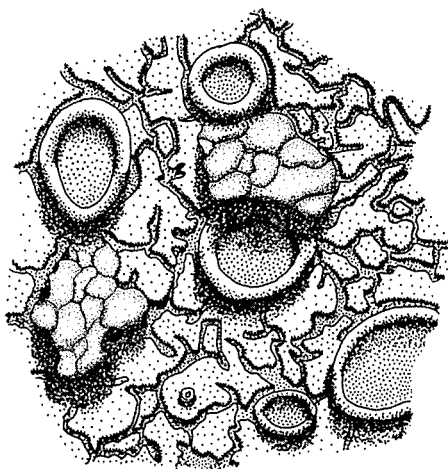


Fig. 4. Cephalodiate thallus of *Huilia aeolotera* with plane areolae and apothecia ($\times 15$).

h. *Spores*. The spores are hyaline and simple. They are most often ellipsoid with obtuse ends varying in the length to width ratio. The shape and

size as well as the thickness of the cell wall are essentially constant within each species, and they sometimes serve as distinguishing characters of the species (see drawings of the individual species). The number of spores in each ascus is almost constantly eight in the species treated here (accidentally less in number, e.g. 4, 5, or 6). The spores in *Lecidea* and *Lecidella* are generally smaller than in *Huilia*. As exceptional cases, however, *Lecidea advena* and *L. speirea* produce rather larger spores, while *Huilia crustulata* produces spores similar in size to those of *Lecidea* and *Lecidella*.

The spores in some species of *Lecidea*, such as *Lecidea plana*, *L. lithophila*, and *L. subleucothallina*, are pseudodiblastic (Körber 1861: 204); at first glance they may be mistakenly regarded as 1-septate; this, however, is a spurious feature derived from having 2 oil drops or a plasmatic cell structure. This type of spore is not known in *Huilia* and *Lecidella*, and at present the taxonomic importance is uncertain.

Another characteristic feature is "halo-formation" in spores. The halo is a colorless gelatinous substance surrounding spores. Although the halo can be seen only in fresh materials or in younger apothecia, it seems to be a stable character in *Huilia*. Halo formation is also seen in some species of *Rhizocarpon* apparently related to *Huilia* because of having the same hyphal structure in the excipulum as Vězda (1972: 211) and Hertel (1977: 200) also pointed out. This character may be important for categories higher than species, but we can not ignore the occurrence of halo formation in species of *Lecidea* (s. str.), such as *Lecidea usbekica* (Hertel 1977), *Lecidea carbonoidea* (Alaska, Thomson, Lich. Arct. ex. n. 94, isotype in H, vidi) and Japanese *L. athrocarpa* which are taxonomically related species.

4. Soredia

Soredia are known in only one species, *Huilia panaeola*, among the species treated here. In general there are only a few species which have soredia in *Lecidea* (s. lat.), actually only *Lecidea leucosoralis* Vain. (*Biatora leucosoralis* ad int., which is near *Biatora vernalis*) is another sorediate Japanese species belonging to *Lecidea* (s. lat.). In these sorediate species, *Huilia panaeola* is usually without apothecia, whereas *Lecidea leucosoralis* produces apothecia. In the majority of foliose and fruticose lichens species with genotypically restricted soredia are usually without apothecia (Poelt 1973), so further materials will be required for confirming the stability of the sorediate-sterile taxon.

5. Cephalodia

Cephalodiate species are restricted to the genus *Huilia* (Fig. 4). Most of the species bear cephalodia constantly. In *H. aeolotera* one specimen studied lacked cephalodia and 36 were cephalodiate. This fact shows that the tendency for producing cephalodia serves to distinguish species but not higher categories, contrary to *Stereocaulon*, *Placopsis*, etc. which form cephalodia constantly.

Chemistry

There are far fewer studies of the chemistry of lichen substances in microlichens such as *Lecidea* (s. lat.) compared with macrolichens such as *Cladonia*, *Parmelia* and others. Huneck (1963, etc.), Leuckert & Hertel (1967, 1970), Hertel & Leuckert (1969), and Culberson & Hertel (1972, 1979) have reported the specific substances found in *Lecidea* (s. lat.). Furthermore, Culberson (1969, 1970) and Culberson et al. (1977) summarize specific substances which have been reported in *Lecidea* (s. lat.). In the present study pannarin, one of the β -orcinol group depsidones, is newly recognized in *Lecidea* (s. lat.).

Figure 5 gives a comparative graphic representation of the substances in *Lecidea* (s. str.) as revealed on plates run in the hexane-ether-formic acid solvent system. The substances identified in *Lecidea* (s. str.) are listed below. A color given in parenthesis indicates the color of a TLC-spot visualized on chromatograms when the plate is heated after spraying with aqueous H_2SO_4 .

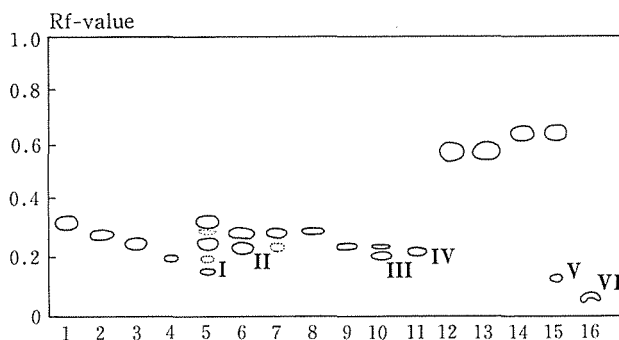


Fig. 5. Chromatograms of *Lecidea* (s. str.) species in a solvent system, hexane-ether-formic acid compared with some chemically purified substances*. 1. Glomelliferic acid, 2. Planaic acid, 3. Confluentic acid, 4. 2-o-Methylconfluentic acid, 5. *L. brachyspora*, 6. *L. lithophila*, 7. *L. plana*, 8. *L. diducens*, 9. Norstictic acid, 10. *L. advena*, 11. *L. subpaupercula*, 12. Pannarin, 13. *L. subleucothallina*, 14. Atranorin, 15. *L. elabens*, 16. *L. lapicida*; I. *Lecidea*-2, II. 4-o-Demethylplanaic acid, III. *Lecidea*-1, IV. *Lecidea*-3, V. Fumarprotocetraric acid, VI. Stictic acid.

Atranorin (yellow): *L. elabens*.

Atranorin gives a pale yellow coloration with K and P but no color reaction with C or KC. It forms yellow needles very quickly in oT. This common β -orcinol group depside is not very commonly encountered in the genus (s. str.).

Confluentic acid (deep yellow to yellow-brown): *L. athrocarpa*, *L. auriculata*, *L. brachyspora*, *L. speirea*, *L. tessellata* var. *caesia*.

* I am obliged to Dr. Isao Yoshimura of Kochi Gakuen College for supplying these authenticated pure samples which were mostly purified by Dr. Huneck of "Akademie der Wissenschaften der DDR" and to Mrs. T. Kurokawa of the same college for developing the chromatograms.

Confluent acid gives a negative color reaction with all reagents used here. Crystals of the substance from *Herpothallon sanguineum* in various solutions and the results of chromatography were described in detail by Culberson (1966). Confluent acid appears as clusters of fine needles in GE (Plate I: 1), and as large radiating clusters of colorless needles in An (Plate I: 2).

4-o-Demethylplanaic acid (deep yellow): *L. lithophila*, *L. plana*.

This acid is separated most effectively in hexane-ether-formic acid, where the spot for 4-o-demethylplanaic acid falls between planaic acid and 2-o-methylconfluent acid, which is the lowest.

Fumarprotocetraric acid (gray): *L. elabens*.

Fumarprotocetraric acid gives an orange-red coloration with P but no color reaction with K, KC, or C. The acetone extract containing this substance is treated with the An-solution to give a compound which crystallizes out in radiating clusters of long yellow needles grouped in sectors in a radiating pattern.

Glomelliferic acid (yellow to pale): *L. athrocarpa* (trace), *L. atrobrunnea* (trace), *L. auriculata* (trace), *L. brachyspora* (trace).

According to J. Santesson (1974), the chemical reaction of the thallus should be KC+ red. However, on the specimens containing the acid I obtained the negative reaction with all reagents used here. Perhaps this may be due to the lower concentration of the acid.

2'-o-Methylanziaic acid (deep yellow): *L. auriculata* (trace), *L. brachyspora* (trace), *L. diducens*.

This acid gives red reaction with C but no color reaction with P, K, or KC. Unfortunately too little material prevented microchemical procedures. The acid was not identified by comparison with purified authentic materials. However, the present identification may be most plausible, because the 2'-o-methylanziaic acid is highest, and confluent acid lowest with planaic acid falling between them (Fig. 5, Culberson & Kristinsson 1970, Culberson & Hertel 1972). Culberson & Hertel (1972) reported 2'-o-methylanziaic acid from *L. diducens* based on five specimens collected from Italy and Norway. On chromatograms the holotype specimen and Japanese specimens of *L. diducens* yield identical spots.

2-o-Methyl confluent acid (deep yellow): *L. auriculata* (trace), *L. brachyspora* (trace).

Species containing confluent acid may produce this acid as an additional component.

Norstictic acid (yellow): *L. advena*, *L. lactea*, *L. lapicida* (\pm trace).

A thallus containing norstictic acid shows a K+ blood red and P+ yellow reaction but is C-, KC-. Short, red, acicular needles are crystallized out in KK. These crystals from KK seem to be the most sensitive and useful for the

detection of norstictic acid.

Pannarin (yellow-brown): *L. subleucothallina*.

Pannarin gives a yellow-brown to orange coloration with P but no reaction with K, KC, or C. When the acetone extract is treated with GE-solution, overlapping yellow-brownish lamellar crystals are formed (Plate I: 4, 5). Pannarin, one of the β -orcinol group depsidones, has been reported from species of *Bombyliospora*, *Lecanora*, *Pannaria*, *Pseudocyphellaria*, and *Psoroma*. Accordingly this is newly recognized in *Lecidea*. At present the substance has not been detected from other Japanese species of *Lecidea* (s. lat.).

Planaic acid (deep yellow): *L. lithophila*, *L. plana*.

The acid gives a negative color reaction with all reagents used here. It is best to identify planaic acid with TLC because the acid does not form any characteristic crystals. Planaic acid, an orcinol group depside, is known only from species of *Lecidea*.

Stictic acid (orange): *L. lapicida*, *L. fuscoatrata*.

Stictic acid gives a yellow to deep yellow coloration with K and miniate red with P but no color reaction with KC or C. Stictic acid can be easily re-crystallized as colorless hexagonal thin-plates in oT.

Unidentified major constituents

Besides the substances mentioned above, several unidentified ones were bound on chromatograms. Of these, the followings are major constituents:

Lecidea-1 (orange): *L. advena*.

The Rf-value of this substance is lower than that of norstictic acid.

Lecidea-2 (pale brown): *L. athrocarpa*, *L. auriculata*, *L. brachyspora*, *L. speirea*, *L. tessellata* var. *caesia*.

This substance usually occurs in conjunction with confluent acid; however, a few specimens of *L. athrocarpa* contain this substance only. I prefer not to recognize this chemical population as a distinct taxon because of the absence of any strong correlating diagnostic characters.

Lecidea-3 (pale yellow): *L. subpaupercula*

The Rf-value of this substance is close to that of norstictic acid; however, it gives a negative color reaction with K.

No colorless substance: *L. fuscoatrata*, *L. instratula*, *L. lithophila*.

Taxonomic Treatment

Key to the genera treated

1. Hypothecium indistinct, subhymenium distinct; paraphyses discrete; tholus well developed, prominently blue with iodine (I+)*Lecidella*
1. Hypothecium and subhymenium distinct; paraphyses coherent; tholus

- moderately developed, faintly blue with iodine (I+)2
2. Hypothecium and excipulum continuous, dark brown to black ("Graphidian-type," Letrouit-Galinou 1968); paraphyses prominently branched and anastomosed*Huilia*
2. Hypothecium and excipulum distinguishable, pale; paraphyses less branched and anastomosed*Lecidea*

Lecidea Ach.

Meth. Lich. 32 (1803). — *Lecidea* D. *Eulecidea* Th. Fr., Lich. Scand. 481 (1874). — *Lecidea* sect. *Eulecidea* (Th. Fr.) Zahlbr. in Engl.-Prantl, Nat. Pflanzenfam. ed. 2, 8: 192 (1926). — *Lecidea* subg. *Eulecidea* Lyngé in Vain., Acta Soc. Fauna Flora Fenn. 57 (2): 71 (1934). — *Lecidea* subg. *Lecidea* Hertel, Beih. Nov. Hedwig. 24: 35 (1967).

Type species: *Lecidea fuscoatra* (L.) Ach. (Lectotype, R. Santesson 1952: 425).

Thallus endolithic or crustose, areolate, or verrucose, or granulose, or continuous, rimose, at times sorediate, consisting of upper cortical layer composed of closely compacted hyphae running perpendicularly, in some species with epinecral layer accumulated on the upper cortical layer; algal layer rather uniform, mostly continuous; medulla composed of perpendicularly running hyphae, usually I+ intensive blue or violet-blue, or at times I—. Algae protococcoid. Hypothallus distinct or indistinct, black or white.

Apothecia round or rarely more or less angular, adnate or subimmersed or immersed in the thallus, usually slightly constricted at the base or prominently constricted or not; disc plane or convex, rarely divided into smaller parts, bare or pruinose, with a concolorous margin or without margin. Excipulum without accessory thalloid margin, originating from the under part of hypothecium, more or less distinct from the hypothecium, non-carbonaceous, colorless or paler internally, darker (blue-green, blackish, dark brown or brown) externally; hyphae intricately radiating, sometimes highly anastomosing and conglutinating. Epithecium tinged with various colors. Hymenium usually colorless or rarely of the same color as the epithecium, with variable height. Subhymenium and hypothecium varying from colorless (or rarely sordid yellowish-cloudy) to pigmented (various shades of brown), with variable height. Paraphyses simple or branched (the branches few in number for the most part), coherent; apices swollen or not. Asci clavate or rarely pyriform, thick-walled; tholus more or less prominent, I+ faintly blue. Spores hyaline and simple, ellipsoidish, very rarely with a halo.

The genus *Lecidea* (s. str.) is separated from *Lecidella*, *Huilia*, and other species groups of *Lecidea* (s. lat.) by the crustaceous thallus, by the non-carbonaceous excipulum, which is not colorless externally, originating from the under part of hypothecium and consisting of intricately radiating hyphae which are sometimes highly anastomosing and conglutinating, by the coherent paraphyses which are simple or branched (branches few in number) and by the rather

thick-walled asci, the tholi of which are moderately developed and stained blue with iodine.

Species of this genus are distributed mainly in the arctic-alpine zone, and also occur in northern or alpine regions of Japan.

A large number of species have been reported from Japan under this genus, as shown in the preceding chapter, but as delimited here the following species are recognized in the Japanese flora.

Key to the Japanese species of *Lecidea*

1. Thallus brown to dark brown or yellow-brown, with an epinecral layer2
1. Thallus whitish, grayish, without an epinecral layer7
 2. Apothecia immersed in the thallus.....3
 2. Apothecia subimmersed to adnate.....4
3. Apothecia minute, up to 0.4 mm in diameter; hymenium 30–60 μm high9. *L. instratula* (p. 34)
3. Apothecia larger, more than 0.5 mm in diameter; hymenium 70–120 μm high2. *L. athrocarpa* (p. 22)
 4. Thallus yellow-brown, P+ orange (pannarin)15. *L. subleucothallina* (p. 45)
 4. Thallus brown to dark brown, P–5
5. Subhypotheical medulla prominent, J+ intensively violet, penetrating the inner apothecia3. *L. atrobrunnea* (p. 25)
5. Subhypotheical medulla not prominent6
 6. Apothecia adnate, constricted at the base16. *L. subpaupercula* (p. 46)
 6. Apothecia subimmersed to appressed-adnate, not constricted at the base8. *L. fuscoatrata* (p. 33)
7. Thallus K+ yellow→blood-red, norstictic acid present8
7. Thallus K+ yellow or negative9
 8. Hymenium 50–70 μm high; hypothecium dark; spores 10–15 \times 5–8 μm 10. *L. lactea* (p. 35)
 8. Hymenium 90–100 μm high; hypothecium colorless; spores 15–20 \times 7–10 μm 1. *L. advena* (p. 20)
9. Hypothecium colorless10
9. Hypothecium dark13
 10. Medulla P+ orange; growing on wood7. *L. elabens* (p. 31)
 10. Medulla P–; growing on rocks.....11
11. Epithecium pale brown to greenish-brown12. *L. lithophila* (p. 39)
11. Epithecium deep green12
 12. Thallus & excipulum K+ yellow, stictic acid present; spores 10–14 \times 5–7 μm 11. *L. lapicida* (p. 38)
 12. Thallus & excipulum K–; spores 9–14 \times 3.5–5 μm

-13. *L. plana* (p. 41)
13. Thallus chalky-white, continuous, powdery on surface; excipulum poorly developed14. *L. speirea* (p. 43)
13. Thallus white with a sordid shade, or grayish, areolate or cracked areolate; excipulum well developed14
14. Apothecia subimmersed in the thallus; spores with thickwall17. *L. tessellata* var. *caesia* (p. 48)
14. Apothecia adnate; spores with thin wall15
15. Excipulum K+ yellow, stictic acid present; hymenium more than 50 μm high11. *L. lapicida* (p. 38)
15. Excipulum K-, stictic acid absent, hymenium less than 50 μm high ...16
16. Excipulum C+ chinese-red6. *L. diducens* (p. 30)
16. Excipulum C-17
17. Spores ellipsoid, 6-11 \times 2.5-4 μm 4. *L. auriculata* (p. 26)
17. Spores broadly ellipsoid, 5-8 \times 3-5 μm 5. *L. brachyspora* (p. 28)

1. ***Lecidea advena*** Nyl. (Figs. 6: A-C, 7; Plate I: 6, 7)

in Hue, Nouv. Archiv. du Muséum, sér. 3, 3: 133 (1891). Type: "Himalaya," 4300 m alt., leg. J. D.

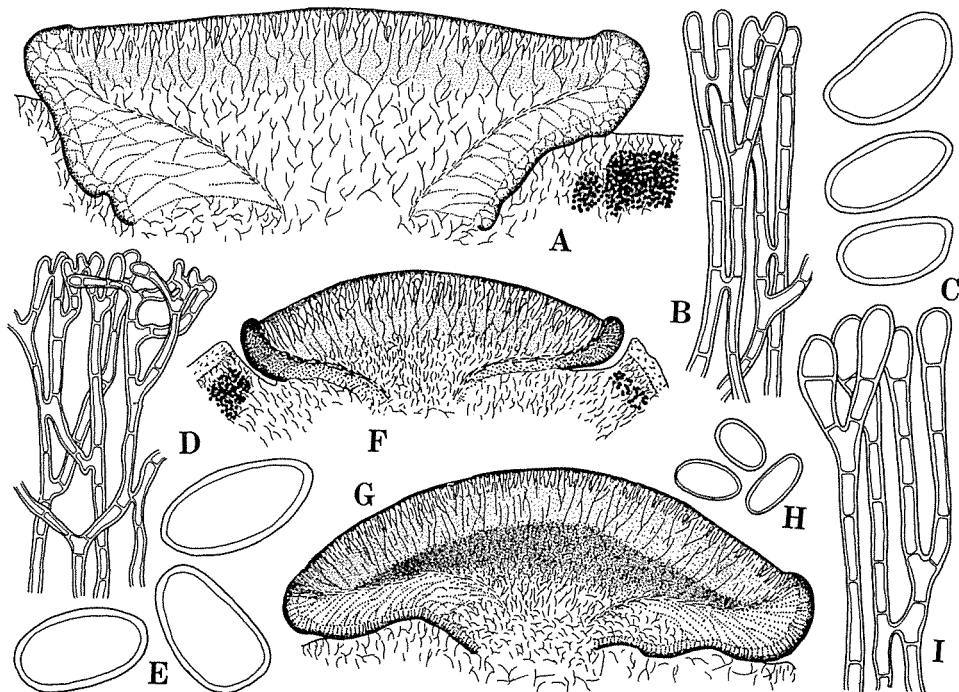


Fig. 6. *Lecidea advena* Nyl. (A-C: drawn from HIRO-Inoue 11452), *L. athrocarpa* (Ach.) Ach. (D-F: drawn from HIRO-Inoue 5414), and *L. atrobrunnea* (Ram. ex Lam. et DC.) Schaer. (G-I: drawn from HIRO-Inoue 1037). A, F, and G. Vertical section of apothecia, $\times 60$. B, D, and I. Upper part of paraphyses, $\times 980$. C, E, and H. Spores, $\times 980$.

Hooker,—holotype in H (H-Nyl. 16020), vidi. — *Lecidea advena* Nyl., Mém. Soc. Imp. Sci. Nat. Cherb. 5: 125 (1857). nomen nud.

Thallus thin to medium, contiguous, irregularly areolate; areolae plane or sometimes slightly bullate, white with yellow shade; medulla I— or +pale reddish-brown. Hypothallus indistinct, grayish.

Apothecia subimmersed to appressed-adnate, on the thallus or among areolae, not constricted at the base, black, up to 1.1 mm in diameter, round or irregularly flexuose or even composed, plane or divided into smaller parts, surrounded by concolorous, prominent margin. Excipulum 50–100 μm thick; hyphae interwoven, loose, 4–5 μm thick, greenish-brown externally, colorless internally, KOH—. Epithecium greenish-brown. Hymenium (60)80–100 μm high, I+ intensively sordid-blue. Subhymenium (20)50–60 μm high; hyphae perpendicular, I+ sordid-blue. Hypothecium with variable height; hyphae interwoven, I—; subhymenium and hypothecium colorless. Paraphyses simple or sometimes branched, anastomosing, 2–2.5(3) μm , not thickened at the apices. Asci clavate, 60–90 \times 18–20 μm . Spores (12)14–20 \times 6–12 μm , with obtuse ends.

Reaction: Thallus P+ deep yellow, K+ yellow, then blood-red, KC—, C—; medulla P—, K—, KC—, C—. Chemical substances: norstictic acid and Lecidea-1 (\pm).

Habitat. On non-calcareous or rarely calcareous rocks in alpine regions.

Range. Japan, Himalayas.

The Japanese specimens studied agree very well with the holotype except for the areolae being plane or slightly bullate as opposed to bullate-areolate in the holotype. This species is distinguished by the subimmersed to appressed-adnate apothecia, the rather large spores for the genus, the excipulum of loosely interwoven hyphae and by production of norstictic acid in the cortex of the thallus.

This species resembles *Lecidea lactea*, in which thallus is sometimes well ad-

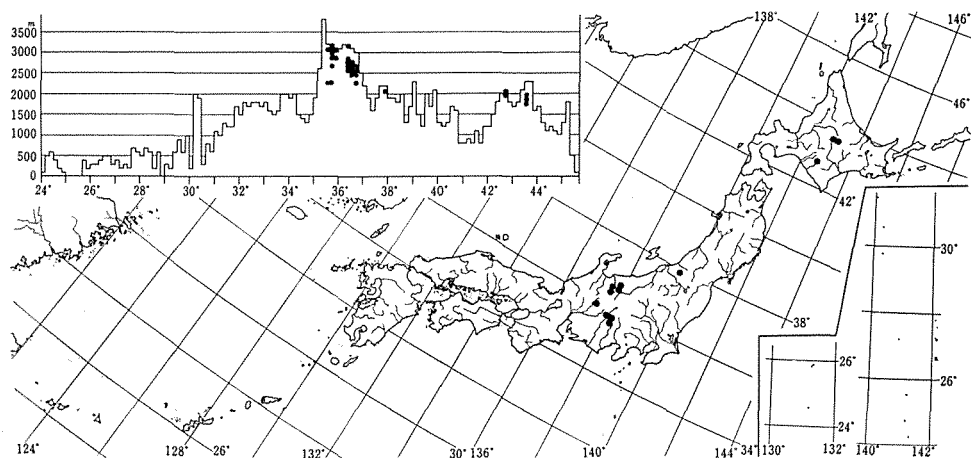


Fig. 7. Distribution of *Lecidea advena* in Japan.

vanced, and *L. subkochiana* (Nyl.) Leight. (France, holotype in H, H-Nyl. 15491, vidi; the occurrence of this species in Japan is not known) in having a well-advanced thallus and subimmersed apothecia and producing norstictic acid as a chemical substance, but it is distinguished from *L. lactea* and *L. subkochiana* by the excipulum of interwoven hyphae and by somewhat larger spores.

Lecidea advena is not closely related to any other species of *Lecidea*. The apothecia are vaguely reminiscent of some species of *Aspicilia*.

Specimens examined.* HOKKAIDO. Prov. Tokachi. *Ishikaridake*, Mt. Otofuke (1740 m, mi-8463 & 8464; 1910 m, mi-8443; 1920 m, mi-8460); Mt. Ishikari (1960 m, mi-8473). Prov. Kamikawa. *Asahidake*, Mts. Daisetsu (Mt. Hakuun) (1810 m, mi-8731). Prov. Hidaka. *Poroshiridake*, Mt. Poroshiri (1950 m, mi-9178; 2040 m, mi-7910; 2050 m, mi-7857 & 7918). HONSHU. Pref. Yamagata. *Iidesan*, Mt. Iide (2080 m, mi-10832). Pref. Nagano. *Shiroumadake*, Mts. Shirouma (Tenguhara) (2200 m, mi-5631); Mts. Shirouma (Mt. Shirouma) (2550 m, mi-14095); Mt. Norikura (2430 m, mi-12930; 2440 m, mi-12969); *Oomachi*, Mt. Goryu, 2640 m, mi-5549 & 5572; 2730 m, mi-5395 & 5451); *Tateyama*, Mt. Renge (2590 m, mi-4994; 2650 m, mi-5053; 2790 m, mi-5044); Mt. Kitakazura (2440 m, mi-5095; 2540 m, mi-4971); *Yarigatake*, Mt. Mitsu (2590 m, mi-5878; 2720 m, mi-5958 & 5959; 2810 m, mi-5912); Mt. Washiba (2840 m, mi-5995; 2860 m, mi-5876 & 5951; 2880 m, mi-5926); Mt. Momisawa (2750 m, mi-4816); Mt. Yari (3120 m, mi-4881); Mt. Tsubakuro (2690 m, mi-5264); *Ontakesan*, Mt. Ontake (2830 m, mi-11452; 3010 m, mi-11562); *Akaho*, Mt. Hoken (2660 m, mi-6785; 2800 m, mi-6741). Pref. Toyama. *Shiroumadake*, Mt. Shirouma (2620 m, mi-14153); *Tateyama*, Mt. Tsurugi (2680 m, mi-12890). Pref. Yamanashi. *Ichinose*, Mt. Kaikoma (Sensui Pass) (2200–2250 m, mi-12330); Mt. Kitadake (2900 m, mi-1021; 3030 m, mi-12259; 3040 m, mi-12260; 3180 m, mi-1036); *Oogawara*, Mt. Ainotake (3050 m, mi-1061). Pref. Shizuoka. *Oogawara*, Mt. Notori (3030 m, mi-1187).

2. *Lecidea athrocarpa* (Ach.) Ach.

(Figs. 6: D–F, 8; Plate I: 8, 9)

Method. Lich. 41 (1803). — *Lichen athrocarpus* (“*athrocarpus*”) Ach., Lich. Svec. Prod. 77 (1798). Type: Sweden, lectotype (P. James 1970 in Acharian Herbarium in H) in H (H-Ach. 84A), vidi. — *Lecidea badiopallens* Nyl., Flora 61: 242 (1878). syn. nov. Type: France, Mont-Dore, leg. E. Lamy, holotype in H (H-Nyl. 15172), vidi.

Thallus indeterminate, contiguous, medium to thick, subopaque, brown, with epinecral layer, distinctly areolate; areolae angular, concave with whitish or paler margin; medulla I+ intensively violet-blue. Hypothallus usually visible between the areolae, black.

Apothecia immersed in the thallus, black, thinly marginate, 0.3–1.1 mm in diameter, disc non-pruinose, plane or concave. Excipulum poorly developed, 30–40 μ m thick; external part blackish-green; hyphae perpendicularly radiating, 4–5 μ m thick, thick-walled; interior part paler, colorless; the hyphae intricate, 1.5–2.5 μ m thick. Epithecium brown with green shade. Hymenium (70)90–110(125) μ m high. Subhymenium 50–60 μ m high, colorless; hymenium and subhymenium bluish, then partly wine-red with iodine. Hypothecium \pm indistinct, 10–20(30) μ m high, pale brown to brown. Paraphyses branched,

* In the enumeration of localities, names (shown in italic) of the topographic map (1: 50,000) are indicated after the name of prefecture. The collector, M. Inoue whose name frequently appears, is abbreviated as “mi-.” Specimens are in HIRO unless otherwise stated.

anastomosed especially in the upper part, 1.5–2 μm thick, apices not thicker. Asci clavate, 65–100 \times 16–25 μm , at apices rather thicker, 4–7 μm thick. Spores 15–22 \times 7–12 μm , at times with a gelatinous halo, ends obtuse, with a thick wall, 1–2 μm thick.

Reaction: Thallus & medulla P—, K—, KC—, C—. Chemical substances: confluent acid and Lecidea-2 (Chemical race I); confluent acid, glomeriferic acid (extremely trace), and Lecidea-2 (Chemical race II-a); confluent acid, glomeriferic acid (distinct), and Lecidea-2 (Chemical race II-b); glomeriferic acid (Chemical race III); glomeriferic acid and Lecidea-2 (Chemical race IV); Lecidea-2 (Chemical race V).

Habitat. on non-calcareous, rarely calcareous rocks in alpine regions.

Range*. Japan; East and Central Asia; USSR; Europe; Africa; Mexico.

The thallus of the lectotype is more or less psoroid and the spores are somewhat wider (19 \times 13 and 21 \times 13 μm , only two spores were detected), while in the Japanese specimens only a crustaceous thallus and narrower spores were seen. However, they should be referred to *L. athrocarpa* because of the positive intense I+ reaction in the medulla, higher hymenium and the rather large spores for the genus.

Besides the above diagnostic characters *L. athrocarpa* is very easily recognized by the morphology of the thallus and immersed apothecia. This species belongs, according to its thalline structure, to the *L. atrobrunnea* group. On account of the dense anastomosed paraphyses in the upper part and the gelatinous halo formation occasionally seen around the spores, it reminds one of *Huilia* species in which halo formation and anastomosed paraphyses are constantly observed. Thomson (1972) reported a "halo" in *Lecidea carbonoidea* Thomson and Hertel (1977) in *L. usbekica* Hertel. They may be closely related to *L. athrocarpa* because of having similar thallus and apothecia. Up to now I have not seen this kind of "halo" among other species of *Lecidea*. I can, however, not really recognize any taxonomic value for this character.

Lecidea athrocarpa is in many respects similar to *L. schitakensis* Zahlbr. (China, Yunnan, 3800–4000 m alt., holotype in W, vidi), but in *L. athrocarpa*, the subhymenium is higher (15–25 μm high in *L. schitakensis*), the brown hypothecium is lower (60–70 μm in *L. schitakensis*), and the iodine reaction in the medulla is intensively positive instead of being negative.

Lecidea athrocarpa is very closely related to *L. instratula*, but is distinguished by larger spores (7–10 \times 4–6 μm in *L. instratula*), higher hymenium (30–50 μm high in *L. instratula*) and by a positive iodine reaction in the medulla.

Examination of type specimens clearly proved that *L. athrocarpa* and *L. badiopallens* belong to the same species. Nylander established *L. badiopallens* as an autonomous species distinguished from *L. athrocarpa* by the color of the

* Literature: Hale & Culberson (1970), Hawksworth et al. (1980), and Hertel (1967, 1971, 1975a, 1975b, 1977).

thallus and spore size. The thallus color in *L. badiopallens* is pale yellowish-brown, which, however, seems to have no taxonomic value. He mentioned that the spores of *L. badiopallens* were $13\text{--}16 \times 8 \mu\text{m}$, but I have measured $15\text{--}20 \times 7\text{--}10 \mu\text{m}$, which agrees with the range in *L. athroocarpa*.

Nine specimens collected from Mt. Kitadake were on calcareous rocks. I could, however, not detect any taxonomic differences between these and the materials collected from non-calcareous rocks.

Lecidea perusta Nyl. (Kergulens Land, Royal Sound, leg. Eaton, holotype in H, H-Nyl. 15321, vidi), which Zahlbruckner (Cat. 3: 584, 1925) incorrectly mentioned as a synonym of *L. fuscoatra*, may be an autonomous species and is apparently close to *L. athroocarpa*. *Lecidea perusta*, however, is very conspicuous by its larger spores ($25\text{--}32 \times 12\text{--}18 \mu\text{m}$).

The significant chemical races which are represented by the species will be discussed in another report.

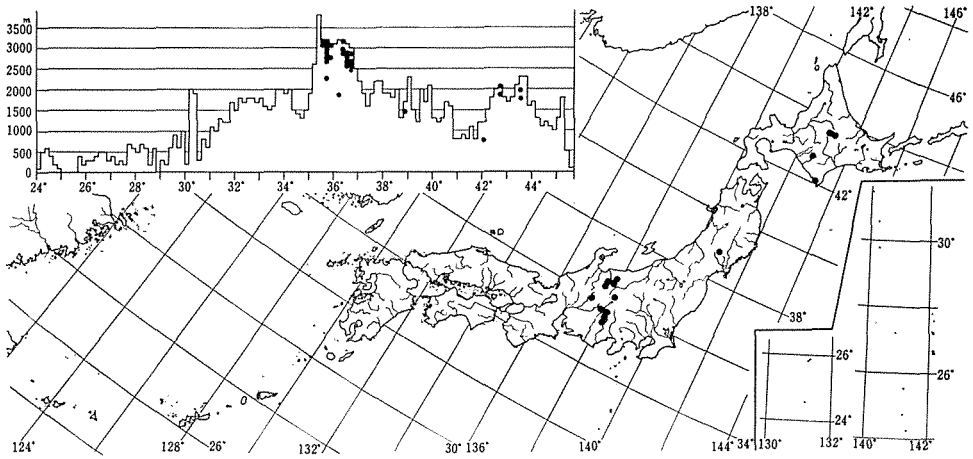


Fig. 8. Distribution of *Lecidea athroocarpa* in Japan.

Specimens examined. HOKKAIDO. Prov. Tokachi. *Ishikaridake*, Mt. Otofuke (1730 m, mi-8435 & 8466). Prov. Kamikawa. *Asahidake*, Mts. Daisetsu (Mt. Kaun) (1950 m, mi-8700). Prov. Hidaka. *Poroshiridake*, Mt. Poroshiri (1890 m, mi-7892; 2010 m, mi-7907; 2040–2050 m, mi-7802); *Horoizumi*, Mt. Apoi (770 m, mi-4051 & 4210). HONSHU. Pref. Miyagi. *Kurikomayama*, Mt. Kurikoma (1430 m, mi-10381). Pref. Nagano. *Shiroumadake*, Mt. Norikura (2410 m, mi-12981; 2420 m, mi-12987; 2430 m, mi-12931); Mt. Karamatsu (2520 m, mi-5801; 2630 m, mi-5814; 2640 m, mi-5865); Mt. Hakubayari (2870 m, mi-5829); *Oomachi*, Mt. Goryu (2640 m, mi-5370; 2720 m, mi-5333 & 5334; 2730 m, mi-5348); Mt. Kashimayari (2700 m, mi-5414 & 5435); *Tateyama*, Mt. Harinoki (2520 m, mi-6047); Mt. Renge (2680 m, mi-4979); *Yarigatake*, Mt. Washiba (2860 m, mi-5909; 2880 m, mi-5918 & 5925); Mt. Yari (2930 m, mi-4849; 3170 m, mi-4869); *Kamikochi*, Mt. Jonen (2800 m, mi-14220); *Wada*, Utsukushiga-hara Heights (1840 m, mi-11654); *Ontakesan*, Mt. Ontake (2770 m, mi-11507; 2790 m, mi-11513; 3040 m, mi-11563); *Akaho*, Mt. Hoken (2850 m, mi-6929; 2920 m, mi-11819); Mt. Utsugi (2650 m, mi-6829). Pref. Toyama. *Tateyama*, Mts. Tateyama (2820 m, mi-12790 & 12822). Pref. Yamanashi. *Ichinose*, Mt. Kaikoma (Sensui Pass) (2200–2250 m, mi-12326 & 12336); Mt. Kitadake (2750 m, mi-985; 2950 m, mi-12172 & 12175; 3030 m, mi-12279; 3040 m, mi-1000; 3050 m, mi-12223 & 12275; 3060 m,

mi-12218; 3090 m, mi-12198; 3150 m, mi-12217; 3160 m, mi-1023, 12237, 12264 & 12286; 3190 m, mi-1075); *Oogawara*, Mt. Ainoake (3050 m, mi-1064; 3100 m, mi-1073; 3150 m, mi-12370; 3185 m, mi-1008).

3. ***Lecidea atrobrunnea*** (Ram. ex Lam. et DC.) Schaer.
(Figs. 6: G–I, 9; Plate II: 1, 2)

Lich. helv. Spic. sect. 3, 134 (1828). — *Rhizocarpon atrobrunneum* Ram. ex Lam. et DC., Flora Franc. ed. 3, 2: 367 (1805). Type: "Alpes" (without precise locality),—holotype in G-DC., vidi. — *Lichen atrobrunneus* Ram. ex Lam. et DC., Flora Franc. ed. 3, 2: 367 (1805). nomen nud. in syn.

Thallus indeterminate, subopaque, dark brown, with an epinecral layer, squamulose-areolate; areolae somewhat scattered, round, plane with white margin; medulla I+ intensively violet-blue. Hypothallus visible between the areolae, black.

Apothecia sessile, moderately constricted at the base, reaching a diameter of 1.3 mm, round or irregularly flexuose or even composed, black; disc non-pruinose, plane or in old apothecia somewhat convex, surrounded by a prominent margin. Excipulum 40–60 μm thick, with radiating and thick-walled hyphae, blackish-green externally, with hyphae 5–7 μm thick, while the interior colorless, with hyphae 4–5 μm thick. Epithecium deep green to blackish-green. Hymenium 40–50 μm high. Subhymenium 60–70 μm high; hymenium and subhymenium colorless, with an intensively blue iodine reaction. Hypothecium brown, 80–100 μm high. Subhypothecial medulla well developed and raised up, I+ intensively violet-blue. Paraphyses simple or sometimes branched, 2–2.5 μm thick, very slightly thickened at the apices, 3–5 μm thick. Asci clavate, 40–45 \times 11–13 μm . Spores 8–10 \times 4–5(6) μm , with obtuse ends.

Reaction: Thallus & medula P–, K–, KC–, C–. Chemical substances: glomelliferic acid (trace).

Habitat: On non-calcareous rocks in alpine regions.

Range: Japan; west and central Asia; Arctic regions; Europe; East Africa;

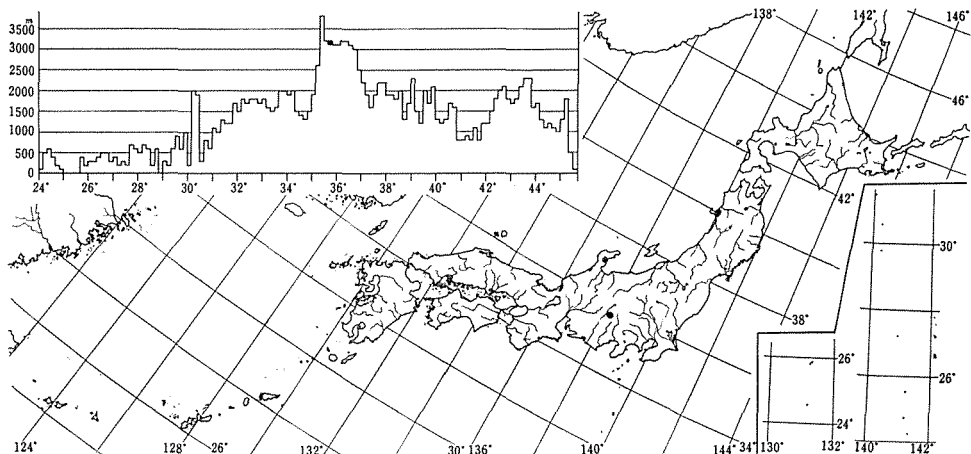


Fig. 9. Distribution of *Lecidea atrobrunnea* in Japan.

north America; Antarctica.

Lecidea atrobunnea is known in Japan only from one gathering, but the material is well developed. Since the species is very characteristic, the identification as this species seems justifiable. *Lecidea atrobunnea* is easily recognized by the blackish, deep brown thallus which has an epinecral layer, sessile apothecia, well-developed subhypotheccial medulla, and the minute spores.

This species is closely related to *L. subpaupercula*, but distinguished by the minute spores and the existence of a well-developed subhypotheccial medulla.

Specimen examined. HONSHU. Pref. Yamanashi. Ichinose, Mt. Kitadake (3180 m, mi-1037).

4. *Lecidea auriculata* Th. Fr.

(Figs. 10: A-C, 11; Plate II: 3, 4)

Nova Acta Reg. Soc. Sci. Upsal., Ser. 3, 3: 213 (1860). Type: Greenland, Holsteinborg, leg. J. Vahl,-

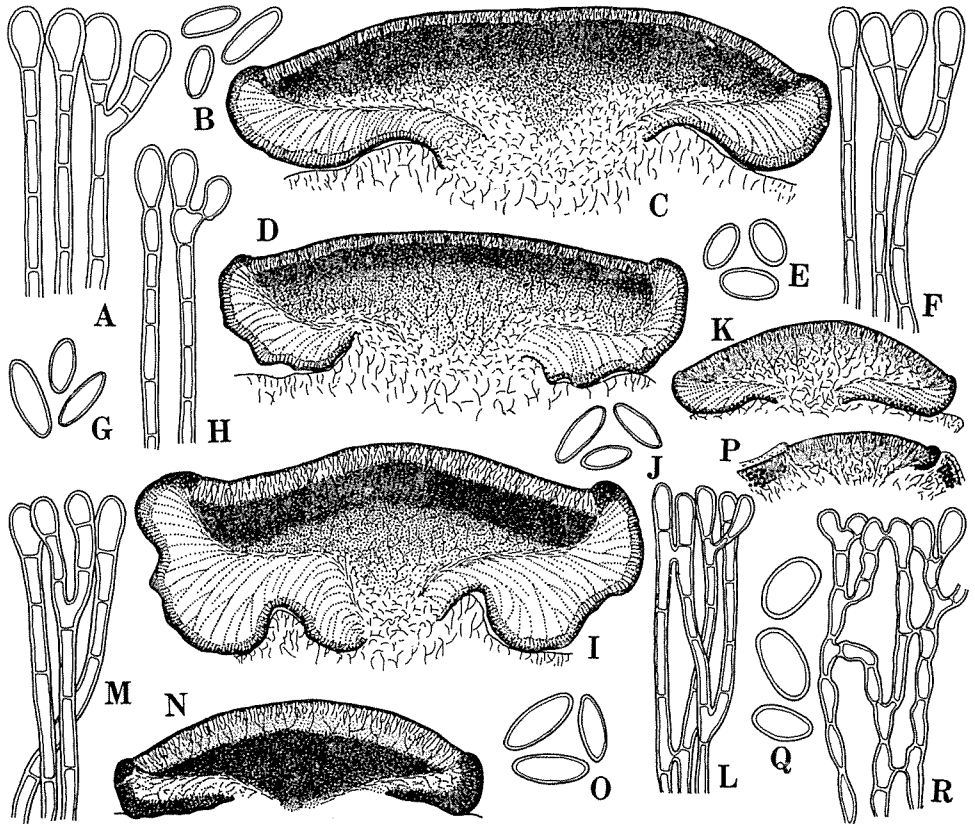


Fig. 10. *Lecidea auriculata* Th. Fr. (A-C: drawn from HIRO-Inoue 8654), *L. brachyspora* (Th. Fr) Nyl. (D-F: drawn from HIRO-Inoue 10515), *L. diducens* Nyl. (G-I: drawn from HIRO-Inoue 5956), *L. elabens* Fr. (J-L: drawn from HIRO-Inoue 960), *L. fuscoatrata* Nyl. (M-O: drawn from HIRO-Inoue 10265), and *L. instratula* Nyl. (P-R: drawn from HIRO-Inoue 5350). A, F, H, L, M, and R. Upper part of paraphyses, $\times 1000$. B, E, G, J, O, and Q. Spores, $\times 1000$. C, D, I, K, N, and P. Vertical section of apothecia, $\times 60$.

lectotype (Hertel 1975a) in UPS, non vidi.

Thallus variable, some endolithic, others epilithic and contiguous, cracky-areolate; areolae sometimes swollen; medulla I+ intensively violet-blue or occasionally I-. Hypothallus indistinct.

Apothecia black, sessile, constricted at the base, 1-2 mm, rarely reaching 3 mm in diameters; disc plane, non-pruinose or occasionally thinly pruinose, surrounded by irregularly flexuose, prominent, concolorous margin. Excipulum well advanced and developed far in below the apothecium, 100-150 μm thick, dark brown to violet-brown externally, while in the interior part paler and with rose shade; hyphae intricate-radiating, 3-5 μm with thin wall. Epithecium blue-green or blackish-green. Hymenium (30)40-50 μm high. Subhymenium 40-50 μm high, violet-brown. Hypothecium concolorous to the subhymenium, paler subhypothecial medulla prominent and raised up, I+ intensively violet-blue. Paraphyses simple, 2-2.5 μm thick, somewhat thickened at the apices, 3-4 μm thick. Asci clavate, (25)30-40 \times 7-9 μm . Spores ellipsoid with obtuse ends, 6-11 \times (2)2.5-4 μm .

Reaction: Thallus & medulla P-, K-, KC-, C-. Chemical substances: confluent acid, glomeriferic acid (trace), 2-o-methylconfluent acid (trace), 2'-o-methylanziaic acid (trace), and Lecidea-2.

Habitat. On non-calcareous rocks in subalpine coniferous forests and in alpine regions.

Range. Japan; East Asia; Arctic regions; Europe; North America.

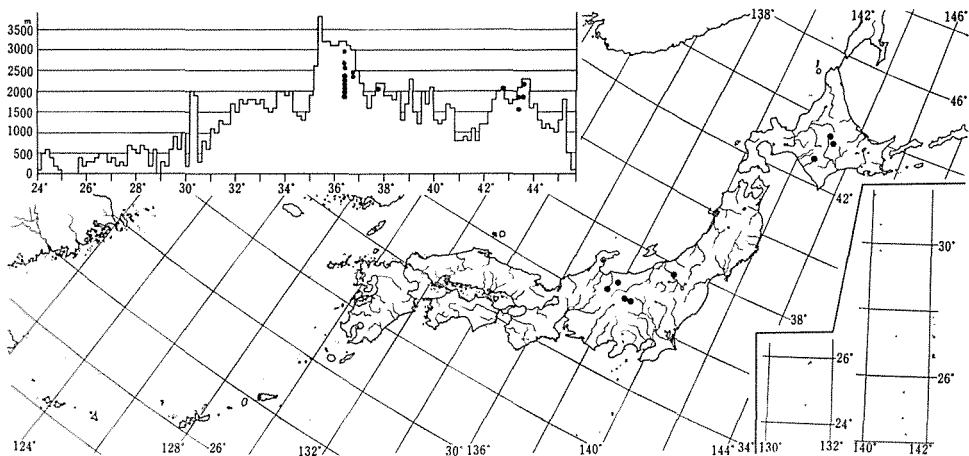


Fig. 11. Distribution of *Lecidea auriculata* in Japan.

Diagnostic characteristics for this species are: well-advanced and developed excipulum far in below the apothecium, blue-green epithecium, thinner hymenium, violet-brown subhymenium, minute spores and the presence of confluent acid as a chemical substance.

The thallus of this species is very variable, as mentioned in the above description. Apothecia of the specimens with a well-advanced thallus are slightly appressed; accordingly these are reminiscent of *Lecidea promiscua* Nyl. (France, "Pyrenees," holotype in H, H-Nyl. 15927B, vidi). *Lecidea auriculata* is, however, distinguished from *L. promiscua* by having an advanced excipulum, colored subhymenium and smaller spores (in *L. promiscua* 11–14 × 4–5 μm). As Hertel (1971, 1977) reported, this species is closely related to *L. promiscens* Nyl. (France, "Pyrenees," holotype in H, H-Nyl. 15927A, vidi), but it is distinguished by smaller spores and well-advanced excipulum.

Specimens examined. HOKKAIDO. Prov. Kamikawa, *Asahidake*, Mt. Midori (1870 m, mi-8546); Mt. Tomuraushi (2110 m, mi-8654). Prov. Tokachi. *Nukabira*, Mt. Nipesotsu (1560 m, mi-8928; 1810 m, mi-8997). Prov. Hidaka. *Poroshiridake*, Mt. Poroshiri (2000 m, mi-7820). HONSHU. Pref. Niigata. *Dainichidake*, Mt. Dainichi (2010 m, mi-10656). Pref. Nagano. *Shiroumadake*, Mt. Norikura (2400 m, mi-12973; 2430 m, mi-12911, 12913 & 12997); *Yarigatake*, Mt. Mitsu (2580 m, mi-5940); Mt. Noguchigoro (2910 m, mi-12728); Mt. Eboshi (2600 m, mi-12723; 2620 m, mi-12710); *Karuizawa*, Mt. Asama (1830 m, mi-11378; 2000 m, mi-11380); *Ueda*, Mt. Asama (2040 m, mi-11332); Kurumazaka Pass (2000 m, mi-1385); Mt. Kagonoto (2120 m, mi-594 & 611; 2200 m, mi-570 & 639).

5. *Lecidea brachyspora* (Th. Fr.) Nyl.

(Figs. 10: D–F, 13; Plate II: 5, 6)

Bull. Soc. Linn. Normand., ser. 4, 1: 245 (1887). — *Lecidea auriculata* subsp. *brachyspora* Th. Fr., Lich. Scand. 501 (1874). Type: Norway, "Finmark; Masöy," leg. Th. Fries, lectotype (Hertel 1974) in UPS, vidi.

Thallus contiguous or in part evanescent, cracked-areolate; areolae plane, tartareous, ash-white; medulla I+ violet-blue. Hypothallus indistinct.

Apothecia black, adnate, slightly constricted at the base, 1–2(2.5) mm in diameters; disc plane, non-pruinose, surrounded by irregularly flexuose, prominent, concolorous margin. Excipulum developed far in below the apothecium, 80–130 μm thick, dark brown to violet-brown externally, while the interior part paler and sometimes colorless; hyphae intricate-radiating, 3–5 μm . Epithecium blue-green. Hymenium 40–50 μm high. Subhymenium 40–50 μm high, violet-brown. Hypothecium concolorous with the subhymenium, paler subhypothecial medulla prominent and raised, I+ violet-blue. Paraphyses simple, 2–2.5 μm thick, somewhat swollen at the apices, 3–4 μm thick. Asci clavate, 30–35 × 6–8 μm . Spores broadly ellipsoid with obtuse ends, pseudodiblastic, 5–8(10) × 3–5 μm .

Reaction: Thallus & medulla P–, K–, KC–, C–. Chemical substances: confluent acid, glomeriferic acid (trace), 2-o-methylconfluent acid (trace), 2'-o-methylanziatic acid (trace), Lecidea-2.

Habitat. On non-calcareous rocks in alpine regions.

Range. Japan; Arctic regions; Europe; Venezuela.

Anatomically the Japanese specimens agree well with the lectotype, which, however, differs in having more subglobose spores (spores 6–7 or rarely 8 ×

4-5 μm in the type specimen) and an obsolete thallus.

This species is closely related to *Lecidea auriculata*, but is distinguished by the somewhat broadly ellipsoid and minute spores (Fig. 12).

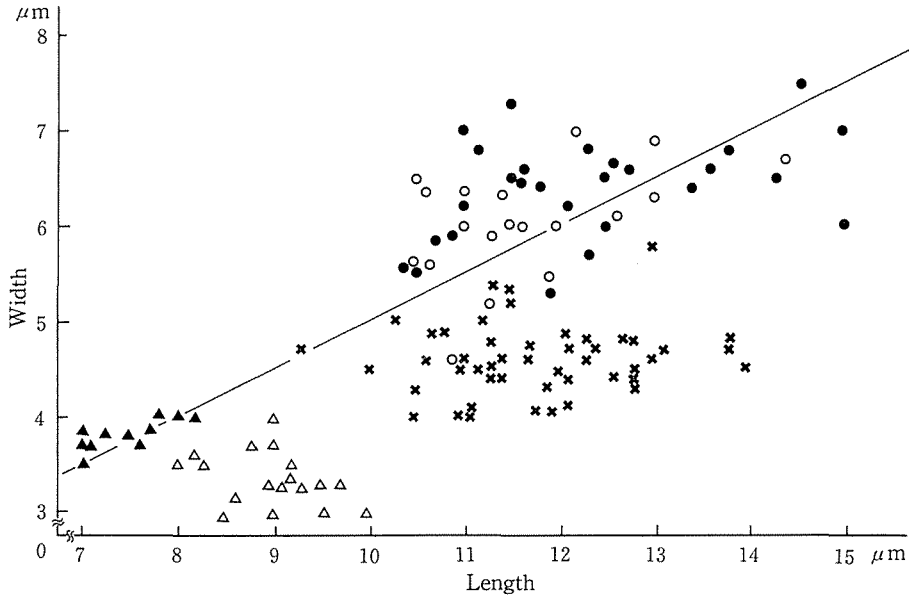


Fig. 12. Mean spore size distributions in *Lecidea auriculata* (Δ), *L. brachyspora* (\blacktriangle), *L. lactea* (\bullet), *L. lapicida* (\circ), and *L. plana* (\times)

This species is most reminiscent of *Lecidea paratropoides* Müll. Arg. (Switzerland, isotype in W, vidi) on account of having well-developed excipulum and broadly ellipsoid and minute spores. However, *L. paratropoides* can be distinguished

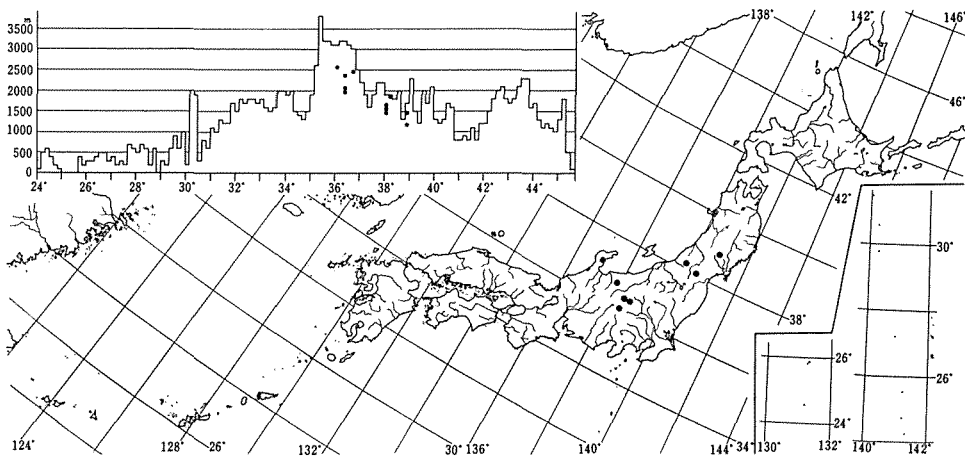


Fig. 13. Distribution of *Lecidea brachyspora* in Japan.

from *L. brachyspora* by the less-developed excipulum and negative iodine reaction in the subhypothecial medulla.

Specimens examined. HONSHU. Pref. Miyagi. *Kurikomayama*, Mt. Kurikoma (1180 m, mi-10423; 1430 m, mi-10379); *Kaminoyama*, Mt. Zao (1480 m, mi-10707; 1530 m, mi-10717; 1610 m, mi-10681). Pref. Yamagata. *Asahidake*, Mt. Asahi (1800 m, mi-10515). Pref. Nagano. *Shiroumadake*, Mt. Norikura (2410 m, mi-12952; 2430 m, mi-12929); *Ueda*, Mt. Asama (2050 m, mi-11340; 2310 m, mi-11351); *Karuizawa*, Mt. Asama (1910 m, mi-11383; 2050 m, mi-11368); *Tateshinayama*, Mt. Tateshina (2520 m, mi-11591).

6. ***Lecidea diducens*** Nyl. (Figs. 10: G–I, 14; Plate II: 7, 8)

Flora 48: 148 (1865). Type: England, Channel Islands, Jersey Isl., Noirmont Point, leg. Larbalestier 104,–holotype in H (H-Nyl. 15704), vidi. — *Lecidea auriculata* f. *subpruinosa* Vain., Ark. f. Bot. 8: 143 (1909). syn. nov. Type: USSR, Siberia, peninsula Jinretlen, leg. E. Almquist,–holotype in TUR (H-Vain. 25141), vidi.

Thallus indistinct or in parts grayish-white, very thin, not continuous; medulla I+ intensively violet-blue. Hypothallus indistinct.

Apothecia black, scattered, sessile, constricted at the base, round or irregularly flexuose or even composed, reaching a diameter of 1.4 mm; margin prominent, rather thick; disc non-pruinose, plane. Excipulum well advanced, developed far in below the apothecia, 100–130 μm thick, dark brown to violet-brown especially externally, while the interior part paler and sometimes colorless, C+ chinese-red; hyphae intricate-rediating, 2.5–4 μm thick. Epithecium blue-green. Hymenium 40–50 μm high. Subhymenium 30–40 μm high, violet-brown. Hypothecium concolorous to the subhymenium, paler. Subhypothecial medulla prominent and raised up. Paraphyses simple, 2–2.5 μm thick, somewhat thickened at the apices, 3.5–4 μm . Asci clavate, 35–40 \times 8–9 μm . Spores ellipsoid with obtuse ends, 7–11 \times 3–4 μm .

Reaction: Thallus & medulla P–, K–, KC–, C–. Chemical substances: 2'-o-methylanziaic acid.

Habitat. On non-calcareous rocks in alpine regions.

Range. Japan; Himalayas; Arctic regions; East Europe; North America.

The Japanese specimens agree very well with the holotype both anatomically and chemically except for the rather thicker excipulum.

This species very closely resembles *Lecidea auriculata* and is a species parallel to it or perhaps only a variety with a chemical difference. Further specimens are required for a definite conclusion.

Lecidea diducens is most reminiscent of *Lecidea cerviniicola* B. de Lesd. (Italy, leg. C. Solari, lectotype in UPS, vidi) in having the similar external features and also the same C+ reaction in the excipulum. *Lecidea cerviniicola*, however, has larger spores (9–12 \times 4–5 μm) and different chemical substances demonstrated with the TLC methods (Culberson & Hertel 1972 reported perlatolic acid and anziaic acid from *L. cerviniicola*).

Specimens examined. HONSHU. Pref. Nagano. *Shiroumadake*, Mt. Norikura (2410 m, mi-12975);

Yarigatake, Mt. Minamisawa (2640 m, mi-5956); Mt. Noguchigoro (2910 m, mi-12697); Tateyama, Mt. Kitakazura (2440 m, mi-5030). Pref. Toyama. Tateyama, Mt. Tateyama (2810 m, mi-12769; 2950 m, mi-12849); Mt. Tsurugi (2680 m, mi-12841 & 12888).

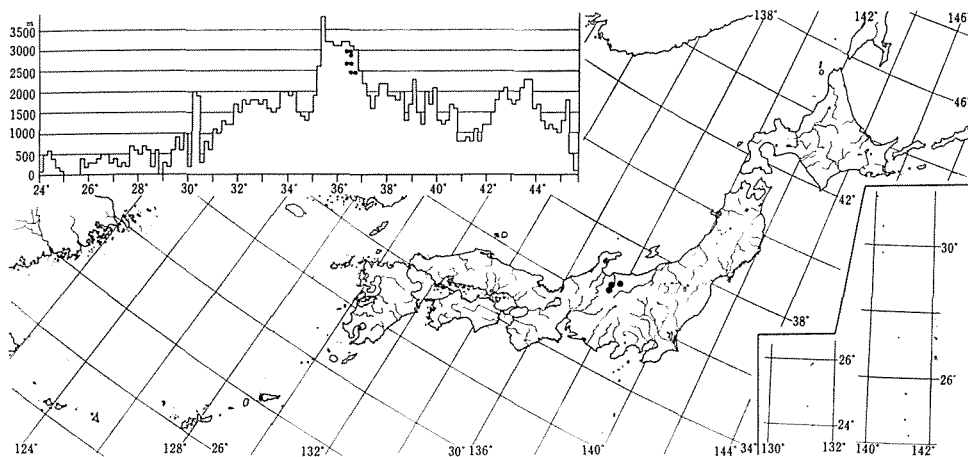


Fig. 14. Distribution of *Lecidea diducens* in Japan.

7. *Lecidea elabens* Fr. (Figs. 10: J–L, 15; Plate II: 9, 10)

Kgl. Vetensk.-Akad. Nya Handl. 256 (1822). Type: Sweden, Smaland, Femsjö, —lectotype in UPS, selected here, *vidi*. — *Lecidea melancheima* Tuck., Proc. Amer. Acad. Arts and Sc. 1: 260 (1848). Type: U.S.A., Mass., Ipswich, leg. Oakes, —lectotype in FH, selected here, *vidi*; Zahlbr., Bot. Mag. Tokyo 41: 329 (1927).

Thallus thin to medium, verrucose; verrucules smooth and polished, crowded and often somewhat confluent or subsparse, usually becoming discrete, white or dull-white; medulla I—. Hypothallus whitish, visible between the verruculae.

Apothecia up to 1 mm in diameter, adnate-appressed, black or blue-black, glossy, slightly constricted at the base; disc non-pruinose, plane to moderately convex or rarely strongly convex; margin usually thin and inconspicuous, often disappearing. Excipulum 30–60 μm thick, dark brown to brown externally, the interior part colorless or very pale yellowish-brown; hyphae radiating, 3–4 μm thick, with walls of variable thickness, at the apices enlarged slightly, with well-developed parathecial crown. Epithecium dark brown to brown, rather thicker, 15–20 μm . Hymenium 35–50 μm high. Subhymenium 20–50 μm high, colorless, with perpendicular hyphae. Paraphyses coherent, firmly coherent at the apical part, 1–2 μm thick; apices not or slightly clavate. Asci clavate, 25–40 \times 8–12 μm . Spores ellipsoid, pseudodiblastic, 6–11 \times 2–4 μm .

Reaction: Thallus P—, K+ yellow, KC—, C—; medulla P+ orange red (P— in chemical race II), K—, KC—, C—. Chemical substances; atranorin and fumarprotocetraric acid in chemical race I; atranorin in chemical race II.

Habitat. On wood of conifers in subalpine coniferous forests.

Range. Japan; Europe; North America.

Lecidea elabens is easily recognized by having a characteristic habitat on coniferous wood, verrucose glossy thallus on a white hypothallus, adnate-appressed glossy apothecia, and minute spores ($6-11 \times 2-4 \mu\text{m}$).

Whether *L. elabens* is identical with *L. melancheima* Tuck. or not has been discussed by many authors. Tuckerman (1888) stated that *L. elabens* was a poorly developed specimen of *Lecidea Friesii* Ach. (= *Psora friesii*; = *Hypocnomyce friesii*) and he recognized *L. melancheima* as a distinct species. Zahlbruckner (1925) and Lowe (1939) followed him, while Jatta (1911), Lindau (1923) and Vainio (1934) accepted *L. elabens* as a distinct species and reduced *L. melancheima* as a synonym of it. Examination of the holotype of *L. friesii* (H-Ach. 436 A in H) has revealed that it is different from *L. elabens*, and hence *L. elabens* can be accepted as a good species.

The Japanese specimens agree very well with the lectotype — both morphologically and anatomically — on which E. Fries, Th. M. Fries and R. Santesson annotated with their own hand writing "L. E. p. 344,"* "Scand. p. 554"**, and "This is the true *L. elabens* Fr. (= *L. melancheima* Tuck.) not *L. friesii* as said by Tuckerman." However, two chemical races have been found; one containing fumarprotocetraric acid and atranorin (as in the type specimen) and the other containing only atranorin. There exist neither ecological nor geographical differences between them. Further materials and elaborate field studies are required for resolving this kind of chemical difference.

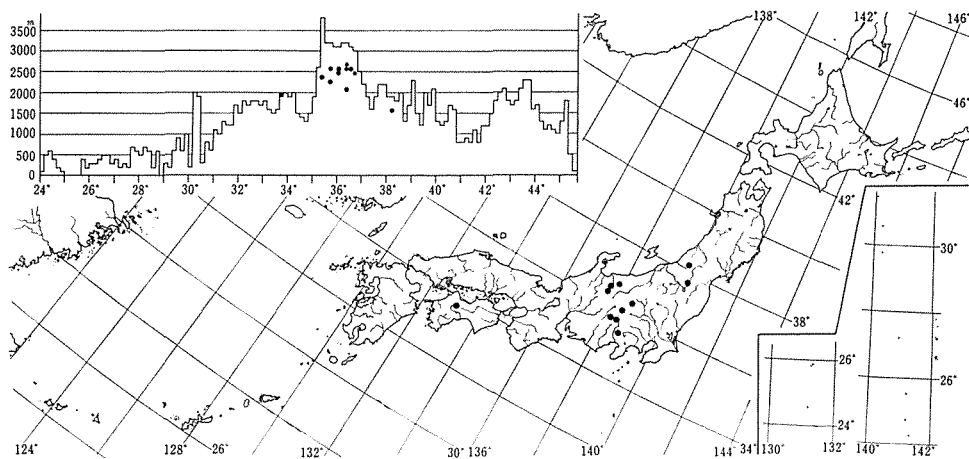


Fig. 15. Distribution of *Lecidea elabens* in Japan.

Specimens examined. HONSHU. Pref. Yamagata. *Asahidake*, Mt. Asahi (1580 m, mi-10595); *Azumasan*, Ubayu (Faurie-5781 as *Lecidea melancheima* Tuck, KYO). Pref. Nagano. *Shiroumadake*, Mt. Norikura (2410 m, mi-12968); *Tateyama*, Mt. Renge (2530 m, mi-4967); *Yarigatake*, Mt. Eboshi (2570 m, mi-12709; 2620 m, mi-12746); *Karuizawa*, Mt. Asama (2050 m, mi-11384); *Tateshinayama*, Mt. Tateshina (2430 m, mi-11633; 2500 m, mi-11589). Pref. Yamanashi. *Nirasaki*, Mt. Kitadake

* E. Fries (1831) ** Th. Fries (1874)

(2580 m, mi-960); *Ichinose*, Sensui Pass (2200–2250 m, mi-12313); *Fujisan*, Mt. Fuji (2320–2350 m, mi-11403). ШИКОКУ. Pref. Ehime. *Ishizuchisan*, Mt. Ishizuchi (1980 m, mi-10997).

8. *Lecidea fuscoatrata* Nyl. (Figs. 10: M–O, 16; Plate III: 1, 2)

Flora 58: 301 (1875). Type: Austria, "Tirol," Kühthe, leg. F. Arnold,–holotype in H (H-Nyl. 15329a), vidi.

Thallus indeterminate, contiguous, brown with yellow shades, with epinecral layer, of distinct flat areolae; areolae angular, thinly white-marginate; medulla I+ violet. Hypothallus black, well developed, visible between the areolae.

Apothecia adnate, rather firmly appressed to the surface of the areolae, reaching a diameter of 0.9 mm, black, somewhat thickly marginate; margin almost level with the disc surface; disc non-pruinose, plane. Excipulum 60–80 μm thick, K+ dirty yellow; hyphae 4–5 μm thick, thick-walled, blackish-green externally, while the interior part paler, colorless; parathecial crown not so advanced. Epithecium blue-green. Hymenium 35–50 μm high, with I+ intensively dirty blue iodine reaction. Subhymenium 15–25 μm high, colorless. Hypothecium 150–200 μm high, dark brown. Paraphyses simple, or rarely branched, 2.5–3(3.5) μm thick; apices slightly swollen, 4–5 μm thick. Asci clavate, 35–40 \times 8–11 μm . Spores 7–11 \times 4–5 μm , with obtuse ends.

Reaction: Thallus P–, K–, KC–, C–; medulla P–, K+ yellow (faintly), KC–, C–. Chemical substances: Stictic acid (Chemical race I); no colorless lichen substances demonstrated in TLC (Chemical race II).

Habitat. On non-calcareous rocks in mountains of southwestern Japan.

Range. Japan; Europe.

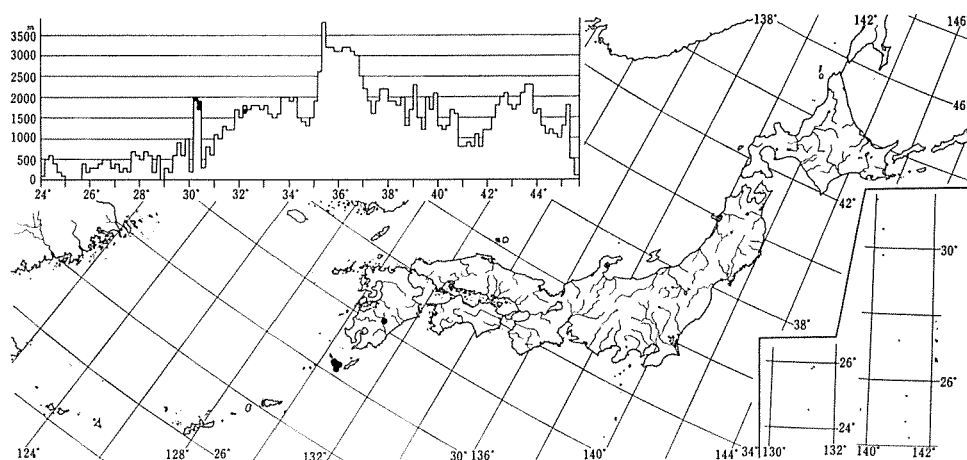


Fig. 16. Distribution of *Lecidea fuscoatrata* in Japan.

The holotype specimen of *L. fuscoatrata* which was mentioned as "specim. orig." by Vainio (1934) is very fragmentary, so a test of its chemical reaction

was limited to the excipulum. Judging from the reaction (K+ yellow), it may be assumed that the holotype of *L. fuscoatrata* contains stictic acid. The Japanese specimens studied agree very well with the type specimen morphologically and anatomically with the exception of the existence of chemically negative populations.

This species is closely related to *Lecidea paupercula* Th. Fr. (lectotype in O, Norway, leg. J. M. Norman 377, vidi) in general appearance but differs in having a lower hymenium (60–70 μm high in the type specimen) and smaller spores (12–16 \times 6–8 μm in the type).

Another ally, *Lecidea subpaupercula*, is distinguished from this species by its somewhat longer spores (9–11 \times 4–5 μm) and by adnate apothecia slightly constricted basally.

Specimens examined. KYUSHU. Pref. Miyazaki. *Muwayo*, Mt. Ichifusa (1660 m, mi-10265). Pref. Kagoshima. *Yakushima-seihokubu*, Mt. Nagata (1850 m, mi-9892; 1890 m, mi-9922); *Yakushima-touhokubu*, Mt. Miyanoura (1730 m, mi-10008); *Yakushima-touanbu*, Mt. Miyanoura (1930 m, mi-9999).

9. ***Lecidea instratula*** Nyl. (Figs. 10: P–R, 17; Plate III: 3, 4)

Flora 61: 242 (1878). Type: France, "Mont-Dore, la Bourboule," leg. E. Lamy 1269,–holotype in H (H-Nyl. 15329b), vidi.

Thallus subdeterminate, thin to medium, brown to dark brown, with epinecral layer, minutely areolate; areolae angular, smooth, plane, subdispersed and embedded in the black hypothallus, or contiguous; medulla I—. Hypothallus distinct, usually visible between the areolae.

Apothecia immersed in the thallus, black, thinly marginate, minute, 0.15–0.4 mm in diameter; disc non-pruinose, plane or concave. Excipulum poorly developed, 10–20 μm thick, concolorous to the epithecium. Epithecium dirty blue-green or blackish-green. Hymenium 30–50 μm high. Subhymenium 20–30 μm high, with irregularly-shaped cavity, colorless, with perpendicular hyphae. Hypothecium \pm indistinct, 40–50 μm high, colorless. Paraphyses branched, 1.5–2 μm thick, anastomosed especially in the upper part; apices slightly swollen, 3–4 μm thick. Asci 28–40 \times 9–10 μm , clavate. Spores 7–10 \times 4–6 μm , with obtuse ends, pseudodiblastic.

Reaction: Thallus & medulla P—, K—, KC—, C—. Chemical substance: *Lecidea*-3.

Habitat. On non-calcareous rock in subalpine and alpine regions.

Range. Japan; Europe.

This species is known only from a few localities in Europe. Japanese materials agree very well with the holotype and are identified with this species. It is easily recognized by the conspicuous black hypothallus in which the thallus is embedded, the minutely areolated thallus, and minute, immersed apothecia.

The apothecia of this species are most similar to those of *Lecidea carbonoides* Thoms. from Alaska (isotype, Lich. Arct. ex. n. 94, in H, vidi) and *Lecidea*

schitakensis Zahlbr. from China (holotype, Handel.-Mazz. 3556, in W, vidi). *Lecidea carbonoidea* can be distinguished from *L. instratula* by the higher hymenium (90–100 μm high), the larger spores (14–18 \times 7–8 μm), and a positive iodine reaction in the medulla. *Lecidea schitakensis* differs in having a higher hymenium (70–90 μm high), brown hypothecium, and larger spores (16–19 \times 7–10 μm).

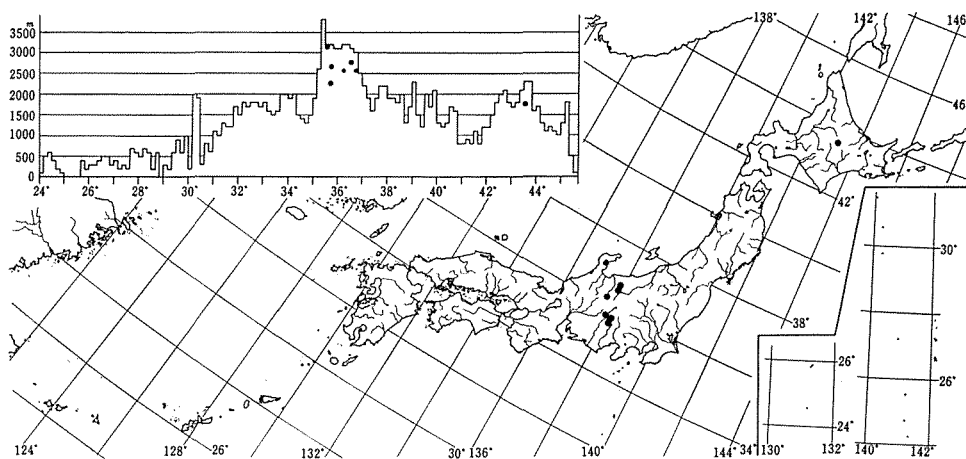


Fig. 17. Distribution of *Lecidea instratula* in Japan.

Specimens examined. HOKKAIDO. Prov. Tokachi. *Ishikaridake*, Mt. Otofuke (1730 m, mi-8436). HOKSHU. Pref. Nagano. *Shirumadake*, Mt. Shirouma (2550 m, mi-14107); *Oomachi*, Mt. Goryu (2730 m, mi-5350); *Kamikochi*, Mt. Chyogatake (2550 m, mi-14244); *Akaho*, Mt. Utsugi (2660 m, mi-14244). Pref. Toyama. *Shirumadake*, Mt. Shirouma (2500 m, mi-14141). Pref. Yamanashi. *Ichinose*, Sensu Pass (2200–2250 m, mi-12300 & 12311); *Oogawara*, Mt. Ainotake (3150 m, mi-12395).

10. *Lecidea lactea* Floerke ex Schaer.

(Figs. 18: A–C, 19; Plate III: 5, 6)

Lich. Helv. spic. 127 (1828). Type: Switzerland, Grimsel,—holotype in B?, non vidi; isotype in M (Schaer. Lich. Helvet. 176), vidi.

Thallus effuse, thin to medium, contiguous or obsolete, at times well advanced, irregularly cracked-areolate; areolae plane or sometimes slightly bullate, whitish with pale yellow-brown shade; medulla I+ intensively violet-blue. Hypothallus \pm distinct, encircled, black.

Apothecia subimmersed to appressed to the thallus, not constricted at the base, or rarely somewhat constricted, up to 1.5 mm in diameter; margin rather thick and entire; disc plane or in old apothecia somewhat convex, thinly white-pruinose or sometimes non-pruinose. Excipulum at the margin 80–100 μm thick, laterally soon thinner, 30–50 μm thick below, concolorous to the epithecium externally, colorless or pale brown with intricate radiating hyphae internally, K+yellow, then blood-red. Epithecium blue-green or blackish-green. Hymenium (40)50–60(70) μm high. Subhymenium 20–40(60) μm high,

colorless, with perpendicular hyphae. Hypothecium with various heights, reaching 200 μm high. Paraphyses simple or slightly branched, 2–2.5 μm thick, not swollen or somewhat swollen at the apices. Asci clavate, 40–60 \times 15–20 μm . Spores ellipsoid with obtuse ends, pseudodiblastic, (9)10–14(15) \times (4)5–7(8) μm .

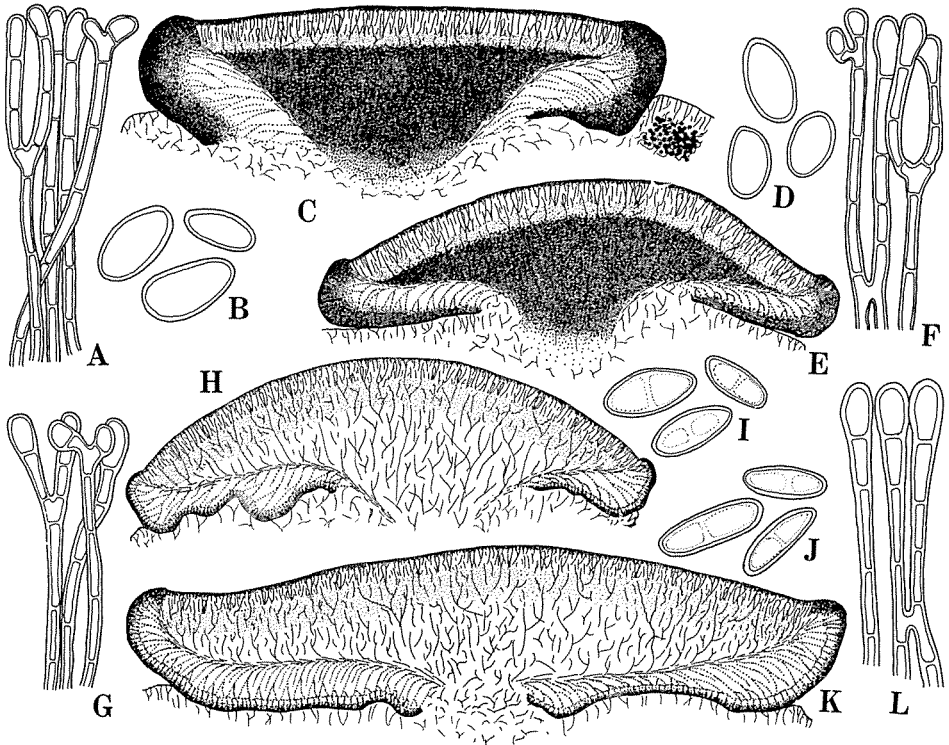


Fig. 18. *Lecidea lactea* Floerke ex Schaer. (A–C: drawn from HIRO-Inoue 8506), *L. lapicida* (Ach.) Ach. (D–F: drawn from HIRO-Inoue 5864), *L. lithophila* (Ach.) Ach. (G–I: drawn from HIRO-Inoue 10650), and *L. plana* (Lahm) Nyl. (J–L: drawn from HIRO-Inoue 11523). A, F, G, and L. Upper part of paraphyses, $\times 1000$. B, D, I, and J. Spores, $\times 1000$. C, E, H, and K. Vertical section of apothecia, $\times 60$.

Reaction: Thallus P+ deep yellow, K+ yellow, then red, KC–, C–; medulla P–, K–, KC–, C–. Chemical substances: norstictic acid.

Habitat. On non-calcareous rocks in alpine regions.

Range. Japan; Asia; Arctic region; Europe; North America.

This species is very closely related to *Lecidea lapicida*, and it is difficult to distinguish them except by the chemical difference (*L. lapicida* produces stictic acid); for example spore size distribution which is often used as a distinguishing character in the genus, is very similar between *L. lactea* and *L. lapicida* (Fig. 12). On studying extensive materials I have found one possibility for maintaining

each of these two as distinct species on the basis of the following morphological difference: the apothecia of *L. lapicida* are adnate and slightly constricted at the base, while in *L. lactea* the apothecia are subimmersed to appressed. But a definite decision could not be made on this character because intermediate specimens are frequently encountered.

In some specimens, especially older ones, narrow fissures sometimes occur between the margin and the disc of the apothecium. As far as I can see, they are of no taxonomic value. The same variation has been detected in *L. lapicida*, to which *L. lactea* is very closely related.

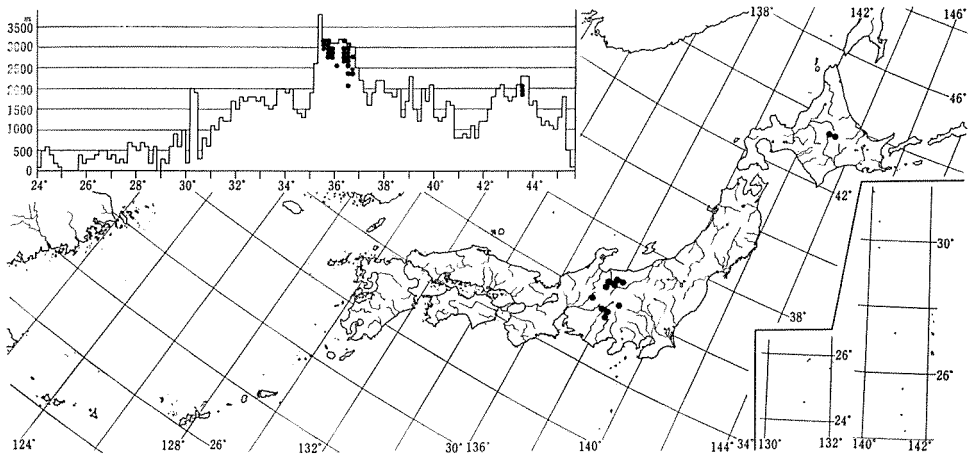


Fig. 19. Distribution of *Lecidea lactea* in Japan.

Specimens examined. HOKKAIDO. Prov. Tokachi. *Ishikaridake*, Mt. Ishikari (1860 m, mi-8484 & 8485; 1890 m, mi-8506; 1960 m, mi-8488). Prov. Kamikawa. *Asahidake*, Mt. Hakuun (1870 m, mi-8616); Mt. Tomuraushi (2080 m, mi-8648). HONSHU. Pref. Nagano. *Togakushi*, Mt. Takatsuma (2350 m, mi-11298); *Shiroumadake*, Mt. Norikura (2430 m, mi-12972); Mt. Karamatsu (2770 m, mi-5782, 5822 & 5839); Mt. Korenge (2740 m, mi-5726); *Oomachi*, Mt. Goryu (2650 m, mi-5550 & 5551); Mt. Jii (2080 m, mi-5306); *Tateyama*, Mt. Harinoki (2520 m, mi-6071; 2540 m, mi-6093); Mt. Renge (2590 m, mi-4995 & 5018); Mt. Kitakazura (2330 m, mi-4968); *Yarigatake*, Mt. Eboshi (2610 m, mi-12721; 2620 m, mi-12719); Mt. Washiba (2790 m, mi-5884; 2830 m, mi-6018; 2890 m, mi-5890); Mt. Yari (2950 m, mi-4889; 3110 m, mi-4853 & 4854; 3140 m, mi-4855); *Tateshinayama*, Mt. Tateshina (2510 m, mi-11574); *Ontakesan*, Mt. Ontake (2790 m, mi-11515; 2820 m, mi-11462; 2850 m, mi-11459; 2860 m, mi-4725; 2930 m, mi-11536, 11541 & 11542); *Akaho*, Mt. Hoken (2910 m, mi-6479); Mt. Utsugi (2780 m, mi-6856; 2810 m, mi-6886). Pref. Toyama. *Tateyama*, Mts. Tateyama (2680 m, mi-12823; 2760 m, mi-12795; 2810 m, mi-12832; 2820 m, mi-12784, 12789 & 12791; 2870 m, mi-12862; 2920 m, mi-12772; 2950 m, mi-12765, 12766, 12843 & 12867; 3010 m, mi-12870). Pref. Yamanashi. *Ichinose*, Mt. Kitadake (2950 m, mi-12168, 12171, 12173, 12174, 12176 & 12178; 2990 m, mi-12290; 3030 m, mi-12263 & 12281; 3050 m, mi-12194, 12253 & 12265; 3060 m, mi-12227 & 12277; 3070 m, mi-12214, 12270 & 12280; 3130 m, mi-12268; 3140 m, mi-12205, 12207 & 12289; 3160 m, mi-12225 & 12239; 3180 m, mi-1035 & 12274); *Oogawara*, Mt. Ainotake (2980 m, mi-12399; 3060 m, mi-12366 & 12385; 3080 m, mi-1082, 1083, 12388 & 12408; 3150 m, mi-12368, 12376, 12386, 12390 & 12402; 3185 m, mi-1012, 1014 & 1113). Pref. Shizuoka. *Oogawara*, Mt. Notori (3030 m, mi-1186; 3040 m, mi-1183).

11. **Lecidea lapicida** (Ach.) Ach.
(Figs. 18: D-F; 20; Plate III: 7, 8)

Method. Lich. 37 (1803). — *Lichen lapicida* Ach., Lich. Svec. Prod. 61 (1798). Type: Sweden, -lectotype (Hertel 1977) in H (H-Ach. 87A), vidi.

Thallus effuse, thin to medium, contiguous or partly evanescent, irregularly cracked-areolate; areolae plane and tartareous, ash-gray; medulla I+ intensively violet-blue, with a \pm indistinct black hypothallus, encircled.

Apothecia appressed or adnate, slightly constricted at the base, reaching a diameter of 1.5 mm, black; disc plane or slightly concave with rather thick prominent margin, non pruinose. Excipulum at the margin 100–120 μ m thick, laterally soon thinner, 20–50 μ m thick below, blue-green externally, colorless or pale brown with intricate-radiating hyphae internally, K+ yellow. Epithecium blue-green or blackish-green. Hymenium (40)50–60 μ m high. Subhymenium 20–50 μ m high, colorless. Hypothecium with various heights, reaching 200 μ m high, varying from colorless (or grayish- to sordid yellowish-cloudy) to pigmented (with various shades of brown); hyphae perpendicular. Paraphyses simple or with a few branches, 1.5–2 μ m thick, slightly thickened at the apices. Asci clavate, 45–50 \times 10–12 μ m. Spores ellipsoid with obtuse ends, pseudodiblastic, (9)10–14(16) \times (4)5–7(8) μ m.

Reaction: Thallus & medulla P–, K+ yellow (faintly), KC–, C–. Chemical substances: stictic acid and norstictic acid (\pm extremely trace).

Habitat. On non-calcareous (or rarely calcareous) rocks in alpine regions.

Range. Japan; India; Arctic regions; Europe; North America; Venezuela.

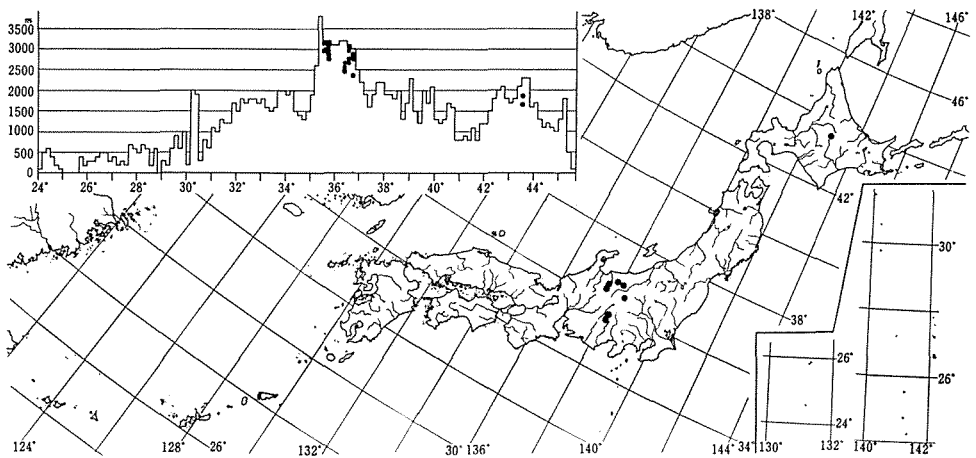


Fig. 20. Distribution of *Lecidea lapicida* in Japan.

This species is part of a group of many closely related species. The differences between most of them have been discussed by Hertel (1977).

At times *Lecidea lapicida* shows a colorless or grayish- to sordid yellowish-cloudy hypothecium and is hardly distinguishable from *Lecidea plana*, which has a colorless hypothecium. It is, however, distinguished from *L. plana* by the wider spores (Fig. 12) and the chemical differences.

Hertel (1977: 259) mentioned that no mature spores were found in the lectotype specimen, but in the same specimen, which I studied, spores of the following dimensions were fortunately observed: $10-11 \times 5-6 \mu\text{m}$ (from 5 spores).

Specimens examined. HOKKAIDO. Prov. Kamikawa. *Asahidake*, Mt. Midori (1620 m, mi-8528); Mt. Hakuun (1870 m, mi-8617). HONSHU. Pref. Nagano. *Togakushiyama*, Mt. Takatsuma (2350 m, mi-11318); *Shiromadake*, Mt. Karamatsu (2770 m, mi-5871; 2800 m, mi-5864); *Yarigatake*, Mt. Eboshi (2570 m, mi-12751; 2600 m, mi-12735; 2620 m, mi-12745); Mt. Mitsu (2490 m, mi-5983); Mt. Noguchigoro (2590 m, mi-12736); *Ueda*, Mt. Asama (2400 m, mi-11338). Pref. Toyama. *Tateyama*, Mt. Tateyama (2650 m, mi-12792, 12810 & 12818; 2730 m, mi-12853; 2950 m, mi-12771; 3010 m, mi-12844); Mt. Tsurugi (2680 m, mi-12834). Pref. Yamanashi. *Ichinose*, Mt. Kitadake (2750 m, mi-982; 2860 m, mi-1041; 2870 m, mi-1054; 2950 m, mi-12185 & 12187; 3040 m, mi-12231, 12235 & 12262; 3050 m, mi-12190 & 12256; 3060 m, mi-12201 & 12255; 3125 m, mi-1024; 3150 m, mi-1032; 3160 m, mi-12267); *Oogawara*, Mt. Ainotake (2930 m, mi-1127 & 11891; 2950 m, mi-1068; 3100 m, mi-1072; 3150 m, mi-12397; 3160 m, mi-12371).

12. *Lecidea lithophila* (Ach.) Ach.

(Figs. 18: G-I, 21; Plate III: 9, 10)

Syn. Lich. 14 (1814). — *Lecidea lapicida* var. *lithophila* Ach., Kgl. Vetensk. Akad. Nya Handl. 29: 233 (1808). Type: Switzerland "Helvetia," leg. J. Schleicher 825-a, —lectotype (Hertel 1970) in H (H-Ach. 96A), vidi.

Thallus thin to somewhat thick or rarely more advanced, sometimes partly evanescent, ash-white, occasionally with ochraceous shade, cracky-areolate; areolae flat or slightly convex with rough surface, separated by \pm wide cracks; medulla I+ violet-blue. Hypothallus indistinct.

Apothecia immersed to subimmersed or appressed-adnate, not constricted at the base, up to 2 mm in diameter or sometimes reaching a diameter of 2.5 mm, blackish-brown, when matured becoming irregular in form and ridged up with 1 to 3 or rarely more lines, running in various directions, sometimes intersecting, at first shallowly but finally deeply splitting the apothecium into about 2-4 variously-shaped, conglomerate apothecia; disc dark brown to blackish-brown, plane to somewhat convex, non-pruinose or with a thin white pruina in younger apothecia, surrounded by flexuose, prominent, concolorous margin. Excipulum (70)90-130(150) μm thick, colorless interiorly, while the exterior part concolorous to the epithecium; hyphae intricate-radiate, 1-3 μm thick, thin-walled. Epithecium pale brown to greenish-brown. Hymenium (40)50-60(70) μm high. Subhymenium (30)50-70(100) μm high. Hypothecium with various heights, \pm indistinctly limited to subhymenium; subhymenium, and hypothecium colorless with perpendicular hyphae, I+ intensively blue. Paraphyses coherent, simple or rarely branched, slender, 1.5-2 μm thick; apices slightly

capitate, 3–4 μm thick or not thickened. Asci clavate, 40–50(60) \times 10–13 μm . Spores with obtuse ends, pseudodiblastic, 10–15 \times 4–7 μm .

Reaction: Thallus & medulla P–, K–, KC–, C–. Chemical substances: planaic acid (major constituent), 4-o-demethylplanaic acid (usually +, or trace).

Habitat. On non-calcareous rocks in alpine regions.

Range. Japan; Arctic regions; Europe; North America.

This species is easily recognized by the colorless subhymenium and hypothecium, the pale brown to greenish-brown epithecium, spore size, and the external apothecial form.

The Japanese specimens differ from the lectotype, in which apothecia are up to 0.8 mm in diameter, only by the somewhat larger apothecia. However, they are referred to this species because apothecial diameter is very variable; occasionally there are a few ridges on the disc and then they divide the apothecium into about 2–4 variously-shaped, conglomerate apothecia, which grow into larger apothecia.

This species is closely related to *Lecidea plana*. For the distinction between the two see the note under *L. plana*.

In some specimens, especially younger ones, whitish pruina sometimes occurs on the disc. It may be, however, of no taxonomical importance in spite of being important in other members such as *Huilia albocaerulescens* and *H. flavocaerulescens*.

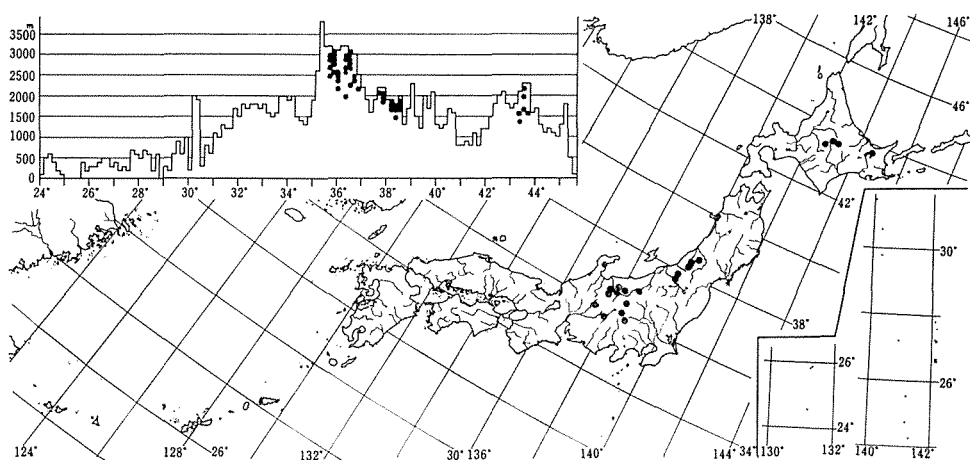


Fig. 21. Distribution of *Lecidea lithophila* in Japan.

Specimens examined. HOKKAIDO. Prov. Abashiri. *Syaridake*, Mt. Syari (1510 m, mi-8320). Prov. Tokachi. *Ishikaridake*, Mt. Otofuke (1640 m, mi-8399). Prov. Kamikawa. *Asahidake*, Mt. Hakuun (2190 m, mi-8579); Mt. Tomuraushi (1900 m, H. Kanda-491; 2130 m, mi-8657); *Tokachidake*, Mt. Furano (1300 m, mi-7950; 1510 m, mi-7945; 1570 m, mi-7957). HONSHU. Pref. Yamagata. *Gassan*, Mt. Gassan (1670 m, mi-10810 & 10830; 1700 m, mi-10799; 1780 m, mi-10823; 1850 m, mi-10816); *Asahidake*, Mt. Asahi (1750 m, mi-10554 & 10561; 1780 m, mi-10577; 1790 m, mi-10556; 1800 m, mi-

10522 & 10542; 1800–1830 m, mi-10650); Mt. Kanko (1690 m, mi-10429, 10434 & 10465); *Ootoriike*, Mt. Itou (1400 m, mi-10493; 1440 m, mi-10495 & 10509; 1480 m, mi-10488; 1680 m, mi-10480; 1710 m, mi-10474; 1740 m, mi-10475; 1770 m, mi-10477); *Iidesan*, Mt. Iide (1850 m, mi-10896; 1890 m, mi-10910; 1940 m, mi-10844, 10847 & 10849; 2000 m, mi-10838; 2010 m, mi-10926; 2080 m, mi-10834 & 10845); *Dainichidake*, Mt. Dainichi (2070 m, mi-10653, 10654 & 10673). Pref. Nagano. *Naebasan*, Mt. Naeba (2145 m, mi-250); *Togakushi*, Mt. Takatsuma (2330 m, mi-11293 & 11296; 2340 m, mi-11305; 2350 m, mi-11310 & 11316); *Shiroumadake*, Mt. Norikura (2430 m, mi-12939; 2440 m, mi-12977); *Oomachi*, Mt. Kashimayari (2700 m, mi-5363); *Tateyama*, Mt. Funakubo (2280 m, mi-5050); *Yarigatake*, Mt. Eboshi (2570 m, mi-12752; 2620 m, mi-12711); Mt. Mitsu (2830 m, mi-12705); Mt. Noguchigoro (2910 m, mi-12694; 2920 m, mi-12690 & 12733); Mt. Tsubakuro (2660 m, mi-4762); Mt. Otensho (2680 m, mi-5291); Mt. Washiba (2890 m, mi-5930); *Ueda*, Mt. Kagonoto (1900 m, mi-587 & 11749; 1950 m, mi-603); *Tateshinayama*, Mt. Tateshina (2100 m, mi-11645; 2370 m, mi-11651; 2460 m, mi-11600 & 11615; 2520 m, mi-11590; *Kinpusan*, Mt. Kinpu (2540 m, mi-10724); *Ontakesan*, Mt. Ontake (2740 m, mi-4683 & 4712; 2770 m, mi-11517; 2790 m, mi-11514; 2820 m, mi-11454; 2930 m, mi-11532; 2940 m, mi-11520 & 11522; 3020 m, mi-11551; 3050 m, mi-4614 & 11566); *Akaho*, Mt. Hoken (2900 m, mi-6480); Mt. Utsugi (2810 m, mi-6840; 2820 m, mi-6855); Mt. Kisokoma (2410 m, mi-6710; 2620 m, mi-6676). Pref. Toyama. *Tateyama*, Mt. Tateyama (2650 m, mi-12802; 2750 m, mi-12863; 2760 m, mi-12794; 2730 m, mi-12852; 2820 m, mi-12850; 2920 m, mi-12861; 2950 m, mi-12868; 3000 m, mi-12848; 3010 m, mi-12842); Mt. Tsurugi, 2630 m, mi-12885; 2650 m, mi-12905; 2680 m, mi-12827; 2810 m, mi-12835). Pref. Yamanashi. *Kinpusan*, Mt. Kokushi (2580 m, mi-1288).

13. *Lecidea plana* (Lahm) Nyl.

(Figs. 18: J–L, 22; Plate IV: 1, 2)

Flora 55: 552 (1872). — *Lecidella plana* Lahm in Körb., *Parerga Lich.* 211 (1861). Type: Germany, an Sandstein Felsen des Stimmberges bei Oer, leg. Lahm, lectotype (Hertel 1977) in B, non vidi. — *Lecidea plana* f. *subsparsa* Nyl., *Lich. Jap.* 72 (1890). Type: Japan, Honshu, Pref. Shizuoka, Mt. Fuji (prope Ichigome), leg. E. Almquist, holotype in S, vidi; isotype in H (H-Nyl. 15860), vidi. — *Lecidea plana* var. *subsparsa* (Nyl.) Zahlbr., *Cat. Lich. Univ.* 3: 670 (1925).

Thallus thin to medium, usually not contiguous, irregularly areolate, sometimes only with scattered areolae; areolae flat to slightly lenticular, with rough surface, white with gray shade; medulla I—. Hypothallus indistinct.

Apothecia sessile, slightly constricted at the base, round or irregularly flexuose or even conglomerate, usually 1–1.5 mm, sometimes up to 2 mm in diameter; margin thin, entire or more or less sinuous, black; disc non-pruinose or rarely pruinose, concave or in old apothecia somewhat convex, concolorous to the disc. Excipulum 50–80(100) μm thick, deep green to blue-green in external part and becoming gradually colorless internally; hyphae perpendicularly radiating, 3–5 μm thick, thin-walled. Epithecium deep green to blue-green. Hymenium (35)40–50(60) μm high. Subhymenium (50)60–80(100) μm high. Hypothecium \pm indistinctly limited to subhymenium and excipulum, with various heights; subhymenium and hypothecium colorless with perpendicular hyphae, I+ intensively blue. Paraphyses coherent, simple or rarely branched, 2–3 μm thick, apices slightly capitate, 4–5 μm thick. Asci clavate, 35–50 \times 9–13 μm . Spores with obtuse ends, pseudodiblastic, (8)9–14(16) \times 3.5–5(6) μm .

Reaction: Thallus & medulla P—, K—, KC—, C—. Chemical substances:

planaic acid and 4-o-demethylplanaic acid (+, or trace, or extremely trace) in chemical race I; 4-o-demethylplanaic acid in chemical race II.

Habitat. On non-calcareous rocks in alpine regions.

Range. Japan; Europe; North America.

Lecidea plana is closely related to *L. auriculata* and *L. lithophila*, especially to *L. lithophila*. *Lecidea auriculata* is easily distinguished not only by the smaller spores but also by the brown subhymenium and hypothecium. The relation between *L. plana* and *L. lithophila* is very close both anatomically and chemically. According to Th. Fries (1874: 497), *L. plana* is distinguished from *L. lithophila* by "mox distincta apotheciis etiam humidis atris, sporis minoribus aliisque partibus internis." Hertel (1977: 269) mentioned that *L. plana* has smaller spores, greenish epithecium, lower hymenium and pure black apothecia when wet as characters distinguishing it from *L. lithophila*. Furthermore, observations on numerous Japanese specimens produced evidence that the apothecia of *L. plana* are adnate and slightly constricted basally, while those of *L. lithophila* are appressed-adnate and not constricted. These characters are usually reliable but specimens which seemed to be intermediate were found. Such specimens are, however, rare and *L. plana* is most probably a good species, characterized especially by the emerald-green epithecium, lower hymenium, and adnate apothecia. Furthermore, Culberson & Hertel (1979) discussed the detail chemical characters in addition to the morphological ones with the *Lecidea lithophila-plana* group.

Lecidea plana f. *subsparsa* was described from Mt. Fuji based on a specimen with unusually scattered, minute areolae, but it certainly should be considered a habitat modification.

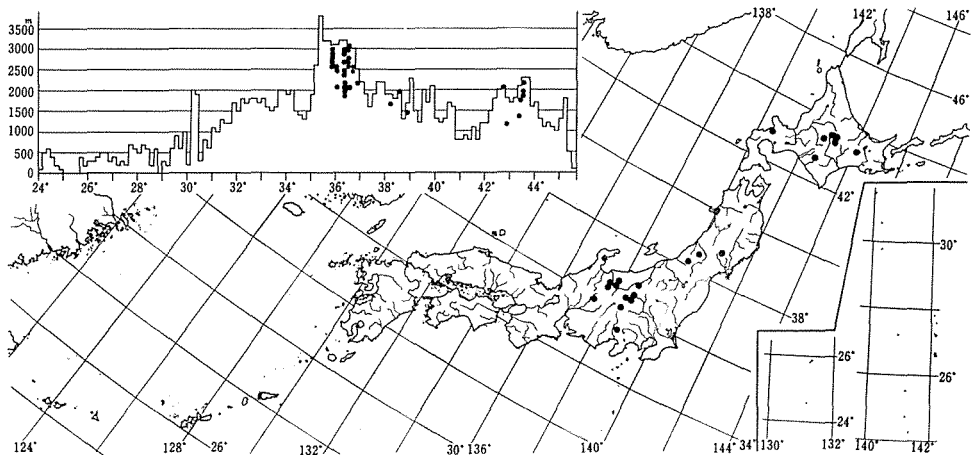


Fig. 22. Distribution of *Lecidea plana* in Japan.

Specimens examined. HOKKAIDO. Prov. Tokachi. *Ishikaridake*, Mt. Ishikari (1880 m, mi-8401); Mt. Otofuke (1890 m, mi-8457 & 8458; 1920 m, mi-8447 & 8459); *Nukabira*, Mt. Nipesotsu (1770 m,

mi-8929). Prov. Kamikawa. *Asahidake*, Mt. Midori (1880 m, mi-8556); Mt. Hakuun (2160 m, mi-8608; 2180 m, mi-8612); Mt. Tomuraushi (2120 m, mi-8644); *Tokachidake*, Mt. Furano (1350 m, mi-7970). Prov. Kushiro. *Akanko*, Mt. Oakan (1340 m, mi-8763). Prov. Shiribeshi. *Iwanai*, Mt. Mekunnai (1190 m, mi-8888). Prov. Hidaka. *Poroshiridake*, Mt. Hidakaporoshiri (2010 m, mi-7887). HONSHU. Pref. Miyagi. *Kurikomayama*, Mt. Kurikoma (1430 m, mi-10377 & 10382). Pref. Yamagata. *Asahidake*, Mt. Kanko (1690 m, mi-10456 & 10458); *Gassan*, Mt. Gassan (1960 m, mi-10928). Pref. Nagano. *Naebasan*, Mt. Naeba (2140 m, mi-381); *Kusazu*, Yamada Pass, Mt. Shirane (2060 m, mi-1758); *Shiroumadake*, Mt. Norikura (2420 m, mi-12949 & 12953; 2430 m, mi-12909 & 13015; 2530 m, mi-12935); *Oomachi*, Mt. Kashimayari (2720 m, mi-5441); *Yarigatake*, Mt. Eboshi (2610 m, mi-12722); Mt. Noguchigoro (2870 m, mi-12699; 2890 m, mi-12691; 2920 m, mi-12683, 12684 & 12695); Mt. Washiba (2880 m, mi-5937); Mt. Yari (2630 m, mi-4877); *Karuizawa*, Mt. Asama (1850 m, mi-11365 & 11391; 2010 m, mi-11373; 2070 m, mi-11370); *Ueda*, Mt. Asama (2360 m, mi-11328 & 11339; 2400 m, mi-11321 & 11355); Mt. Kagonoto (1950 m, mi-583 & 584; 2100 m, mi-576); *Tateshinayama*, Mt. Tate-shina (2070 m, mi-11639; 2410 m, mi-11621; 2470 m, mi-11609; 2480 m, mi-11607; 2490 m, mi-11632; 2500 m, mi-11577, 11585 & 11594; 2510 m, mi-11652; 2520 m, mi-11595); *Ontakesan*, Mt. Ontake (2530 m, mi-11475; 2560 m, mi-11484 & 11485; 2570 m, mi-11486; 2600 m, mi-11501 & 11502; 2640 m, mi-11496; 2760 m, mi-4666; 2820 m, mi-11450; 2850 m, mi-11457; 2920 m, mi-11523; 2930 m, mi-11518, 11521 & 11538). Pref. Toyama. *Tateyama*, Mts. Tateyama (2550 m, mi-12900; 2650 m, mi-12903; 2680 m, mi-12828; 2760 m, mi-12808; 2920 m, mi-12869; 2950 m, mi-12777; 3010 m, mi-12806). Pref. Shizuoka. *Fujisan*, Mt. Fuji, Ichigome, coll. E. Almquist (s.n.), in S, holotype of *L. plana* f. *subsparsa* Nyl.; *ibid.*, in H, H-Nyl. 15860, isotype.

14. *Lecidea speirea* (Ach.) Ach.

(Figs. 23: A–C, 24; Plate IV: 3, 4)

Method. Lich. 52 (1803). — *Lichen speireus* Ach., Lich. Svec. Prod. 59 (1798). Type: Sweden, Östergötland, Vänersunda s: n, 12.7. 1934, leg. R. Santesson 1030,–neotype in UPS, *vidi*. For an account of the neotypification, see Hertel 1975b: 386–397. — *Lecidea peltata* Zahlbr. in Handel-Mazzetti, Symbol. Sinic. 3: 95 (1930). Type: China, Yünnan, 4350–4450 m, alt., leg. Handel-Mazzetti 6946,–lectotype (selected here) in W, *vidi*.

Thallus effuse, or subdeterminate, surface not polished, rather powdery, continuous and undulated towards the centre, not continuous and verrucose-areolae scattered or crowded to conglomerate towards the circumference, chalky or glaucous-white; with positive intense I+ reaction in the medulla. Hypothallus black.

Apothecia black, at first innate with plane disc surrounded by a entire whitish-suffused pseudothalline margin, then somewhat raised up, the disc flat to slightly convex, finally thickened upwards, the disc convex and immarginate, not constricted at the base, reaching a diameter of 1.4 mm; disc thinly pruinose. Excipulum poorly developed, dark brown without limit to the hypothecium. Epithecium blackish-brown to greenish-brown. Hymenium 50–70 μ m high. Subhymenium 20–30(50) μ m high, colorless in the upper part, pale brown in the lower. Hypothecium dark brown. Paraphyses simple or with some few branches and anastomosing, 2–2.5 μ m thick, not thickened at the apices. Asci narrowly clavate, 60–65 \times 10–12 μ m. Spores ellipsoid with obtuse or sometimes slightly acute ends, 12–15 \times 6–8 μ m.

Reaction: Thallus & medulla P–, K–, KC–, C–. Chemical substances:

confluent acid and *Lecidea*-2.

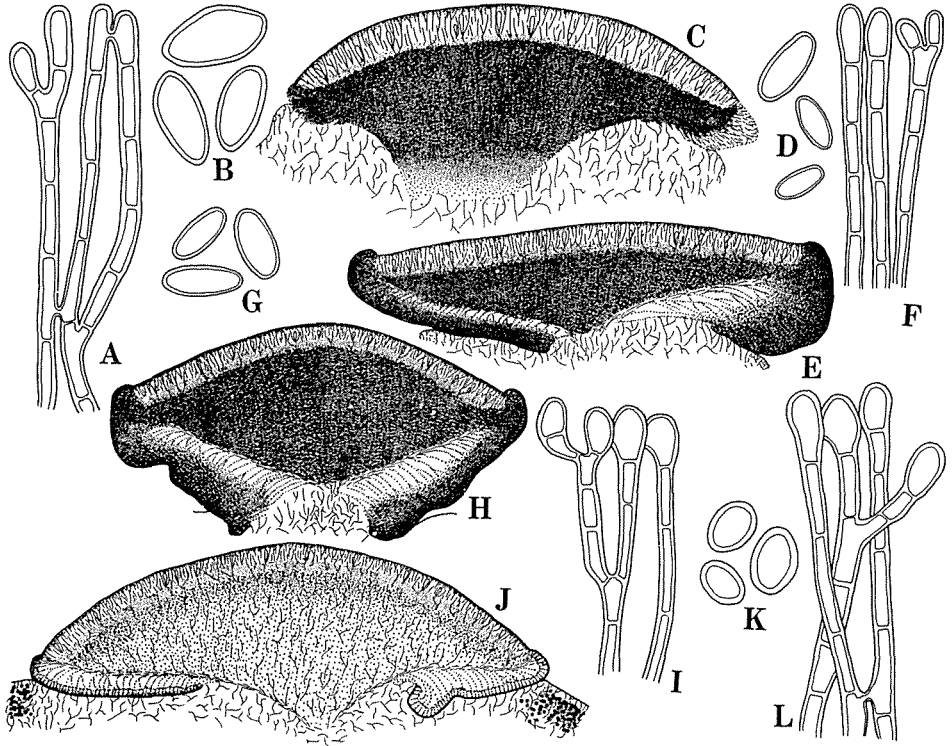


Fig. 23. *Lecidea speirea* (Ach.) Ach. (A-C: drawn from HIRO-Inoue 1084), *L. subleucothallina* M. Inoue (D-F: drawn from HIRO-Inoue 8666, holotype), *L. subpaupercula* M. Inoue (G-I: drawn from HIRO-Inoue 5680, holotype), and *L. tessellata* var. *caesia* (Anzi) Arnold (J-L: drawn from HIRO-Inoue 1001). A, F, I, and L. Upper part of paraphyses, $\times 980$. B, D, G, and K. Spores, $\times 980$. C, E, H, and J. Vertical section of apothecia, $\times 60$.

Habitat. On calcareous rocks in alpine regions.

Range. Japan; East and Central Asia; Arctic regions; Europe; North America.

Hertel (1975b) selected a neotype in spite of the existence of the specimens named *Lecidea speirea* by Acharius in H, UPS and BM. I am inclined to agree with Hertel's delimitation of the Acharian Herbarium to that represented in H, from which I have examined four specimens (H-Ach. 289A, B, C, and D). I would concur with his opinion concerning the specimens conserved in other herbaria (Hertel 1975b).

Lecidea speirea belongs to the genus *Lecidea* because of juvenile apothecial structure and positive intense I+ reaction in the medulla. Because of the brown excipulum without limit to the hypothecium in the mature stage, however, it reminds one of the species of *Huilia*. The excipulum of *L. speirea* may be regarded

as degenerative though no close allies are known among other species of the genus.

Lecidea speirea is distinctive by the chalky or glaucous-white thallus and early innate apothecia with whitish-suffused pseudothalline margin.

Specimen examined. HONSHU. Pref. Yamanashi. Oogawara, Mt. Ainotake (3080 m, mi-1084).

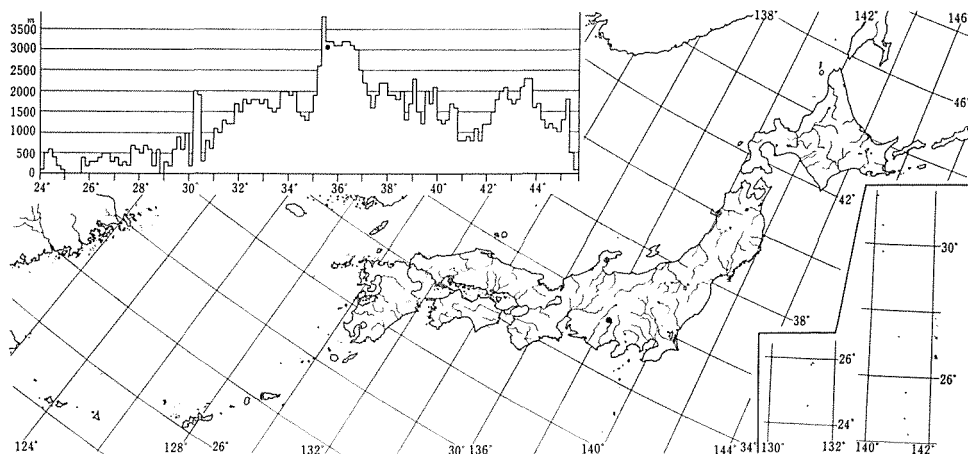


Fig. 24. Distribution of *Lecidea speirea* in Japan.

15. ***Lecidea subleucothallina*** M. Inoue, sp. nov.

(Figs. 23: D-F, 25; Plate IV: 5, 6)

Thallus modice incrassatus, olivaceo-bubalinus aut viridi-flavus, nitidus, strato obductus decolore, ex hyphis subdestructis, conglutinatis, horizontalibus formato, P+ aurantiacus, areolatus, areolis dispersis aut contiguis, vulgo plus minus distincte albomarginatis, medulla jodo non reagente, hypothallo nigricante.

Apothecia nigra, thallo adnata aut rarius in hypothallo sita, basi leviter constricta, ca. 1.3 mm lata, disco plano, pruinoso, margine tenui, persistente aut fere mox excluso. Excipulum extus fusco-fuliginum aut violaceo-fuliginum, hyphis 3.5–4.5 μm crassis, modice aut leviter pachydermatis, intus dilute coloratis. Epithecium aeruginoso-fuliginum. Hymenium 40–50 μm altum. Subhymenium 20–30 μm altum, incoloratum. Hypothecium fusco-nigrum, sat crassum. Paraphyses arcte cohaerentes, 2–2.5(3) μm crassae, apicem non incrassatae. Asci anguste clavati, 40–45 \times 8–10 μm . Sporae ellipsoideae, pseudodyblastae, 7–11 \times 3–5(6) μm .

Reaction: Thallus P+ orange, K+ yellow, KC–, C–; medulla P–, K–, KC–, C–. Chemical substances: pannarin.

Type: Japan, Hokkaido, Mts. Daisetsu, Goshiki-ga-hara, 1680 m alt., on rock, 11. VIII. 1974, leg. M. Inoue 8666,–holotype in HIRO.

Habitat. On non-calcareous rocks in alpine regions.

Range. Endemic to Japan.

This species is apparently closely related to *Lecidea leucothallina* Arnold, first

reported from Austria (holotype in M; Arn. Lich. ex. n. 760, vidi) and also to *Lecidea fuscoatra* (L.) Ach. (neotype in UPS; R. Santesson 16299, vidi) which is widely distributed in the world. However, *L. subleucothallina* can be distinguished from them mainly by the distinct P+ orange reaction (pannarin in *L. subleucothallina*; *L. leucothallina* produces no lichen substance, while *L. fuscoatra* produces gyrophoric acid) in the thallus and by the somewhat smaller spores ($10-12 \times 3.5-5 \mu\text{m}$ in the type of *L. leucothallina* and $10-12 \times 3.5-6 \mu\text{m}$ in that of *L. fuscoatra*).

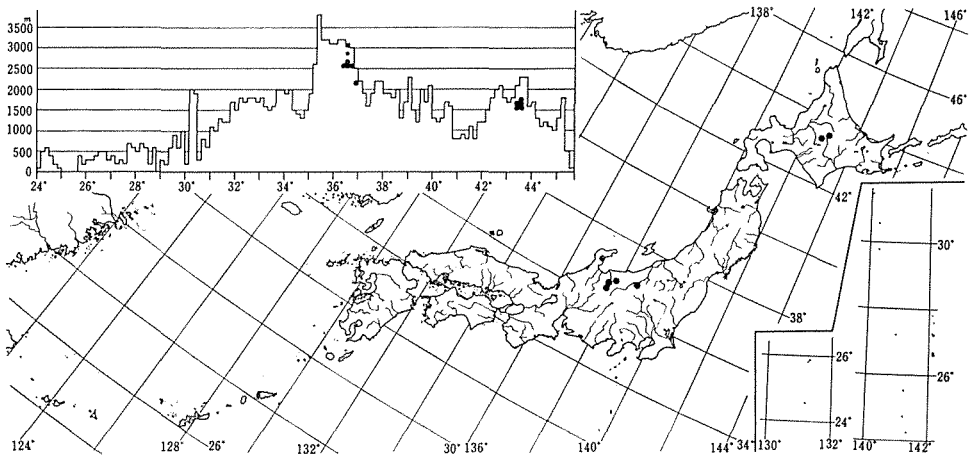


Fig. 25. Distribution of *Lecidea subleucothallina*.

Specimens examined. HOKKAIDO. Prov. Kamikawa. *Asahidake*, Mt. Hakuun (1550 m, mi-8627); Goshikigahara, Mts. Daisetsu (1680 m, mi-8666 holotype & 8667; 1760 m, mi-8684); *Tokachidake*, Mt. Furano (1510 m, mi-7961; 1610 m, mi-7958). HONSHU. Pref. Nagano. *Naebasan*, Mt. Naeba (2140 m, mi-366; 2145 m, mi-344); *Shiroumadake*, Mt. Shirouma (2530 m, mi-14055); *Tateyama*, Mt. Harinoki (2540 m, mi-6095); *Yarigatake*, Mt. Momisawa (2590 m, mi-4834). Pref. Toyama. *Tateyama*, Mt. Tsurugi (2650 m, mi-12904); Mt. Tateyama (2500 m, mi-12803 & 12819; 2650 m, mi-12786 & 12813; 2820 m, mi-12780; 3010 m, mi-12846 & 12873).

16. *Lecidea subpaupercula* M. Inoue, sp. nov.

(Figs. 23: G-I, 26; Plate IV: 7, 8)

Thallus tenuis aut modice incrassatus, strato obductus decolore, ex hyphis subdestructis, conglutinatis, horizontalibus formato, areolatus, areolis contiguus aut dispersis, planis aut leviter convexis, rufo-fuscescentibus, nitidis, vulgo albo aut cinereo-marginatis, medulla jodo caerulescente. Hypothallus nigricans.

Apothecia adnata, 0.5–1.2 mm lata, basi leviter constricta, disco plano aut raro demum convexo, nigro, nudo, margine tenui aut sat tenui. Excipulum 50–60 μm altum fusconigrum, in margine aeruginoso-fuligineum, hyphis 5–6 μm crassis, pachydermaticis, conglutinatis. Epithecium aeruginoso-fuligineum. Hymenium 40–50 μm altum, jodo caerulescens. Subhymenium 30–40 μm altum, incoloratum. Hypothecium sat crassum, fusco-nigrum. Paraphyses

arcte cohaerentes, 2–3 μm crassae, apice leviter incrassatae, 4–6 μm . Asci clavati, 40–45 \times 10–12 μm . Spores ellipsoideae, 9–11 \times 4–5(6) μm .

Reaction: Thallus & medulla P—, K—, KC—, C—. Chemical substances: Lecideia-3.

Type: Japan, Honshu, Nagano Pref., Kitaazumi-gun, Otari-mura, Mts. Shirouma (Hakuba), Mt. Norikura, 2180 m alt., on rock, 28. VIII. 1973, leg. M. Inoue 5680,—holotype in HIRO.

Habitat. On non-calcareous rocks in subalpine and alpine regions.

Range. Endemic to Japan.

Lecidea subpaupercula is in many respects very closely related to European *Lecidea paupercula* Th. Fr. (lectotype in O: Norway, leg. J. M. Norman 377, vidi), which is, however, distinguished by having a higher hymenium (60–70 μm high) and larger spores (12–16 \times 6–8 μm) and by containing stictic acid (chemical reaction in the excipulum and the medulla of thallus K+ yellow).

Nylander (1890) and Hertel (1977) reported *L. paupercula* from Japan. The voucher specimen cited by Hertel (1977) is very fragmentary, and I could not test it with TLC. But judging from the chemical reaction in the excipulum and the medulla of thallus (K—), the specimen does not seem to contain stictic acid. In addition, the spores are narrower (12–16 \times 4–5 μm) than those of *L. paupercula*. Accordingly, the occurrence of *L. paupercula* in Japan is tentative until more materials are obtained. Up to now I have not had an opportunity to examine the voucher specimen of *L. paupercula* cited by Nylander (1890).

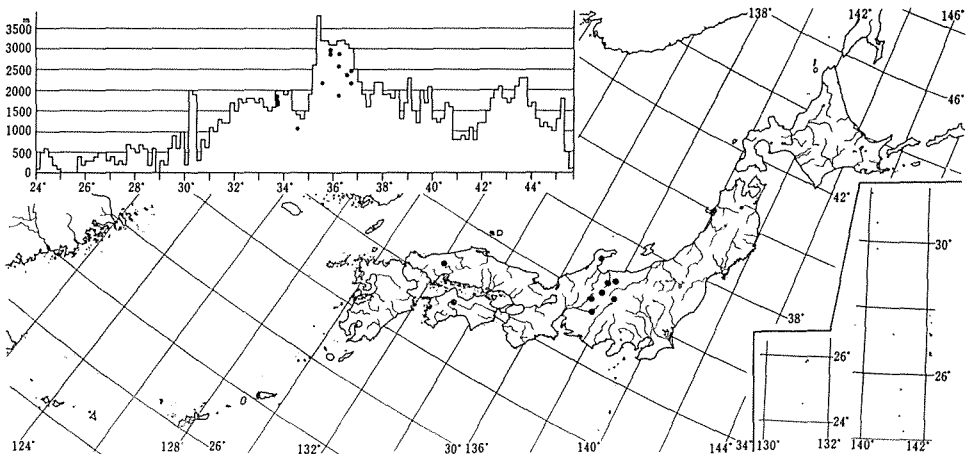


Fig. 26. Distribution of *Lecidea subpaupercula*.

Specimens examined. HONSHU. Pref. Nagano. *Shiromadake*, Tenguhara, Mts. Shirouma (2180 m, mi-5680 holotype); Mt. Norikura (2430 m, mi-12922); *Tateyama*, Mt. Kitakazura (2340 m, mi-5057 & 5059); *Kamikochi*, Mt. Chogatake (2550 m, mi-14233); Mt. Jyonen (2850 m, mi-14181); *Wada*, Utsukushigahara Heights (1840 m, mi-11656); *Tsumago*, Mt. Surikogi (2130 m, mi-14518 & 14627); *Ontakesan*, Mt. Ontake (2890 m, mi-11444; 2950 m, mi-4621). Pref. Hiroshima. *Sandankyo*, Mt. Osorakan

(1000 m, mi-11123). ШИКОКУ. Pref. Ehime. *Ishizuchisan*, Mt. Ishizuchi (1620 m, mi-11033); Mt. Kamegamori (1760 m, mi-11053; 1840 m, mi-11052).

17. ***Lecidea tessellata*** Floerke var. ***caesia*** (Anzi) Arnold
(Figs. 23: J-L, 27; Plate IV: 9, 10)

Verh. zool.-bot. Ges. Wien, 39: 264 (1889). — *Lecidea spilota* Fr. var. *caesia* Anzi, Catal Lich. Sondr. 80 (1860). Type: Italy, Alps "Bormii, alpe della Rocca," leg. M. Anzi, —holotype in TO(?), non vidi; isotype in M (Anzi Lich. Langob. 125), vidi.

Thallus determinate to subdeterminate, thickish, 1–1.3 mm thick, cracky-areolate, contiguous; areolae minute, with plane surface, tartareous, whitish with gray shade, bordered by a narrow blackish hypothalline line; medulla I+ intensively violet-blue.

Apothecia subimmersed in the thallus or appressed-adnate, black, reaching 1.3 mm in diameter, when young with a smooth, plane, rounded disc, concave, when matured becoming convex and variously irregular in form and ridged up with several lines running in various directions, sometimes intersecting; disc non-pruinose or with a thin white pruina. Excipulum 15–20 μm thick in exterior part, blackish-green, with hyphae 4–6 μm thick, perpendicular to the surface, in internal part 25–30 μm thick, colorless with radiating to intricate hyphae of 2.5–3 μm thickness. Epithecium brownish-green to blackish-green. Hymenium (40)50–60 μm high. Subhymenium 30–40 μm high, pale brown. Hypothecium pale brown without limit to the medulla, with perpendicular hyphae. Paraphyses simple or with some few branches, 2–3 μm thick; apices slightly swollen, 3.5–4.5 μm thick. Asci clavate, 40–50 \times 10–12 μm . Spores with obtuse ends, 7–9 \times 5–6(6.5) μm , walls thickish.

Reaction: Thallus & medulla P—, K—, KC—, C—. Chemical substances: confluent acid and *Lecidea*-2.

Habitat. On calcareous rocks in alpine regions.

Range. Japan; Europe; North America.

According to Hertel (1967: 45), this variety is distinguished from var. *tessellata* by its bright blue-gray, chalky, and well-advanced thallus, the circumference of which is characteristically descendent. He also mentioned that var. *caesia* is limited to calcareous rocks. Japanese specimen agrees with var. *caesia* in morphological as well as ecological respects. It may, however, be possible to treat var. *caesia* as an autonomous species because of the flat areolae in addition to the thallus form mentioned above (the areolae of var. *tessellata* are somewhat bullate, as observed in the isolectotype in O: Flörke, Deutsch Lich. no. 64). Following Hertel (1967), I have maintained this lichen as a variety but with some hesitation.

The external appearance of the apothecia and the thallus of this species is somewhat reminiscent of *Lecidea confluescens* which also grows on calcareous rocks. It is, however, distinguished from *L. confluescens* by the positive intense

I+ reaction in the medulla and the rather thick-walled, smaller spores ($12-14 \times 5-7 \mu\text{m}$ in the holotype of *L. confluenscens* in H, H-Nyl. 16293).

Specimen examined. HONSHU. Pref. Yamanashi. Ichinose, Mt. Kitadake (3040 m, mi-1001).

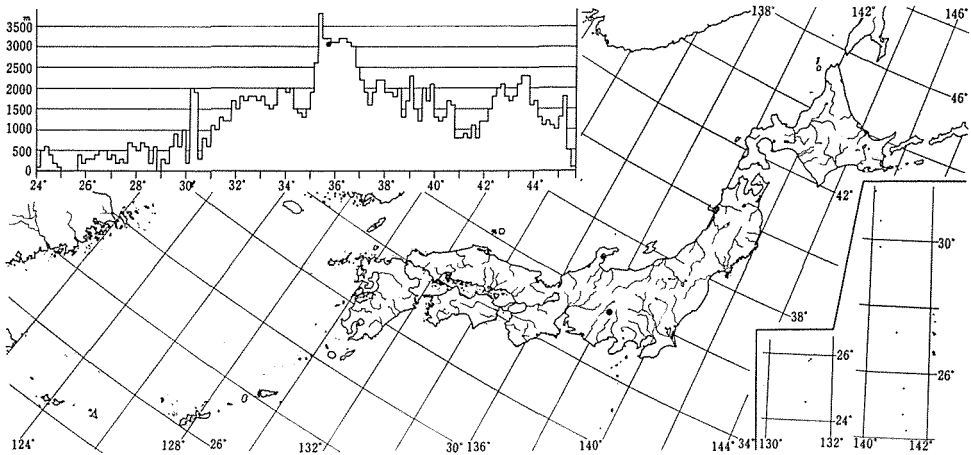


Fig. 27. Distribution of *Lecidea tessellata* var. *caesia* in Japan.

Summary

The total number of the Japanese *Lecidea* (s. str.) revised includes 17 species, 2 of which are new to science: 1) *Lecidea advena* Nyl., 2) *L. athrocarpa* (Ach.) Ach., 3) *L. atrobrunnea* (Ram. ex Lam. et DC.) Schaer., 4) *L. auriculata* Th. Fr., 5) *L. brachyspora* (Th. Fr.) Nyl., 6) *L. diducens* Nyl., 7) *L. elabens* Fr., 8) *L. fuscoatrata* Nyl., 9) *L. instratula* Nyl., 10) *L. lactea* Floerke ex Schaer., 11) *L. lapicida* (Ach.) Ach., 12) *L. lithophila* (Ach.) Ach., 13) *L. plana* (Lahm) Nyl., 14) *L. speirea* (Ach.) Ach., 15) *L. subleucothallina* M. Inoue sp. nov., 16) *L. subpaupercula* M. Inoue sp. nov., and 17) *L. tessellata* Floerke var. *caesia* (Anzi) Arn. Taxonomic and chemical data and a distribution map of each taxon as well as a key to the known taxa were provided.

Thirteen species were reported as new additions to the lichen flora of Japan: *Lecidea advena*, *L. athrocarpa*, *L. atrobrunnea*, *L. auriculata*, *L. brachyspora*, *L. diducens*, *L. fuscoatrata*, *L. instratula*, *L. lactea*, *L. lapicida*, *L. lithophila*, *L. speirea*, and *L. tessellata* var. *caesia*.

The following species were treated as synonyms (correct names in parenthesis): *Lecidea badiopallens* Nyl. from France (= *Lecidea athrocarpa*) and *Lecidea auriculata* f. *subpruinosa* Vain. from Siberia (= *Lecidea diducens*).

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 — *oreinodes* 5
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 — *panaeola* 4
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 — *peltata* 43
 — *personatula* 4
 — *perusta* 24
 — *plana* 5, 11, 14, 16, 17, 20, 29, 36, 39, **41**, 49
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 — — f. *subsparsa* 4, 41, 42
 — *platycarpa* 4, 5
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 — *pseudohaematomma* 4
 — *pseudohandelii* 4
 — *puncticulata* 4
 — *rosulata* 4, 5
 — *rubiformella* 4, 5
 — *russula* 4
 — *sanguineoatra* 4
 — *scalaris* 5
 — *schitakensis* 23, 34, 35
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 — *spilota* var. *caesia* 48
 — *spumosula* 4
 — *subkochiana* 22
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 — *subpaupercula* 15, 17, 19, 26, 34, 44, **46**, 49
 — *subrubiformis* 4, 5
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 — — var. *caesia* 15, 17, 20, 44, **48**, 49
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 — *usbekica* 14, 23
 — *vernalis* 4
 — *vorticosa* 5
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 — *yezoensis* 4
 — *yomotoensis* 4
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 — *bullata* 5, 9
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 Parmelia 15
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 — *densiflorae* 5
 — *haemophaea* 5
 Placopsis 14
 Pseudocyphellaria 17
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 — *nipponica* 5
 — *ostreata* 5
 — *rubiformella* 5
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 — *atrobrunneum* 25
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Plate I

Figs. 1–3. Confluent acid obtained from *Lecidea brachyspora* (1, in GE; 2, in An; 3, in GAW).

Figs. 4, 5. Pannarin in GE, obtained from *Lecidea subleucothallina*.

Figs. 6, 7. *Lecidea advena* Nyl., mi-11452 (6, $\times 2$; 7, $\times 6$).

Figs. 8, 9. *Lecidea athrocarpa* (Ach.) Ach., mi-5414 (8, $\times 1.3$; 9, $\times 6$).

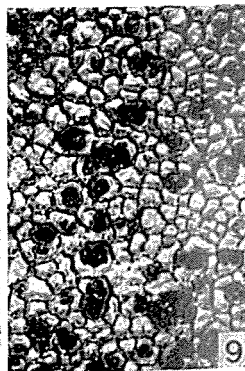
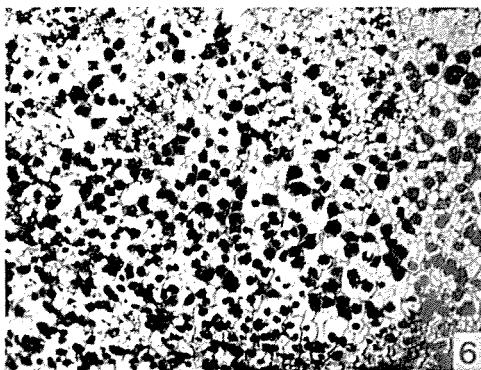
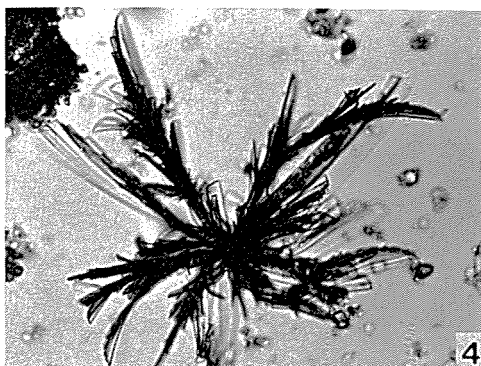
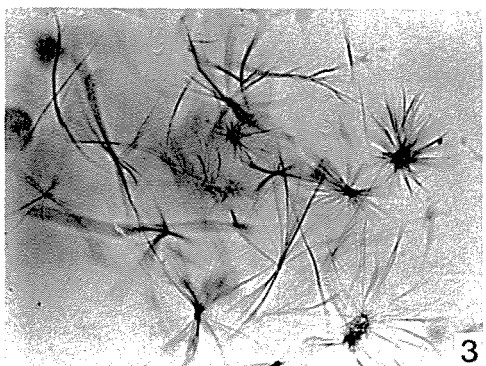
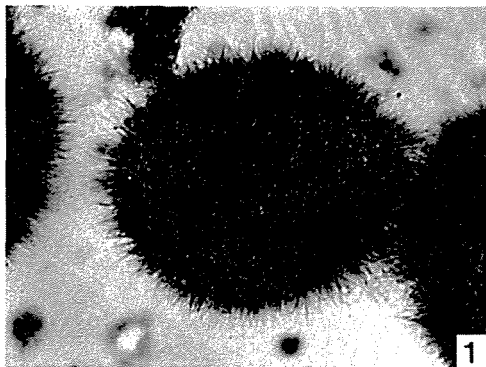


Plate II

- Figs. 1, 2. *Lecidea atrobrunnea* (Ram. ex Lam. et DC.) Schaer., mi-1037 (1, $\times 1.6$; 2, $\times 7$).
Figs. 3, 4. *Lecidea auriculata* Th. Fr., mi-8654 (3, $\times 6$; 4, $\times 2$).
Figs. 5, 6. *Lecidea brachyspora* (Th. Fr.) Nyl., mi-10515 (5, $\times 2$; 6, $\times 6$).
Figs. 7, 8. *Lecidea diducens* Nyl., mi-5956 (7, $\times 2$; 8, $\times 10$).
Figs. 9, 10. *Lecidea elabens* Fr., mi-960 (9, $\times 1.5$; 10, $\times 10$).

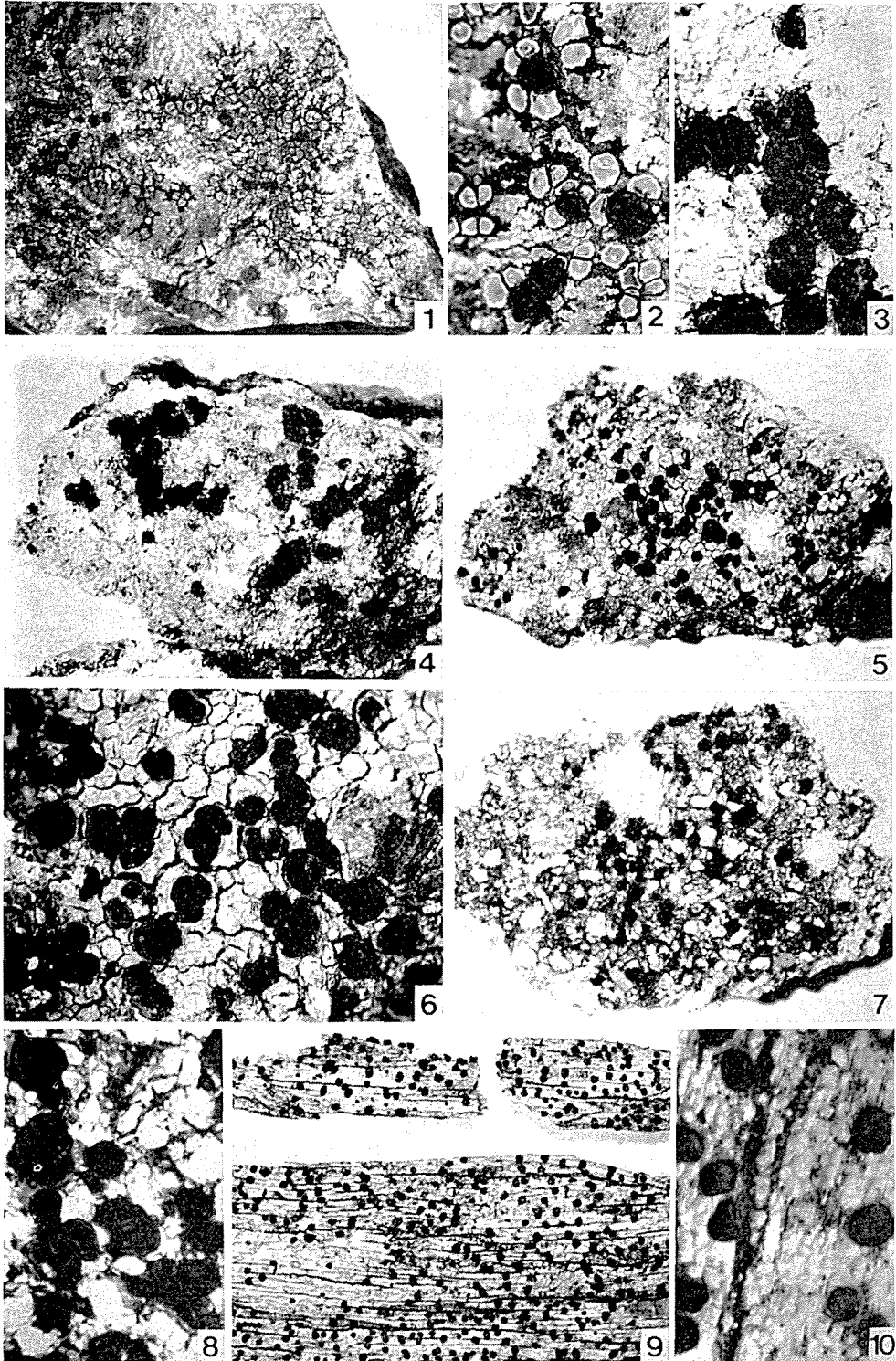


Plate III

- Figs. 1, 2. *Lecidea fuscoatrata* Nyl., mi-10265 (1, $\times 2$; 2, $\times 6$).
Figs. 3, 4. *Lecidea instratula* Nyl., mi-5350 (3, $\times 7$; 4, $\times 1.7$).
Figs. 5, 6. *Lecidea lactea* Floerke ex Schaer., mi-8506 (5, $\times 1.8$; 6, $\times 6$).
Figs. 7, 8. *Lecidea lapicida* (Ach.) Ach., mi-5864 (7, $\times 1.5$; 8, $\times 6$).
Figs. 9, 10. *Lecidea lithophila* (Ach.) Ach., mi-10650 (9, $\times 1.5$; 10, $\times 6$).

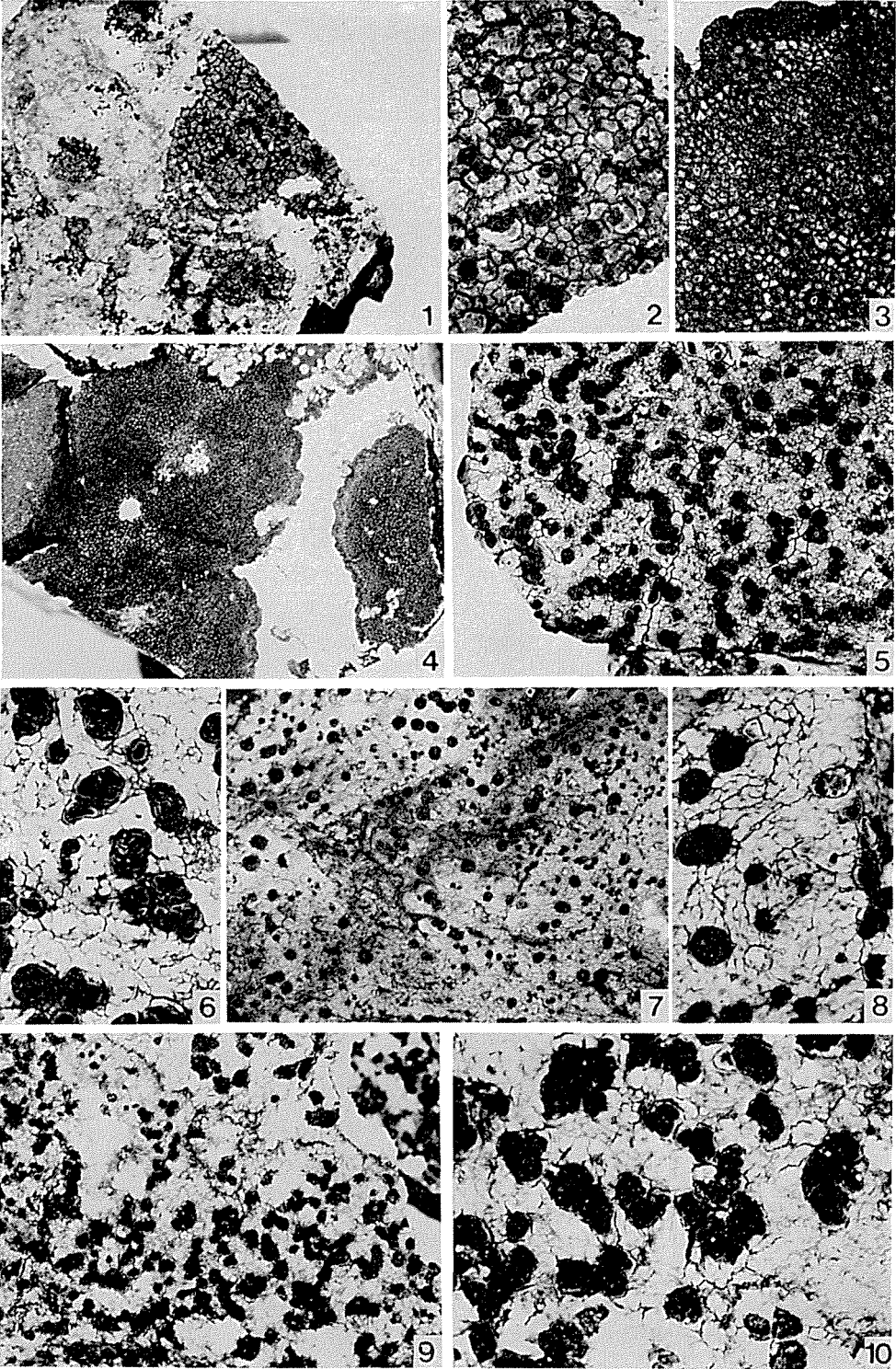


Plate IV

Figs. 1, 2. *Lecidea plana* (Lahm) Nyl., mi-11523 (1, $\times 1.5$; 2, $\times 6$).

Figs. 3, 4. *Lecidea speirea* (Ach.) Ach., mi-1084 (3, $\times 6$; 4, $\times 1.5$).

Figs. 5, 6. *Lecidea subleucothallina* M. Inoue, mi-8666, holotype (5, $\times 7$; 6, $\times 0.6$).

Figs. 7, 8. *Lecidea subpaupercula* M. Inoue, mi-5680, holotype (7, $\times 1.8$; 8, $\times 6$).

Figs. 9, 10. *Lecidea tessellata* var. *caesia* (Anzi) Arnold, mi-1001 (9, $\times 1.2$; 10, $\times 6$).

