A Monograph of the Lichen Genus
Parmelina Hale (Parmeliaceae)

Mason E. Hale, Jr.
Hale, Mason E., Jr. A Monograph of the Lichen Genus Parmelina Hale (Parmeliaceae). Smithsonian Contributions to Botany, number 33, 60 pages, 21 figures, 1976.—The 47 species of Parmelina are revised on the world level. Two sections are recognized: section Parmelina with 30 species widely distributed in temperate to tropical montane regions and section Myelochroa with 17 terpene-containing species concentrated in eastern and southern Asia. The genus is most closely related to Parmotrema Massalongo. Five new species, P. crassata Hale, P. degelii Hale, P. indica Hale, P. rhytidodes Hale, and P. schindleri Hale, are described, and six new combinations proposed, P. amagiensis (Asahina) Hale, P. damaziana (Zahlbruckner) Hale, P. endoleuca (Taylor) Hale, P. irrugans (Nylander) Hale, P. jamesii (Hale) Hale, and P. pastillifera (Hale) Hale. New combinations are also made for Hypotrachyna bagioensis (Hale) Hale and Parmotrema nylanderi (Lynge) Hale.
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A Monograph of the Lichen Genus
\textit{Parmelina} Hale (Parmeliaceae)

\textit{Mason E. Hale, Jr.}

\textbf{Introduction}

The genus \textit{Parmelina} Hale is a segregate of \textit{Parmelia} Acharius comprising 47 species widely distributed in temperate and tropical regions. It is recognized by the narrow, adnate lobes, marginal cilia, and absence of usnic acid in the cortex (Hale, 1974:438). Some of the species included here were formerly classified in the ill-defined (and invalid) genus \textit{Imbricaria} (Schreber) Michaux (Hale and Kurokawa, 1964:130). This world level monograph is based on the study of all available type specimens, collections preserved in the major herbaria, and personal field work. The format follows my earlier treatments of \textit{Bulbothrix} (Hale, 1976b), \textit{Hypotrachyna} (Hale, 1975a), \textit{Pseudoparmelia} (Hale, 1976a), and \textit{Relicina} (Hale, 1975b).

I wish to thank curators of the following institutions who sent specimens on loan so promptly and often allowed extensions of loan periods: BM, BO, BP, COLO, DUKE, F, FH, FI, G, GLAM, H, KAN, KR, L, LD, M, MICH, MSC, MVM, NSW, NY, PC, PH, REN, S, SI, TNS, TRH, TUR, UC, UPS, W, WIS, WU, and ZT. Specimens in TNS were annotated during 1964–65 while I studied in Tokyo. The private herbaria of Dr. D. D. Awasthi, Dr. Gunnar Degelius, Dr. S. Nakanishi, Dr. Clyde Reed, and Dr. R. Santesson were also generously placed at my disposal. The material in these various herbaria was chemically tested and annotated between 1958 and 1975, but not all of it has been re-examined for possible name changes in the light of new synonymies, species concepts, or improved chemical techniques.

Any monograph is bound to be more complete if the author has had an opportunity to observe and collect specimens in the field. I am especially grateful to the following colleagues for assistance in arranging excursions: Mr. J. Anderson (Sarawak), Mrs. Sheila Collenette (Sabah), Dr. S. Kurokawa (Japan), Dr. M. López-Figueiras (Venezuela), Dr. W. Meijer (Sabah), Dr. M. Nakanishi and Dr. S. Nakanishi (Japan), Dr. P. G. Patwardhan (India), Dr. Stella Thrower (Hong Kong), and Dr. Flora Uyenco (Philippines). I have also conducted field studies in Mexico and Central America, the Lesser Antilles, and Malaya.

The scanning-electron photographs were prepared by the Smithsonian Scanning-Electron Microscope Laboratory. Photographs of the specimens were taken by the Smithsonian Photographic Services.

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Morphology

Thallus Structure.—Parmelina basically has a closely appressed to adnate foliaceous thallus with narrow lobes (1–4 mm wide). Most species have more or less subirregular lobation and apically rounded lobes (Figures 16e, 18b), although narrow lobed species are sublinear (Figures 12d, 16c). There is, however, a wide range of variation in lobe configuration and width, much more than exists, for example, in Hypotrachyna (Hale, 1975a).

The internal anatomy is similar to that of other epicorticate genera (Hale, 1973a). A thin, generally palisade plectenchymatous cortex is overlain by a pored epicortex (Figures 1 and 2). The medulla consists of loosely packed hyphae, often encrusted with lichen substances (Figure 2f). The lower cortex is paraplectenchymatous (Figure 2a–d).

The upper surface is strongly white maculate in Parmelina consors (Figure 3a), P. muelleri, and P. pilosa, less conspicuously so in P. melanochlaena, P. pastillicera, P. querina, and P. tiliacea, and faintly or not at all in the remaining species.

The lower surface is black with only three exceptions. Parmelina enormis has a uniformly pale brown lower surface, and P. expallida and P. versiformis are darker brown tending toward black at the center.

Cilia.—The marginal cilia which characterize Parmelina are usually distinct but may be variably dispersed around the lobe margins. In many species they occur more or less regularly both on lobe tips and in the axils (Figures 3a, 17a, 18b). In others cilia may be lacking at the lobe tips and confined to the axils (Figure 3b) or may be so sparse and inconspicuous in a few species, such as P. simplicior, that they are overlooked. In these cases one might tend to classify them in the genus Pseudoparmelina (Hale, 1976a), which is differentiated from Parmelina, among other ways, by the total absence of marginal cilia. Great care must be taken to establish the presence or absence of cilia in the lobe axils. Another example of this problem is Parmelina endoleuca and Pseudoparmelina subtilicera (Nyländer) Hale, two very similar species in Australia that differ in the production of cilia. Both have fatty acids and cannot be separated easily by a chemical test.

Confusion may also arise with species of Hypotrachyna that lack cilia but may have a very dense rhizinal mat below. The mat may assume a marginal position and resemble cilia. These "cilia," however, will be dichotomously branched. Such a distinction fails in many specimens of H. revoluta (Floerke) Hale having rather sparsely branched rhizines and a few marginally positioned "cilia." If incorrectly interpreted as having furcate rhizines and sparse marginal cilia, such a lichen might be identified as Parmelina cryptochlora, which has more powdery capitate soralia, or as pustulate P. spinosa, which has a pale yellowish medulla. All of these species have gyrophoric acid.

One further example of parallelism involving Parmelina dissecta and Hypotrachyna neodissecta (Hale) Hale can be mentioned. The latter has clearly dichotomously branched rhizines and lacks cilia, yet both contain the same chemical, gyrophoric acid, and have virtually identical lobe configuration. It is difficult, if not impossible, to decide at this time whether intergeneric hybridization has occurred in these cases and resulted in "hybrid" species.

Rhizines.—The rhizines of Parmelina are of two types: simple to sparsely furcate (Figure 3c) and squarrose. Squarrose rhizines, that is, those with a main axis and short lateral branches, are confined mostly to some species in section Myelochroa. This pattern is also known in a few species of Parmelia (e.g., P. silicata Taylor) and Parmotrema (the P. reticulatum group).

Isidia and Lobules.—Isidia are normally cylindrical and erect as in other Parmelioid genera and occur in the following 13 species: P. antillensis, P. expallida, P. dissecta (Figure 3d), P. horrescens, P. jamesii, P. indica, P. lindmanii, P. melanochlaena, P. obsessa, P. perisidians, P. tiliacea, P. usambarensis, and P. wallichiana. Isidia are distinctly lobulate in P. degelii and P. spathulata (Figure 4d) and uniquely peltate in P. pastillifera (Figures 5e, 5f), a close relative of P. tiliacea. Apical cilia almost always occur in P. horrescens and P. melanochlaena (Figure 4c) and resemble those in Parmotrema crinitum (Acharius) Choisy.

Lobules not originating from isidia are found in P. schindleri and P. xantholepis (Figure 4e,f); they are mostly marginal.

Pustules.—These are characteristic of four species, P. hayachinensis, P. leucotyliza (Figure 5g), P.
FIGURE 1.—Epicortical pores on the surface of Parmelina species: a,b, P. enormis (× 400 and 1600) (Jellicoe 150 in US); c,d, P. muelleri (× 400 and 1600) (Hale 42219); e,f, P. indica (× 400 and 1600) (Hale 48884). (Scanning-electron microphotographs.)
Figure 2.—Internal structure of Parmelina; a, vertical cross section of P. degelii (Degelius in US) (× 800); b, upper cortex of P. degelii (same section as in a) (× 1600); c, vertical cross section of P. galbina (Hale 23415) (× 800); d, upper cortex of P. galbina (same section as d) (× 1600); e, epicortex (arrow) of P. pastillifera (Schröppel 143) (× 5000); f, crystals of lecanoric acid on hyphae of P. pastillifera (Schröppel 143) (× 4000).
Figure 3.—Morphological structures of Parmelina: a, white maculae and marginal cilia of P. consors (Malme 1282 in US) (× 10); b, axillary cilia of P. lindmanii (Nee and Mori 4258 in US) (× 10); c, rhizines of P. galbina (Hale 18930) (× 70 with scanning-electron microscope); d, isidia of P. dissecta (Montes 10121 pro parte) (× 90 with scanning-electron microscope); e, peltate isidia of P. pastillifera (Schröppel 143) (× 90 with scanning electron microscope); f, cross-section of a peltate isidium of P. pastillifera (Schröppel 143) (× 400 with scanning-electron microscope).
Figure 4.—Morphological structures of Parmelia: a, isidia of *P. dissecta* (Hale 33375) (× 10); b, peltate isidia of *P. pastilliifera* (Schrüppel 143) (× 10); c, ciliate isidia of *P. horrescens* (Imshaug 22174) (× 10); d, procumbent isidia of *P. spathulata* (Koefter, in US) (× 10); e, lobules of *P. schindleri* (Schindler 4569 in US) (× 10); f, lobules of *P. xantholepis* (Hale 25993) (× 10).
FIGURE 5.—Morphological structures of Parmeliina: a, soralia of *P. aurulenta* (Weber and McVean L-51280 in US) (× 10); b, soralia of *P. cryptochlora* (Hale 35837) (× 10); c, pustules of *P. subfatisens* (isotype in US) (× 10); d, coarse soralia of *P. swinseowii* (Swinseow K 31/13 in US) (× 10); e, pustules of *P. spumosa* (Hale 19897) (× 10); f, pustule of *P. spumosa* (Hale 19897) (× 100 with scanning-electron microscope); g, pustules of *P. leucotyliza* (Hale 29544) (× 10).
spumosa (Figure 5e,f), and P. subfatsiscens (Figure 5c). Soredia are not produced on these pustules. Parmelina denegans, on the other hand, is clearly pustulate initially but produces coarse soredia at maturity.

Soredia.—Soralia are produced in seven species of Parmelina: P. awulenta, P. cryptochlora, P. denegans, P. metarevoluta, P. muelleri, P. pilosa, and P. swinscowii (Figures 5a,b,d, 17b, 18b). They are orbicular and laminal or subterminal but never marginal and linear as in Parmotrema.

The remaining 17 species of Parmelina produce no vegetative propagules, although the very wrinkled and often fragile upper cortex of P. entotheiochroa or P. rhytidodes might be mistaken for pustules (Figure 6).

Apothecia.—The apothecia are typically adnate or sessile and less than 5 mm in diameter, though Parmelina irrugans has discs up to 10 mm broad. The disc is occasionally perforate in P. consors. No species has a coronate rim, and only two, P. quercina and P. tiliacea, sometimes have retrorse rhizines on the lower part of the amphithecium. No fertile collections are known yet for P. cryptochlora, P. degelii, P. hayachinensis, P. indica, P. jamesii, P. spathulata, or P. swinscowii.

Spore size is very uniform within a given species and not greatly different between unrelated species. For example, the species in the P. dissecta–P. horrescens group (Figure 9) have spores 8–12 × 12–18 μm. The P. awulenta–P. subaurulenta group (section Myelochroa) has spores 5–10 × 7–15 μm. The largest spores have been measured in P. versiformis (10–14 × 18–28 μm), but no other species in the genus have spores greater than 19 μm long. The smallest spores (3–6 × 7–8 μm) occur in the two anomalous norstictic acid-containing species, P. antillensis and P. phlyctina.

Chemistry

The chemistry of Parmelina species was determined with microcrystal tests before 1965 (Hale and Kurokawa, 1964) and later with thin-layer chromatography (Merck F–254 silica gel pre-coated plates). Two solvent systems, hexane-ether-formic acid and benzene-dioxane-acetic acid, have been routinely employed using C. Culberson’s methods (1972). I have had the benefit of Dr. Culberson’s advice on the identification of many of the lichen substances, and she has very kindly communicated to me the results of her work on the “horrescens” unknown. It should be assumed, incidentally, that, unless otherwise stated, the components of each species in the taxonomic section refer to the holotype or lectotype specimens with additional comments on the results from other specimens.

Before listing the lichen substances discovered so far in Parmelina, I might point out a most remarkable feature in its chemical profile. Orcinol
depsides (except for glyrophoric and lecanoric acids), meta-depsides, orcinol depsidones (except for rare lobaric acid), and the β-orcinol depsides related to barbatic acid are completely lacking. Two other cortical substances, lichexanthone and usnic acid, are also missing. The general impression is that Parmelia has a relatively "primitive" assemblage of substances and would fall on a lower evolutionary scale than Hypotrachyna, Parmotrema, and Pseudoparmelia but significantly higher than Bulbocodium, Parmelia, and Relicina (Hale, 1967).

Aliphatic Acids.—The identification of fatty acids presents many problems and no entirely satisfactory techniques have been worked out to deal with them. The most direct method is to spray the chromatographic plates with water and carefully watch for opaque, white, water-repellant spots as the plate dries. These are the fatty acids. Terpenes have a similar reaction but differ in turning bluish, purple, or brown when sprayed with H2SO4 and heated. Dr. Myles Kohl of the Universidad de los Andes, Merida, Venezuela, has also informed me (pers. comm.) that the fatty acids turn brownish when heated for 12 hours or more at 100°C (in contrast to the 10 minutes usually needed for development of phenolic substances). In any event, protoliches-

certerinic acid has been identified in P. expallida (Kurokawa, 1968a), and unidentified fatty acids are the principle components in P. endoleuca and P. heterochron.

Depsidones.—These well-known substances are common in section Parmelia (those species of Parmelia lacking terpenes) and occur in most of the pantemperate-montane pantropical species.

Atranorin is the primary cortical substance found in all species of Parmelia.

Glyrophoric acid, a tridepside, occurs in Parmelia cryptochlora, P. dissecta, P. melanochaeta, P. spathula, and P. spumosa. It is a probable minor component in P. damaziana, P. horrescens, P. schindleri, and P. subfatisens along with the "horrescens" unknown. Glyrophoric acid is not easily chromatographed because of the tendency for streaking and variable Rf values that are highly influenced by solvent composition. In addition, one or more associated spots, still unidentified, may appear on the plates.

"Horrescens" unknown is actually several substances presumed to be depsides related to lecanoric acid. The spots react with H2SO4 the same as orcinol depsides and fall close to glyrophoric and lecanoric acids in the usual solvent systems. The best separation is achieved in benzene-dioxane where a single large spot, the main "horrescens" unknown, falls well above glyrophoric acid. This unknown has now been detected in P. damaziana, P. horrescens, P. schindleri, and P. subfatisens. I have also recently discovered this substance in an undescribed species of Hypotrachyna.

The widespread medullary component lecanoric acid occurs in P. pastillifera, P. pruinata, P. quercina, and P. tiliae. It falls close to glyrophoric acid on chromatographic plates and must be carefully distinguished from it by running controls. The toluene-acetic acid solvent system should be used in addition to the other two systems.

Depsidones.—These substances occur in many lichen genera but are at best sporadically developed in Parmelia. Phylogenetically "primitive" salazinic acid and its close acetate galbinic acid predominate in section Parmelia.

Constictic acid is an accessory substance with stictic acid and salazinic acid (see below).

Fumarprotocetraric acid is extremely rare in the genus, occurring in only one species, the Australian–New Zealand endemic P. jamesii. It is accompanied by protocetraric acid. Succinpro-

cotactaric acid is lacking.

Galbinic acid is confined to a small group of very closely related species: P. galbina, P. hayachinensis, P. metarevoluta, and P. obsessa, accompanied by secalonic acid A and the "subaururenta" terpene series. It is easily identified as a deep H2SO4 orange spot below norstictic acid in benzene-dioxane.

Lobaric acid is the only orcinol depsidone in Parmelia and occurs as an accessory substance with salazinic acid in P. swinscowii.

Norstictic acid is the main component in two closely related Caribbean species, P. antillensis and P. phlyctina. A lower spot of the, as yet, unidentified connorstictic acid may be present.

Protocetraric acid occurs only in P. jamesii with fumarprotocetraric acid (see above).

Salazinic acid, a very common substance in the Parmeliaceae, occurs in P. enormis, P. simplicior, P. swinscowii, P. usambarensis, P. versiformis, and P. wallichiana. It is a rare accessory with leucotylin in P. crassata and may be accompanied by constictic
acid in *P. metarevoluta*. All of these species, excepting *P. versiformis*, are distributed in the Old World following a pattern seen in *Bulbothrix* (Hale, 1976b).

Stictic acid has been discovered in only one species, *P. muelleri*, where it is accompanied by constictic acid and two unknown compounds falling between stictic and constictic acids in benzene-dioxane.

**Terpenes.**—A closely related series of triterpenes with a hopane skeleton have been described for species in section *Myelochroa*. Their structures have been determined by Yosioka and his group in Japan using nuclear magnetic resonance (NMR) spectra, mass spectrometry, etc. The thin-layer chromatography is not yet standardized or well understood, and I have not tried to identify individual spots. Typical profiles for the terpene-containing species of *Parmelina* are illustrated in Figure 7.

Leucotylin, the progenitor of leucotylic acid, is the main terpene component in *P. amagienensis*, *P. crassata*, *P. degelii*, *P. entotheiochroa*, *P. galbina*, *P. hayachinensis*, *P. indica*, *P. leucotylin*, *P. metarevoluta*, *P. obsessa*, *P. perisidians*, *P. subaurulenta*, and *P. rhytidodes*. It forms a low major spot in benzene-dioxane, but I have generally identified it as a profile of several terpene spots as illustrated in Figure 7.

Yosioka (Yosioka and Nakanishi, 1963; Yosioka and Nakanishi, 1966) has isolated at least six other compounds related to leucotylin in “*Parmelia entotheiochroa*.” I presume that at least some of these make up the numerous spots resolved in hexane-ether (see Figure 7), but no attempt has been made to identify any of them on the plates. There seems to be great variation in the intensity of the spots, reflecting different concentrations in the thallus. It remains to be seen whether this variation has any taxonomic value.

Zeorin is a well known lichen substance. The stereochemistry of its hopane skeleton was only recently studied by Yosioka et al. (1966b). It occurs in all species in section *Myelochroa* and has been reported in *Acrocyphus*, *Cladonia* spp., *Hypotrachyna majoris* (Vainio) Hale, *Lecanora*, *Nephroma*, *Peltigera*, and the Physciaceae. It may be identified as the highest blue spot on the chromatographic plates in both solvent systems (Figure 7).

**Pigments.**—Medullary pigments are especially characteristic of species in section *Myelochroa*. The chromatography of these is extremely difficult and usually unsuccessful. There is considerable streaking and individual components cannot be distinguished.

Secalonic acid A was first identified by Yosioka et al. (1963a:2090), who established its identity with entothein. It also occurs in ergot (Shibata et al., 1964). Yosioka found secalonic acid A in *Parmelina aurulenta*, *P. entotheiochroa*, *P. perisidians*, and *P. subaurulenta*, and I presume it is the major pigment in all species of section *Myelochroa* with a yellowish orange medulla, as well as in *P. immiscens* and *P. lindmanii*, both lacking terpenes. Unidentified reddish pigments accompany secalonic acid A in the lower medullary layer of *P. amagienensis* and *P. denegans*.

**Phytogeography and Speciation**

*Parmelina* occurs primarily on trees in secondary forests in temperate zones and at higher elevations in the tropics. A number of the commoner species may also occur on rocks. There are, however, only four obligatorily saxicolous species, *P. enormis*, *P. indica*, *P. obsessa*, and *P. usambavensis*. The *Parmelina* floras of various geopolitical units are enumerated below. It is altogether obvious that many countries are underrepresented because they have not been visited by lichen collectors.

**North America**

United States: *P. antillensis*, *P. aurulenta*, *P. dissecta*, *P. galbina*, *P. horrescens*, *P. metarevoluta*, *P. obsessa*, and *P. spumosa*.

**Mexico and Central America**

Mexico: *P. antillensis*, *P. aurulenta*, *P. dissecta*, *P. hor-
rescens, P. immiscens, P. lindmanii, P. muelleri, and P. spumosa.

Guatemala: P. horrescens.
Panama: P. dissecta, P. horrescens, and P. subfasciatus.

Cuba: P. antillensis, P. dissecta, P. horrescens, and P. phlyctina.

Figure 7.—Chromatographic profiles of Parmelina species: profiles in the hexane-ether solvent system (top) and benzene-dioxane solvent system (bottom). (1 = P. aurulenta, 2 = P. degelii, 3 = P. irragans, 4 = P. rhytidodes, 5 = P. amagiensis, 6 = P. crassata, 7 = P. denegans, 8 = P. entothiochroma, 9 = P. indica, 10 = P. leucotylica, 11 = P. perisidian, 12 = P. subaurulenta, 13 = P. xantholepis, 14 = P. galbina, 15 = P. metarevoluta, 16 = P. obsessa, Z = zeorin spot, G = galbinic acid, S = salazinic acid, and C = constictic acid; leucotylic acid is presumed to be the series of spots in 1 to 4 just below zeorin, and leucotylin is the lowest series in 5-10 in benzene-dioxane; atranorin falls just above the point where the photographs were trimmed.)

Hispaniola: P. antillensis, P. dissecta, P. horrescens, and P. phlyctina.

Puerto Rico: P. phlyctina.

Lesser Antilles (including Trinidad): P. antillensis, P. cryptochloa, P. dissecta, P. horrescens, and P. phlyctina.

South America

Colombia: P. lindmanii, P. melanochaeta, and P. spumosa.


Ecuador: P. pilosa.

Peru: P. muelleri.


Uruguay: P. consors, P. horrescens, P. lindmanii, and P. pilosa.

Paraguay: P. consors, P. lindmanii, and P. melanochaeta.

Argentina: P. consors, P. lindmanii, P. muelleri, P. pilosa, and P. versiformis.

Chile: P. horrescens, P. pilosa, P. spumosa, and P. swinscowii.

Europe

Western Europe: P. dissecta, P. horrescens, P. pastillifera, P. quercina, and P. tiliacea.

Russia: P. aurulenta, P. quercina, and P. tiliacea.

Israel: P. tiliacea.

Africa

Morocco: P. tiliacea.

Tunisia: P. tiliacea.

Ivory Coast: P. usambarensis and P. wallichiana.

Guinea: P. usambarensis and P. wallichiana.

Uganda: P. usambarensis and P. wallichiana.

Kenya: P. dissecta, P. pilosa, P. swinscowii, and P. wallichiana.

Angola: P. wallichiana.

Rhodesia: P. wallichiana.

Zambia: P. enormis.

Tanzania: P. aurulenta, P. dissecta, P. usambarensis, and P. wallichiana.

Union of South Africa (including Swaziland): P. dissecta, P. horrescens, P. pilosa, P. spathulata, P. spumosa, P. subfatiscens, and P. wallichiana.


Asia and Pacific Areas

Pakistan: P. aurulenta, P. quercina, and P. tiliacea.


Thailand: P. expallida, P. perisidians, P. usambarensis, P. wallichiana, and P. xantholepis.

Indochina: P. aurulenta.

China (including Hong Kong): P. aurulenta, P. irugans, P. quercina, P. subaurulenta, and P. wallichiana.

Korea: P. entotheiochoroa.


Taiwan: P. aurulenta, P. dissecta, P. expallida, P. horrescens, P. spumosa, P. subaurulenta, and P. wallichiana.


Malaya: P. wallichiana.


Sabah: P. denegans, P. leucotyliza, and P. wallichiana.

New Guinea: P. aurulenta.


Hawaiian Islands: P. aurulenta.

To summarize, the New World has a total flora of 20 species, 12 of them endemic, 5 (P. pilosa, P. subfatiscens, and P. swinscowii) shared with Africa, and the remaining 5 (P. aurulenta, P. dissecta, P. horrescens, P. quercina, and P. spumosa) essentially pantemperate or montane pantropical.

Europe has a small Parmelina flora. Dahl and Krog (1973) list only P. tiliacea in Scandinavia. The checklist by James (1965) for Great Britain includes P. dissecta, P. horrescens, P. quercina, and P. tiliacea. For the rest of Europe, Poelt (1969) adds only P. carporrhizans (= P. quercina) and P. pastillifera.

Africa has only two endemic species, P. enormis and P. spathulata, and nine other species either shared with the Americas, Asia, or pantemperate in distribution.

Asia is especially rich in Parmelina with 15 species on the Indian subcontinent and 16 in Japan and eastern Asia. Tropical Southeast Asia has nine species, none of them endemic and all occurring in the higher elevation cloud forests. The genus is not represented at all in the lowland dipterocarp rain forests from Sri Lanka to Indonesia.

The Australia–New Zealand region has seven species, of which four, P. degelli, P. endoleuca, P. jamesii, and P. pruinata, are endemic.
Figure 8.—Number of species in section *Myelochroa* in each major geographical division.

*P. aurulentata* have been collected on the Pacific Islands except for *P. aurulentata* at higher elevations in Hawaii. The total Old World flora (Africa, Asia, and Australia–New Zealand) comprises 26 species.

One distribution pattern of considerable phyto-geographic interest stands out. The species of section *Myelochroa*, a rather homogeneous group, are concentrated in India and eastern Asia (Figure 8) and only one of them, *P. aurulentata*, occurs in all geographic areas (Figure 10). The species in section *Parmelina*, on the other hand, are not strongly concentrated in any region.

Within section *Myelochroa* the species related to *P. galbina* form a particularly interesting group. As pointed out by Kurokawa (1972), *P. galbina*, the fertile progenitor species, behaves as an Arcto-tertiary plant which migrated southward and has survived in Japan and eastern North America. A rare sorediate morph, *P. metarevoluta*, has the same range, whereas the isidiate morph, *P. obsessa*, is restricted to North America, and the pustulate morph, *P. hayachinensis*, to Japan. W. Culberson (1972) also regards *P. aurulentata* as a Tertiary relict.

*Parmelina* has several complex groups of species that have evidently resulted from combined chemical and morphological evolution. The species in section *Myelochroa*, for example, all of which contain terpenes and almost always have secalonic acid A, a yellow pigment, have evolved from two chemically dissimilar ancestors, one, the smaller group, with leucotylic acid and resembling *P. ir- rugans*, and the other, a larger series with leuco-tylin, resembling the present-day *P. subaurulentata*. The numerous morphs derived from these presumptive parents or their ancestors, *P. amagiensis*, *P. aurulentata*, *P. crassata*, *P. degelii*, *P. denegans*, *P. entotheiochroa*, *P. leucotyliza*, *P. perisidians*, *P. rhytidodes*, and *P. satholepis*, have diversified mostly by production of soredia, isidia, pustules, and wrinkles, variation in apothecial diameter, etc. Morph formation (see Hale, 1975a:13) is not strongly delineated for the most part since the parents cannot be traced directly. We are left to conclude that section *Myelochroa* is an ancient group.
evolved over a long period. The *P. galbina* group, as mentioned above, forms the only exception to this rule.

Morph formation has also been an important mode of speciation in section Parmelina. The following parent morph–vegetative morph series are indisputable: *P. consors–P. pilosa* (sorediate), *P. quercina–P. tiliacea* (isidiate), and *P. immiscens–P. lindmanii* (isidiate). Parmelina phlycta and isidiate *P. antillensis* are extremely close but less clear-cut morphs. A large complex of species have been derived from now extinct parents in the *P. dissecta–P. horrescens* group, as illustrated in Figure 9. Like the *P. subaurulenta* group of section Myelochroa, the parent morphs of these numerous vegetative morphs are either extinct or have yet to be discovered.

The remaining species in the genus appear to have no discernible interrelationships or morphs. These include *P. endoleuca*, *P. enormis*, *P. expallida*, *P. heteroloba* (part of the *P. damaziana* series?), *P. pruinata*, *P. simplicior*, *P. swinscowii*, *P. usambarenensis*, *P. versiformis*, and *P. wallichiana*.

**Classification of Parmelina**

The taxon *Lichen* section Imbricaria was first proposed by Schreber (1791:767). He cited no species, only *Squamaria* Hoffmann, which is invalid as the later homonym of *Squamaria* Ludwig (Phanerogamae). Acharius (1794:250) adopted the name as a tribe of *Lichen* and included in it *L. olivaceus* L. and *L. tiliaceus* Hoffmann, as well as several other species now recognized as belonging to *Hypogymnia*, *Parmeliopsis*, *Physcia*, and *Xanthoria*. Michaux (1808) raised the name to generic rank and cited one species, a lichen now called *Anzia colpodes* (Acharius) Stizenberger. Fries (1825:242) later transferred it to *Parmelia* as *Parmelia* section Imbricaria, and Koerber (1855:68) used it at the generic rank, even though he realized that the name was a later homonym of *Imbricaria* Decandolle (Phanerogamae). Koerber and contemporary lichenologists placed many species that we now consider parmeliod in *Imbricaria*, while at the same time using *Parmelia* for many species now placed in *Physcia*.

After the delimitation of *Parmelia* in a modern sense by authors such as Müller and Nylander, *Imbricaria* was relegated to synonymy under it. Hale and Kurokawa (1964:130) grouped the narrow-lobed, marginally ciliate *Parmeliae* in *Parmelia* subgenus *Parmelia* section *Imbricaria* (Schreber) E. Fries, and it is essentially this group that I have segregated as a distinct genus, *Parmelina* (Hale, 1974:482).

*Parmelina* is a rather heterogeneous assemblage of 47 species differing in lobe width, production of cilia, pigmentation, and rhizine branching. Two major groups can be recognized, one including those species lacking terpenes and one with terpene-containing species. They may be conveniently regarded as sections.

**Section Parmelina**


The species in this section are characterized by the lack of any triterpenes. Except for two species, *P. immiscens* and *P. lindmanii*, the medulla is white and unpigmented. Several internally homogeneous groups can be recognized. For example, the *P. dissecta–P. horrescens* group (Figure 9) includes seven species with very similar lobe configuration, abundant marginal cilia, and gyrophoric acid or the closely related “horrescens” unknown. Heavily white-maculate *P. consors*, *P. pilosa*, and *P. muelleri*, having coarse, leathery thalli and thick, furcate marginal cilia, are obviously related.

The predominantly European complex of species, *P. quercina–P. tiliacea–P. pastillifera*, contains lecanoric acid and forms an easily recognized but isolated group. *Parmelina antillensis* and *P. phlyctina*, both unusual in containing norstictic acid, have no close relatives in the genus. Two other New World species, *P. immiscens* and *P. lindmanii* with a yellow medulla, form an isolated branch of this section.

The species with salazinic acid, *P. enormis*, *P. simplicior*, *P. swinscowii*, *P. usambarenensis*, *P. versiformis*, and *P. wallichiana*, have little in common except their chemistry. Finally, the remaining species, *P. endoleuca*, *P. expallida*, *P. heteroloba*, *P. jamesii*, and *P. pruinata*, have no obvious common ancestry or affinities with other species in the section.
Section *Myelochroa* (Asahina) Hale, new status


All of the species in this section contain zeorin and either leucotylin or leucotylic acid and associated terpenes, and all, excepting *P. indica*, produce varying amounts of the yellow-orange pigment secalonic acid A and possibly other, as yet, unidentified pigments. This group is highly restricted to Asia, and the 17 species have very close affinities, in sharp contrast to section *Parmelina*.

Two apparently unrelated groups are recognizable in the section. One, the *P. galbina* group (*P. galbina*, *P. hayachinensis*, *P. metarevoluta*, and *P. obessa*), is characterized by galbinic acid in addition to leucotylin and secalonic acid A. The other group includes two closely related subgroups, the *P. aurulenta* subgroup (*P. aurulenta*, *P. degelli*, *P. irregans*, and *P. rhytidodes*) with leucotylic acid, and the *P. subaurulenta* subgroup (*P. amagiensis*, *P. crassata*, *P. denegans*, *P. entotheiochroa*, *P. leuco-

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**Figure 9.—**Hypothetical derivation of species in the *Parmelina dissecta-P. horrescens* group. Not shown are *P. damaziana*, a presumptive nonisidiate, nonsorediate derivative of the "horrescens" progenitor, and *P. melanochaeta*, a possible relative of *P. dissecta* but derived from a different progenitor.

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P. subaurulenta subgroup with leucotylin. *Parmelina indica* can probably be classified in the *P. subaurulenta* subgroup although it has a small saxicolous thallus and lacks secalonic acid A.

The affinities of *Parmelina* lie primarily with *Parmotrema* Massalongo, a broader lobed, loosely attached, often ciliate genus (Hale, 1965). *Parmelina*, however, has a far less evolved chemistry, narrower adnate lobes, consistently small spores, and adnate or sessile, usually imperforate apothecia. Where soredia are produced, they are laminal rather than marginal in contrast to most *Parmotrema* species. All in all, however, the apparent intergradation between broad-lobed *Parmelinae* and the smaller lobed species of *Parmotrema*, involving perhaps six or eight species, poses difficult problems in the correct generic identification of individual specimens and for the “lumper,” at least, raises questions on the distinctness of the two genera as circumscribed here. I do not expect that the problem can be resolved to the satisfaction of all lichenologists, but the basic differences should become clearer as more collections are made in tropical...
countries and our knowledge of soredial formation, significance of chemical variation, etc., broadens.

The key below is divided into three sections: (1) species lacking isidia, soredia, and pustules; (2) those with isidia, lobulate isidia, or lobules; and (3) those with soredia or pustules.

**Key to the Species of Parmelina**

**I. THALLUS LACKING ISIDIA, SOREDIA, AND PUSTULES**

(Cortex flaking off in *Parmelina entothetiochroa* and *P. phlyctina*, and heavily rugose in *P. crassata* and *P. rhytidodes*)

1. Medulla more or less completely yellow to yellow-orange (pigmented mostly below the apothecia in *P. galbina*).
2. Upper surface more or less plane.
3. Upper cortex very fragile, flaking away over extensive areas (Figure 6a).
   4. Medulla deep yellow ........................................... 13. *P. entothetiochroa*
   5. Medulla white (turning reddish if improperly curated) ....... 31. *P. phlyctina*
4. Upper cortex entire and continuous.
5. Lower half of medulla darker reddish orange ................. 1. *P. amagiensis*
6. Lower half of medulla not darkly pigmented.
7. Lobes narrow and sublinear, 1-2 mm wide ................. 15. *P. galbina*
8. Lobes broader, subirregular, 2-4 mm wide.
9. Collected in Mexico ........................................... 19. *P. immiscens*
11. Apothecia 3 mm or less in diameter ....................... 40. *P. subaurulenta*
12. Apothecia 3-10 mm in diameter.
13. Thallus coarse, about 250 μm thick; leucotylin present .... 5. *P. crassata*
14. Thallus membranous, about 150 μm thick; leucotylic acid present ... 21. *P. irrugans*
15. Medulla K+ yellow turning red.
   17. Cortex distinctly white maculate ....................... 34. *P. quercina*
   18. Cortex emaculate ........................................ 55. *P. pruinata*
19. Thallus coriaceous, heavily white-maculate; lobes 2-5 mm wide ..... 4. *P. consors*
20. Thallus thin, emaculate; lobes 1-3 mm wide.
   21. Medulla KC+ rose; "horrescens" unknown present ........ 7. *P. damaziana*
   22. Medulla KC-; fatty acids present.
11. Collected in Africa .......................................... 12. *P. enormis*
12. Collected in trees in South America ................... 45. *P. versiformis*
13. Collected in trees in Africa.

**II. THALLUS ISIDIATE, LOBULATE-ISIDIATE, OR LOBULATE**

1. Medulla yellow to pale orange-yellow.
2. Thallus densely lobulate without formation of isidial initials (Figure 4f) …………………… 47. P. xantholepis

2. Thallus normally isidiate or lobulate-isidiate.
3. Isidia large, dorsiventral and lobulate ………………………………………………………… 8. P. degelii
3. Isidia normal, cylindrical and erect.
4. Lobes subirregular and apically rotund, 3-6 mm wide …………………… 24. P. lindmanii
4. Lobes sublinear, 1-2 mm wide.
5. Plants saxicolous (rarely corticolous) in eastern North America ………… 28. P. obsessa
5. Plants corticolous in Southeast Asia ………………………………………………………… 30. P. perisidiants

1. Medulla white.
6. Thallus densely lobulate without isidial initials (Figure 4e) ………………………………… 36. P. schindleri
6. Thallus isidiate or lobulate-isidiate.
7. Isidia in part procumbent and lobulate (Figure 4c,d).
8. Medulla C+ rose …………………………………………………………………………………… 38. P. spathulata
8. Medulla C- ………………………………………………………………………………………… 18. P. horrescens
7. Isidia erect, cylindrical.
9. Medulla K+ yellow turning red.
10. Collected in tropical America; norsttic acid present …………………… 2. P. antillensis
10. Collected in Asia and Africa; salazinic acid present.
11. Lobes subirregular, crowded, apically rotund ……………………………………………… 46. P. wallachiana
11. Lobes sublinear, loosely divaricate ………………………………………………………… 44. P. usambarensis
9. Medulla K- or faintly yellow.
12. Medulla C+ rose or red.
13. Isidia apically flattened and peltate …………………………………………………………… 29. P. pastillifera
13. Isidia cylindrical, not peltate.
14. Medulla C- intense red (lecanoric acid) ……………………………………………………… 43. P. tiliacea
15. Lobes narrow, 1-2 mm wide; upper surface emaculate; isidia eciliate …………………… 10. P. dissecta
15. Lobes broader, 2-6 mm wide; upper surface maculate; isidia eciliate …………………… 25. P. melanochaeta
12. Medulla C-.
16. Medulla P+ red ……………………………………………………………………………………… 22. P. jamesii
16. Medulla P-.
17. Lower surface brown to blackening in part …………………………………………………… 14. P. expallida
17. Lower surface uniformly black.
18. Isidia apically ciliate; medulla KC+ rose …………………………………………………… 18. P. horrescens
18. Isidia ciliate; medulla KC- ……………………………………………………………………… 20. P. indica

III. THALLUS SOREDIAE, SOREDIAE-PUSTULATAE, OR PUSTULATAE

1. Medulla entirely white.
2. Lobes broad and apically rotund; cortex conspicuously white-maculate (Figure 5a).
3. Medulla K+ yellow (stictic acid) ………………………………………………………………… 27. P. muelleri
3. Medulla K- ………………………………………………………………………………………… 32. P. pilosa
2. Lobes narrower and sublinear; apically obtuse.
4. Medulla C+ rose (gyrophoric acid).
5. Rhizines simple …………………………………………………………………………………… 6. P. cryptochna
[5. Rhizines furcate to dichotomously branched, marginal cilia lacking …………………… Hypotrachyna revoluta (Floerke) Hale]
4. Medulla C-.
6. Medulla K+ yellow to red (salazinic acid) …………………………………………………… 42. P. swinsecowii
6. Medulla K negative (“horrescens” unknown) ………………………………………………… 41. P. subfatisens
1. Medulla entirely or partially yellow to yellow-orange (at least pigmented below the soralia).
7. Upper cortex flaking off without formation of soredia (Figure 6a) …………………… 13. P. entotheiochroa
7. Upper cortex entire, soredia or pustules present.
8. Thallus pustulate without formation of soredia (Figure 5e,f).
9. Lobes rather broad, subirregular, 2-4 mm wide.
10. Pustules forming in capitate masses (Figure 5g) 23. P. leucotylica
10. Pustules irruptive, intermixed with wrinkles (Figure 6b) 35. P. rhytidodes
9. Lobes narrow and sublinear, less than 2 mm wide.
11. Medulla K+ reddish, P+ orange 16. P. hayachinensis
11. Medulla K-, P-, C+ rose, pigmented very faint yellow 39. P. spumosa
8. Thallus soerediate or pustulate-sorediate at maturity.
12. Medulla deeper reddish orange in the lower half 9. P. denegans
12. Medulla uniformly pigmented to white and pigmented only under the soralia.
13. Lobes 2-4 mm wide; medulla P- 3. P. aurulenta
13. Lobes less than 2 mm wide; medulla P+ orange 26. P. metarevoluta

Species Treatment

The 47 species of Parmelina are arranged below in alphabetical order. Location of specimens listed under “Specimens Examined” are indicated by the standard herbarium acronyms except for those collected by Hale, all of which are preserved in the Smithsonian Institution (US).

1. Parmelina amagiensis, new combination

Figure 11a

Parmelina amagiensis Asahina, 1951a:228 [type collection: Mt. Amagi, Prov. Izu, Japan, Asahina 95 (TNS, lectotype)].

Description.—Thallus loosely adnate on bark or mosses over bark, buff mineral gray, 4–8 cm broad; lobes more or less subirregular, imbricate, 2–3 mm wide, the marginal cilia numerous, simple, up to 1 mm long; upper surface plane, white-maculate, becoming heavily pycnidiate, isidia and soredia lacking; medulla deep salmon orange; lower surface black, densely rhizinate, the rhizines black, simple or sparsely squarrosely branched, 0.5–1.0 mm long. Apothecia sessile to subpedicillate, 2–4 mm in diameter; spores 8, 6–7 × 9–11 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and related “subaurulenta” terpenes, secalonic acid A, and unidentified pigments).

Distribution.—Japan.

Remarks.—This rare Japanese species is very close to P. denegans, a pustulate or sorediate-pustulate species in tropical Asia. Both have a more deeply pigmented medulla, especially in the lower half, than other members of section Myelochoa. I have not been able to resolve these pigments with the usual chromatographic solvent systems. Parmelina amagiensis appears to be somewhat more robust than P. denegans, judging from the few specimens available, and does not seem to be a parent morph for the latter.

Specimens Examined.—Japan: Prov. Echigo, Yanagisawa 599a (TNS); Prov. Hyuga, Kurokawa 50058 (TNS, US).

2. Parmelina antillensis

Figure 11b

Parmelina antillensis (Nylander) Hale, 1974:482.

Parmelia antillensis Nylander, 1868:264 [type collection: Matouba, Guadeloupe, Husnot 445 (H. Nylander herbarium number 35119, lectotype; isolecotypes in G, P)].

Parmelia blastica Vainio, 1896:32 [type collection: Shawford Estate, Dominica, Elliott 899 (TUR, lectotype; isolecotype in BM)].

Description.—Thallus adnate on bark, fragile and membranous, up to 10 cm across, greenish mineral gray, often more or less white-pruinose at the lobe tips; lobes irregularly branched, subimbricate to convoluted, the marginal cilia sparse, mostly in lobe axils, to 0.5 mm long; upper surface shiny, plane, cortex continuous or cracked with age; densely isidiate, the isidia fine, to 0.4 mm high, sparingly branched or simple; lower surface black, brown and shiny in a narrow zone along the margins, densely rhizinate, the rhizines simple. Apothecia adnate, 3–5 mm in diameter, the amphithecium isidiate; spores 8, 5–6 × 7–8 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C–, KC–, P+ orange (norstictic and connorstictic acids).

Distribution.—Caribbean region.

Remarks.—Parmelia antillensis and its close Caribbean relative P. phlyctina are the only two species in the genus containing norstictic acid. This trait, along with the rather broad, apically round lobes, might tempt one to place them in Parmotrema Massalongo, where, in fact, I had originally suggested they might belong (Hale, 1959). The
lower surface, however, has at most a narrow bare or papillate zone, the lobes are generally adnate at
the tips, not ascending, and the cilia are generally in the axes of the lobes. Both *P. antillensis* and *P.
phlyctina* share traits intermediate between *Parmelina* and *Parmotrema* and have evolved in a very
restricted region, the rain forests of the Caribbean basin (excepting the unusual record of *P. antil-
lessis* from the southeastern United States discussed in Hale, 1971b:46). Other parmelioid groups have
evolved here, e.g., *Pseudoparmelia martinicana* (Nylander) Hale and *P. raunkiae* (Vainio) Hale and
perhaps also *Relicina eximbricata* (Gyelnik) Hale (1975b, 1976a), but these are all lowland spe-
cies in dry, disturbed habitats. Although *Parmelia antillensis* is often collected on citrus trees at 600–
700 m elevation, its primary habitat is the canopy branches of trees in virgin rain forest.

**Specimens Examined.** United States: Tennessee, Yoshi-
miura et al. 660872 (US). Mexico: Chiapas, *Hale* 20288.1

3. *Parmelia aurulenta*

*Figs. 10, 11c*


*Parmelia aurulenta* Tuckerman, 1858:424 [type collection: 
Harper's Ferry, Virginia, Tuckerman (FH-Tuck, lectotype)].

*Parmelia tiliae* var. *efforescens* Müller Argoviensis, 
1887:316 [type collection: Siberia, Russia, *Lahm* 5 and 6
(G, lectotype; isolecotype in W)].

*Parmelia albido-straminea* Hue, 1899:161 [type collection: 
Sanctum Dionysium, Réunion, *Rodrigues* (PC, lectotype)].

*Parmelia subrevoluta* Harmand, 1928:326 [type collection: 
Cha Pon, Indochina, *Demange* (PC, lectotype)].

*Parmelia huanensis* Zahlbruckner, 1930:187 [type collection:
Tschangcha, Hunan, China, *Handel-Mazzetti* 11454 (WU, lectotype)].

*Parmelia silvestris* Degelius, 1940:47 [type collection: Togue
Pond near Mt. Katahdin, Maine, *Degelius* (Degelius herbari-
um [not seen]; isolecotype in US)].

*Parmelia aurulenta* var. *silvestris* (Degelius) Degelius, 1941:58.

**Description.**—Thallus adnate on bark or rock, pale greenish mineral gray, 4–10 cm broad; lobes
sublinear to subirregular, apically subround, 2–4
mm wide, the marginal cilia irregularly dispersed
but mostly in the lobe axils, to 0.8 mm long; upper
surface shiny, plane to rugulose, soon sorediate to
pustulate-sorediate, the soralia up to 1 mm in diam-
eter, coalescing into large subcapitate clumps, the
soredia coarse (Figure 5a); medulla white and becom-
ing orange sulfur yellow only beneath soralia
and near exposed cracks in the upper cortex or
entirely sulfur yellow; lower surface black and
moderately to densely rhizinate, the rhizines black,
simple or becoming sparsely furcate or squarrosely
branched. Apothecia rare, adnate to stipitate,
the amphithecium sorediate-pustulate, 2–5 mm in
diameter; spores poorly developed, 7 × 12 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); me-
dulla negative with color reagents or if pigmented
areas tested becoming more intensely yellow (zeorin,
leucotylic acid and related terpenes, and secalonic
acid A).

**Distribution.**—Pantemperate and montane pantem-
trropical (Figure 10).

**Remarks.**—*Parmelia aurulenta* is one of the most
widely distributed species in the genus and, at least in the
United States, is one of the most commonly col-
llected foliose lichens. It is also unusual in being the
only species of the *subaurulenta* complex that oc-
curs in the New World, perhaps suggesting merely
that efficient dispersal by soredia is the prime reason
for the pantemperate distribution.

Soredial formation is extremely variable. The
lectotype, for example, is densely pustulate with
well developed soredia that obscure most of the
pustular initials (Figure 5a). At other times, the
pustules become only sparsely and coarsely soredi-
ate, being especially true of saxicolous forms.
In no case, however, do the pustules remain intact
from different
geographic areas but it does not seem significant or consistent. I did not, incidentally, recheck the terpene profiles of Parmelia tiliae var. efflorescens, P. albido-staminea, P. subrevoluta, or P. hunanensis, but assumed that they have the “aurulenta” terpenes since they are sorediate and fall outside the range of P. leucotyliza. Should any of them be found to contain “subaurulenta” terpenes, the nomenclature of P. aurulenta would not change.

The parent morph of Parmelia aurulenta might well be P. irrigans, which is identical in chemistry. It would be desirable, however, to examine more specimens of P. irrigans in relation to P. aurulenta in Japan before making a final decision.

The ecology of P. aurulenta has been intensively studied in Wisconsin, an area of typical deciduous and conifer forests well within its range. For example, I found in 1955 that it occurred on 30% of a 2800 tree sample at the 1.3 m level on the trunk and on 21% at base level in mesic deciduous forests. It was most common in closed oak-hickory stands and much rarer in both open, savanna-like oak stands and in heavily shaded maple (Acer saccharum) climax forests. Parmelia aurulenta occurs frequently with Parmelia rudecta Acharius and Pseudoparmelia caperata (L.) Hale.

In northern Wisconsin, an area of hardwood-conifer forests more comparable in climate to northern Europe, P. aurulenta had an overall frequency of only 11.6% at the 1.3 m level and 1.3% at the base. It avoided Pinus spp. and grew almost exclusively on Acer and Quercus (W. Culberson, 1955). This avoidance of Pinus was demonstrated even more graphically by W. Culberson (1958) in an ecological survey exclusively of Pinus in North Carolina. Although otherwise common in this state, not a single collection was made on conifers.

FIGURE 11.—Species of Parmelina: a, P. amagiensis (Kurokawa 550058 in US); b, P. antillensis (Hale 38291); c, P. aurulenta (Hale 18941); d, P. consors (Reitz and Klein 15973 in US); e, P. crassata (Kurokawa 550446 in US); f, P. cryptochlora (Hale 87782). (Scale in mm.)
Parmelia continentalis H. L. Flörke, 1912

**Description.**-Thallus adnate on bark, coriaceous greenish mineral gray and turning deep olive-buff in the herbarium, 5–10 cm in diameter; lobes irregularly branched, sublinear-elongate to subirregular, apically rotund, often imbricate, 1–4 mm wide, the margins crenate, moderately to densely ciliate, the cilia stout, blackish brown to black, becoming furcate, 0.2–1.0 mm long; upper surface shiny, becoming heavily maculate, sometimes pruinose towards the tips, isidia and soredia intermixed, simple or squarrose. Apothecia subresupinate, 2–8 mm in diameter, amphithectum smooth, the disc cinnamon brown, rarely perforate; spores 8, 8–12 × 14–19 μm.

**Chemistry.**-Cortex K+ yellow (atranorin); medulla negative with color tests (no substances demonstrated).

**Distribution.**-South America.

**Remarks.**-This robust, coriaceous lichen is characterized by its heavily white-maculate cortex (Figure 3a), thick, furcate cilia (Figure 3a), and lack of medullary chemistry. It is also the only species assigned to *Parmelina* with perforate apothecia, a trait usually associated with *Parmotrema* Massalongo. The dense rhizine mat below to the margin and the generally close adnation, however, do not conform to *Parmotrema*. *Parmelina consors* is evidently a common lichen in dry, scrubby forests and on trees along roads. The presumptive sorediate morph, *P. pilaosa*, is a broader distribution in South America and also occurs in Africa.

**Specimens Examined.**-Brazil: *Waura* 669 (M); Mato Grosso, Montes 10146 (DUKE, LD, US); Minas Gerais, Malme 201B (S), Vainio in *Lichenes Brasilienses Exsiccati* 998 (BM, M, TUR); Rio de Janeiro, Burchell 2508 (BM), Gardner 37 (BM), Glassow 1821, 1836 (M), 1840 (M, S), Hemmendorf 5886 (S, UPS), Milne (BM); Rio Grande do Sul, Malme 1282 (LD, S, UC, UPS, US); Santa Catarina, Reitz and Klein 12901, 15073, 16032a (US); Sao Paulo, Eiten 5731 (US), Gehrt (US), 5924 (MICH), Puiggari (G), Paraguay: Itapua, Malme 1462 (S, UPS, US); Uruguay: Lavallaja, Lamb (H), Argentina: Buenos Aires, Kuhnemann 22 (S), Santesson 76, 77a (S); Misiones, Montes 36 (US), 3353 (WIS).

**4. Parmelina consors**

*Parmelina consors* (Nylander) Hale, 1974:482.

*Parmelina consors* Nylander, 1885:615 [type collection: Minas Gerais, Brazil, Weddell (H, Nylander herbarium number 35277, lectotype)].

*Parmelina balansae* Müller Argoviensis, 1888a:1 [type collection: Asunción, Paraguay, Balansá 5 (G, lectotype)].

*Parmelina sampainana* Hue, 1899:170 [type collection: São Paulo, Brazil, Sampainó (H, lectotype)].

*Parmelina continentalis* Lynghe, 1914:111 [type collection: Corumba, Mato Grosso, Brazil, Malme 48 (S, lectotype)].

**Description.**-Thallus adnate on bark, coriaceous greenish mineral gray and turning deep olive-buff in the herbarium, 5–10 cm in diameter; lobes irregularly branched, sublinear-elongate to subirregular, apically rotund, often imbricate, 1–4 mm wide, the margins crenate, moderately to densely ciliate, the cilia stout, blackish brown to black, becoming furcate, 0.2–1.0 mm long; upper surface shiny, becoming heavily maculate, sometimes pruinose towards the tips, isidia and soredia lacking; medulla white; lower surface black, moderately rhizinate, the rhizines black, thick and thin intermixed, simple or squarrose. Apothecia subresupinate, 2–8 mm in diameter, amphithectum smooth, the disc cinnamon brown, rarely perforate; spores 8, 8–12 × 14–19 μm.

**Chemistry.**-Cortex K+ yellow (atranorin); medulla negative with color tests (no substances demonstrated).

**5. Parmelina crassata, new species**


**Description.**-Thallus laxe adnatus, corticola, crassatus coriaceusque, cinereo-albidus vel obscurascens, usque ad 15 cm latus, lobis sublinearibus vel subirregularibus, contiguis vel congestis, 3–6 mm latis, margine ciliatis, ciliis irregulariter dispersis, nigris, 0.3–0.8 mm longis, superne planis vel acetate rugulosis, nitidus, continuus, isidiis sorediosusque destitutus, cortex superior ca. 12 μm crassus, epicorticatus, stratum gonidiale 16–18 μm crassum, medulla omnino sulphureo-salmonea, 160–210 μm crassa, cortex inferior fuscus, 14–16 μm crassus, substus niger, dense rhizinosus, rhizinis nigris, nitidis, 1–2 mm longis, simplicibus vel pro parte furticis vel squarroso-ramosis. Apothecia numerosa, subpedicillata, amphithecto rugoso, usque ad 10 mm diametro, sporis octonatis, 6–8 × 14–15 μm.

**Chemistry.**-Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and associated terpenes, and secalonic acid A).
Holotype.—Mt. Akagi, Japan, S. Kurokawa 550466, 23 August 1955 (US; isotype in TNS).

Distribution.—Japan.

Remarks.—This is another member of the P. subaurulentia group so abundantly developed in Japan. It has the same chemistry as P. subaurulentia but is well separated by the larger, leathery thallus, averaging 218 µm in thickness (sample of 10 specimens), as opposed to 150 µm for P. subaurulentia. It also has significantly larger, substipitate apothecia (along with P. homogenes) as opposed to 150 pm for P. homogenes in Japan, but, as explained below, P. homogenes was misinterpreted and in reality the same as P. subaurulentia. Parmelia crassata is a common species in Japan, but since I have not had an opportunity to re-examine the chemistry of the rich collections in TNS, I have cited below only those specimens also represented in US.


6. Parmelia cryptochlera

Figure 11f

Parmelia cryptochlera (Vainio) Hale, 1974:482.

Parmelia cryptochlera Vainio, 1896:34 [type collection: Laudat, Dominica. Elliott 912 (BM, lectotype)].

Description.—Thallus closely adnate on bark, whitish mineral gray, 1–3 cm broad; lobes sublinear, separate to crowded, 1–2 mm wide, the marginal cilia sparsely developed, 0.1–0.3 mm long; upper surface plane to convex, sorediate toward the tips, the soralia capitate, up to 1 mm in diameter (Figure 5b), the sorediate lobe tips becoming revolute: lower surface black, sparsely rhizinate, the rhizines black, simple. Apothecia not seen.

Chemistry.—Cortex K+ yellow (atranorin); medulla K–, C+ rose, KC+ red, P– (gyrophoric acid).

Distribution.—West Indies and India (?).

Remarks.—As I explained in my study of the Parmeliales of Dominica (Hale, 1971a:12), Vainio’s type collection is so poor that I had not been able to interpret it until I collected additional specimens from the type-locality in Dominica. It is rather common at one locality (base of Morne Anglais) on trees in a pasture at 600–800 m elevation. One collection that I made in South India also appears to be this species. It is so small and inconspicuous that it has undoubtedly been overlooked elsewhere or, if collected, has been set aside as unidentifiable. It has the same chemistry as P. dissecta, a common species with which it is clearly allied as the sorediate morph of the extinct or still undiscovered parent morph. It also has the same chemistry as sorediate Hypotrachyna revoluta (Floerke) Hale, which would normally be amply distinguished by a larger thallus, more ascending lobes, dichotomously branched rhizines, and broader sorediate pustules. A poorly developed specimen of H. revoluta, however, and a large specimen of P. cryptochlera would have to be separated with extreme care.


7. Parmelia damaziana, new combination

Figure 12a

Parmelia damaziana Zahlbruckner, 1905:541 [type collection: Mt. Ituculumi, Brazil. Damazio 1757 (W, lectotype; isolectotype in G)].

Parmelia brachyconidia Zahlbruckner, 1908:465 [type collection: Velloro, Serra do Ouro Preto, Brazil. Damazio 1741 (W, lectotype)].

Parmelia brachyconidia var. chlorocarpa Zahlbruckner, 1908:466 [type collection: Cachoeira do Campo, Brazil. Damazio 1740 (W, lectotype)].


Description.—Thallus closely adnate on twigs, whitish ashy mineral gray, 3–6 cm broad; lobes short, sublinear-elongate to subirregular, 1–3 mm wide, the marginal cilia evenly dispersed, about 0.5 mm long; upper surface plane, shiny; lower surface black, moderately rhizinate, the rhizines simple, black. Apothecia common, sessile to subcorticate, to 12 mm in diameter, the disc flat, often radically split; spores 8, 8–12 × 12–18 µm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K–, C–, KC+ rose, P– (“horrescens” unknown).

Distribution.—South America.

Remarks.—Although clearly distinct because of
FIGURE 12.—Species of Parmelina: a, *P. damaziana* (Damazio 1375 in W); b, *P. degelii* (Degelius A-182 in Degelius herbarium); c, *P. denegans* (Hale 43855); d, *P. dissecta* (Hale 14999); e, *P. endoleuca* (Weber in *Lichenes Exsiccati* 244 in US); f, *P. enormis* (Jellicoe in US). (Scale in mm.)
the chemical constituents, *P. damaziana* is a rare and not well comprehended species. The lectotype was collected on tree branches whereas Lyne's species was apparently saxicolous. *Burchell* 1105–06 is tentatively placed here since the chemistry, while not clear, is closest to the "horrescens" type. *Parmelia damaziana* has rather large spores, just as the other members of the *P. horrescens* group. It could be regarded theoretically as the parent morph for *P. horrescens*, *P. schindleria*, and *P. subfatiscens*, but all of these vegetative morphs have smaller, more fragile thalli.

**Specimens Examined.**—Brazil: *Burchell* 1105–06 (BM, US).

8. *Parmelia degelii*, new species  
**Figure 12b**

**Description.**—Thallus adnatus, corticola, fragilis, pallide viridi-albicans, 6–8 cm latus, lobis plus minusve subirregularibus, ciliatibus, ciliis usque ad 0.8 mm longis, superne planus vel acetato rugulosus, nitidus, sparse vel modice isidiatus, isidiis primum cylindricis, mox procumbentibus, dorsiventralibus, expansis, ad 0.6 mm longis, cortex superior 12 μm crassus, epicorticatus, stratum gonidiale 12–14 μm crassum, medulla pallide sulfurea, 60–90 μm crassa, cortex inferior paraplectenchymatus, brunneus, 12 μm crassus, subtus niger, dense rhizinosus, rhizinis nigris, simplicibus, 0.5–0.9 mm longis. Apothecia ignota.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla more intensively yellow-orange with color tests (zeorin, leucotylin and associated terpenes, secalonic acid A, and possibly anthraquinones).

**Distribution.**—India, Sri Lanka, and Sabah.

**Remarks.**—Except for the darker reddish orange pigment in the lower part of the medulla, this species is the pustulate morph of *P. subaurulenta*. They have similar lobe configuration and habitats, occurring at about 2000 m elevation in open forests. The lectotype specimen is fertile and has few pustules. The specimens that I collected are heavily pustulate-sorediate by contrast.


10. *Parmelia dissecta*  
**Figures 12d, 13**

*Parmelia dissecta* (Nylander) Hale, 1974:482.


*Parmelia laevigata* var. *gracilis* f. *furfuracea* Müller Argovien-
DESCRIPTION.—Thallus adnate on bark or rock, yellowish glaucous to pale greenish mineral gray, 3–7 cm broad; lobes sublinear-elongate, contiguous, 1–3 mm wide, the marginal cilia irregularly dispersed, mostly simple, 0.7 mm long; upper surface shiny, emaculate, plane to convex, moderately to densely isidiate, the isidia cylindrical, erect, often branched, less than 0.5 mm high; medulla white; lower surface black, moderately rhizinate, the rhizines black, shiny, simple or sparsely branched. Apothecia adnate, the rim crenate, the amphithecium isidiate; 1–4 mm in diameter; spores 8, 8–10 × 12–17 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K-, C+ rose, KC+ red, P-- gyrophoric acid with or without associated unknown substances.

DISTRIBUTION.—Pantropical and montane pantropical (Figure 13).

REMARKS.—This is one of the most widespread and commonly collected species in the genus, especially in temperate zones, occurring on a wide variety of substrates in open, secondary forests. In tropical regions it is strictly montane, usually being most abundant in cloud forests up to 2300 m elevation. Morphological variation is wide, even though the basic characters, isidia, ciliate lobes, and gyrophoric acid, are constant. The lobes, for example, are narrow, sublinear, and separate in the lectotype specimen. At the other extreme are plants such as those collected in Dominica (Hale, 1971a) with broader, contiguous to subimbricate lobes.

Figure 13.—Distribution of Parmelia dissecta based on all available herbarium specimens.
**Parmelina dissecta** has been correctly identified by European lichenologists both on the Continent and in tropical regions. Degelius (1941:60) was the first to identify the species correctly in North America. He noted two populations differing in C test (C+ rose or C−) and presence or absence of cilia on the isidia. Hale and Kurokawa (1962) determined that the C− ciliate population is *P. horrescens*. No parent morph has been discovered for *P. dissecta*, but it forms a convenient nucleus of the “dissecta” group, including isidiate but significantly larger *P. melanochaeta* and isidiate-lobulate *P. subfatiscens* (Figure 9).

**Specimens Examined (selected).—**United States: Pennsylvania, Hale 17140; Maryland, Hale 14867; West Virginia, Hale 11470; Ohio, Hale 13910, 15735; Kentucky, Hale 13770; Virginia, Hale 38419, Luttrel 3799 (US); Tennessee, Hale 31124, 37038; North Carolina, Culberson 7099 (DUKE), Hale 30645; South Carolina, Culberson 7459 (DUKE), Hale 16601; Alabama, Hale 33987, Skorepa 4547 (US); Georgia, Culberson 7249 (DUKE), Hale 7509; Florida, Nelson (US) (see Moore, 1968:220 for additional records in Florida); Mississippi, Hale 7977, Hubricht 1532 (US); Texas, Hale 5242; Mexico: Chiapas, Hale 20304; Vera Cruz, Hale 21231; Panama: Chiriqui, Hale 38879; Cuba: Oriente, Inshaug 24720 (MSC); Jamaica: Inshaug 14172 (MSC); Guadeloupe: Duss 1030 (TUR). Dominica: Hale 35569 (see Hale, 1971a:13, for additional records). Martinique: Degelius (Degelius herbarium). St. Vincent: Guilting 46 (BM). Trinidad: Imshaug 146 (TNS); Prov. Owari, Hale 96096 (TNS); Prov. Settsu, Hale 10317, 30483. Philippines: Java, Groenhart 6022 (L), 8483 (BOR); Sumatra, Groenhart 967 (L). Hawaii: Hale 31340, 32953.

**Parmelina endoleuca**, new combination

*Parmelina endoleuca* Taylor, 1847:167 [type collection: Swan River, Australia, Drummund (FH-Tayl, lectotype)].

**Description.**—Thallus closely adnate on bark, whitish mineral gray, 2–4 cm broad; lobes sublinear to subirregular, short and crowded, 1–2 mm wide, the marginal cilia sparse, less than 0.3 mm long; upper surface shiny, plane to minutely rugulose, becoming more strongly rugose and lobulate toward the center, heavily pycnidiate, soredia and isidia lacking; medulla white; lower surface dark brown at the margins and black toward the center, moderately rhizinate, the rhizines simple, brown but blackening at maturity. Apothecia very numerous, sessile, 1–2.5 mm in diameter, the disc dark brown, plane; spores 8, 6–7 × 11–12 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla negative with color tests (an unidentified fatty acid).

**Distribution.**—Australia.

**Remarks.**—In my earlier work on *Parmelia* I placed this species in synonymy under *Parmelina galbina*, a Japanese–North American species. Since the Australian locality seemed at variance with the Arcto-Tertiary distribution pattern of *P. galbina* and since my first chemical tests had been done with crystal techniques, I have checked the type of *Parmelina endoleuca* again and found that it contains neither galbinic acid nor any of the associated terpenes that characterize *P. galbina*. I have concluded, therefore, that *Parmelina endoleuca* is a good species in spite of the very close external resemblance to *P. galbina*. The fatty acid falls higher on the chromatographic plates than either caperatic acid or protolichsterinic acid. The species is endemic to the dry scrub forests of eastern Australia.

**Specimens Examined.**—Australia: Australian Capital Territory, Weber in Lichenes Exsiccati 244 (COLO, US).
**DESCRIPTION.**—Thallus expanded, loosely attached on rock, coriaceous, whitish to ivory mineral gray, 10–30 cm broad; lobes sublinear, dichotomously branched, imbricate and crowded toward the center, 5–8 mm wide, the margins entire, ciliate mostly in the lobe axils, the cilia to 2.0 mm long; upper surface plane to convex, continuous, lacking soredia and isidia; medulla white; lower surface pale brown, densely rhizinate, the rhizines pale brown, simple. Apothecia numerous, subpedicillate, 3–8 mm in diameter; spores 8, 6–7 × 8–11 μm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and associated terpenes, and secalonic acid A).

**DISTRIBUTION.**—Korea and Japan.

**REMARKS.**—This is one of the commonest lichens in Japan, recognizable by the large rather fragile thallus with patches of the yellow medulla visible where the cortex breaks away (Figure 6a). It grows on both trees and rocks in open forests. The densely pustulate-rugose areas are more or less identical to those of *P. rhytidodes* but they differ in breaking open. In addition, *P. rhytidodes* has a different terpene profile, the “aurulenta” series. *Parmelina entotheiochroa* is clearly a member of the *P. subaurulenta* group, most closely related to *P. leucotyliza* and lacking a parent morph.

**SPECIMENS EXAMINED.**—Korea: Fujikawa (TNS). Japan: Prov. Aki, Hale 29534; Prov. Awa, Kishida (TNS); Prov. Bitchu, Yoshino (TNS); Prov. Etchu, Asahina (TNS); Prov. Higo, Fujikawa (TNS); Prov. Ise, Uemara 102 (US); Prov. Izu, Asahina (TNS). Prov. Kii, Kurokawa 64131 (TNS), Numajiri 384 (TNS); Prov. Kozuke, Uematsu 388 (TNS); Prov. Musashi, Kurokawa 550535 (TNS, US), Nakaji 50 (TNS); Prov. Ohmi, Hale 29456a; Prov. Rikuzen, Ishiba 43 (US); Prov. Satsuma, Fujikawa (TNS); Prov. Settsu, Ui 2667 (TNS); Prov. Shimotsuke, Asahina (TNS), Culberson 10680 (DUKE, US); Prov. Shinano, Kurokawa 51620 (TNS, US), Togashi 5100 (TNS); Prov. Suruga, Asahina (TNS).

**13. Parmelina entotheiochroa**

**FIGURE 14a**

*Parmelina entotheiochroa* (Hue) Hale, 1974:482.

*Parmelina entotheiochroa* Hue, 1899:161 [type collection: Hakodate, Japan, Faurie 104 pro parte (PC, lectotype in BM)].

**DESCRIPTION.**—Thallus adnate to loosely attached, fragile and easily breaking apart, saxicolous and corticolous, light greenish mineral gray with small sulfur-yellow patches where the cortex has broken away, 8–10 cm broad; lobes subirregular, congested, 2–3 mm wide, marginal cilia produced mostly in the lobe axils, about 0.5 mm long; upper surface plane and shiny on young lobes but soon becoming strongly rugose-wrinkled to pustulate, the surface dull and in part white pruinose, the wrinkles or pustules breaking open and large areas of cortex (1–3 mm across) breaking away to expose the deep sulfur-colored medulla; lower surface black except for a narrow brown zone at the tips, densely rhizinate to the margins, the rhizines black and shiny, simple or sparsely furcate. Apothecia rare, sessile, the amphithecium rugose, 2–4 mm in diameter; spores 8, 5 × 10–11 μm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and associated terpenes, and secalonic acid A).

**DISTRIBUTION.**—Zambia.

**REMARKS.**—This species does not fit well in *Parmelina* if judged from lobe configuration alone. It appears to be a very large, typically sublinear *Hypotrachyna*, but the rhizines are simple (not dichotomously branched), the lower surface brown (not black), and the marginal cilia are distinct. No vegetative morphs are known. The species is known only from the type collection but should be found on rock outcrops in countries adjacent to Zambia.

**14. Parmelina expallida**

**FIGURE 14b**

*Parmelina expallida* (Kurokawa) Hale, 1974:482.


**DESCRIPTION.**—Thallus adnate on bark, whitish mineral gray, 5–7 cm broad; lobes sublinear, more or less imbricate, 1–3 mm wide, the marginal cilia sparse, simple, about 0.5 mm long; upper surface plane, emaculate and opaque, densely isidiate, the isidia cylindrical, simple or becoming coralloid-branched, 0.3–1.0 mm high; medulla white; lower surface pale brown or darkening, moderately rhizinate, the rhizines simple or rarely furcate, about 0.5 mm long. Apothecia rare, sessile, the rim crenate and the amphithecium isidiate, 2–5 mm in diameter; spores 8, 8–10 × 14–17 μm.
Figure 14.—Species of Parmelina: a, _P. entotheicrhoa_ (Hale 29456a); b, _P. expallida_ (Kurokawa 2930 in TNS); c, _P. galbina_ (Hale 28415); d, _P. hayachinensis_ (Kurokawa 67081 in TNS); e, _P. heteroloba_ (Schiffler in W); f, _P. horrescens_ (Hale 36959).
Chemistry.—Cortex K+ yellow (atranorin); medulla negative with color tests (protolichesterinic acid and an unidentified fatty acid).

Distribution.—India, Thailand, and Taiwan.

As pointed out by Kurokawa (1968a:191), an unusual feature of this species is the brown lower surface, indicating some relationship with *P. versiformis*, a South American species. It is also one of the few Parmelinae to produce a fatty acid.

Specimens Examined.—See Kurokawa (1968a:193) for records from India, Taiwan, and Japan.

15. *Parmelina galbina*

**Figures 14c, 15**

*Parmelina galbina* (Acharius) Hale, 1974:482.

*Parmelina galbina* Acharius, 1814:195 [type collection: North America (=Pennsylvania), Muhlenberg (H-Ach, lectotype; isolecotypes in FH)].

* Parmelia tiliae var. minor Müller Argoviensis, 1877:78 [type collection: near Dallas, Texas, Boll (G, lectotype: isolecotypes in FH, M, W)].

* Parmelia tiliae var. sulphurosa Tuckerman, 1882:57 [type collection: Illinois, Hall (FH-Tuck, lectotype)].

* Parmelia deminuta Hue, 1899:156 [type collection: Texas, Boll (PC, lectotype)].

* Parmelia subquercifolia Hue, 1899:157 [type collection: Ohio, Sullivant (PC, lectotype)].

* Parmelia subquercifolia var. rugosa Hue, 1899:175 [type collection: Oyama, Japan, Faurie (not seen)].

* Parmelia tiliae subquercifolia (Hue) Merrill and Burnham in Burnham, 1922:75 [rank not designated].

* Parmelia quercina var. sulphurosa (Tuckerman) Zahlbruckner, 1929:192.

* Parmelia sulphurosa (Tuckerman) Fink, 1935:328.

* Parmelia laevisata ssp. extremi-orientalis f. rugosa (Hue) Asahina, 1951c:291.


* Parmelia galbina var. rugosa (Hue) Asahina, 1963:225.


Description.—Thallus closely adnate on bark, yellowish-glaucous to greenish mineral gray, 3-10 cm in diameter; lobes short, sublinear, contiguous, 1-2 mm wide, marginal cilia mostly in axils, sometimes only sparsely developed, less than 0.5 mm long; upper surface plane to rugulose, continuous, pycnidia usually numerous; medulla white or pale yellow to orange, especially beneath the apothecia; lower surface densely rhizinate. the rhizines black, simple. Apothecia very common, adnate, 2-5 mm in diameter, the disc cinnamon brown; spores 8, 7-9 × 10-13 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K+ yellow, C- or C+ yellow, KC-, P+ pale orange (galbinic acid, zeorin, secalonic acid A, trace of salazinic acid, and leucotylin and associated terpenes).

Distribution.—Japan and eastern North America.

Remarks.—During a visit to the Academy of Natural Sciences in Philadelphia in 1958 I found a specimen in the Muhlenberg herbarium without a name but with a penciled number “15.2.” I later found the same plant in the Acharian collection (H) also numbered 15.2 and described by Acharius as *Parmelia galbina*. This discovery clarified the status of one of the very common corticolous lichens in eastern North America. W. Culberson (1961:179) subsequently studied the problem and lectotypified *P. subquercifolia* Hue as synonymous with *P. galbina*. The second syntype of Hue's species was determined by Culberson to be *Parmelia livida* (= *Hypotrachyna livida* (Taylor) Hale), another very common corticolous lichen in eastern North America distinguished by more or less distinctly dichotomously branched rhizines and the lividic acid complex (Hale, 1975a:45). As a rule, *H. livida* has a whiter cast than *P. galbina*, is more robust, and lacks pigments in the medulla or under the apothecia. Still, care must be taken when identifying these two species. One other distinguishing character is the unique moniliform cells in the medulla of *P. galbina* and its morphs, *P. hayachinensis*, *P. metarevoluta*, and *P. obsessa*, first described by Asahina (1951c). The cells, however, are not easy to find and their exact significance is unknown at this time.

Specimens Examined.—United States: See W. Culberson (1961:171) for a discussion of the distribution and map of localities in North America based on specimens in DUKE and US (Figure 15). Japan: Prov. Aki, Kurokawa 64431 (TNS); Prov. Bungo, Kurokawa 65191 (TNS); Prov. Hizen, Kurokawa 62588 (TNS); Prov. Hoki, Yasuda (TNS); Prov. Hyogo, Tagawa L15 (TNS); Prov. Kozuke, Degelius As-1072 (Degelius herbarium); Prov. Mikawa, Takaki 353 (TNS); Prov. Musashi, Kurokawa 64279 (TNS); Prov. Mutsu, Kurokawa 55085 (TNS); Prov. Shimotsuke, Kurokawa 64057 (TNS); Prov. Shinano, Kurokawa 51758 (TNS, US), 59179 (TNS); Prov. Totomi, Nakanishi 27 (Kobe University); Prov. Ugo, Suzuki 272 (TNS).
17. Parmelina heteroloba

**Figure 14c**

*Parmelina heteroloba* (Zahlbruckner) Hale, 1974:482.

*Parmelina heteroloba* Zahlbruckner, 1909:171 [type collection: Mt. Itatiaya, Rio de Janeiro, Brazil, Schiffner (W, lectotype)].

**Description.**—Thallus adnate on bark, light buff mineral gray in the herbarium, 5–8 cm broad; lobes more or less sublinear, short and imbricate, becoming lobulate toward the center, 2–3 mm wide, the marginal cilia mostly in the lobe axils, to 0.4 mm long; upper surface shiny, plane to rugulose, becoming somewhat lobulate; lower surface black except for a narrow brown zone at the tips, densely rhizinate, the rhizines black, simple or sparsely furcate. Apothecia numerous, substipitate, the disc splitting, 2–9 mm in diameter; spores 8, 8 × 12 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla negative with color tests (an unidentified fatty acid and a faint unknown spot, perhaps related to one of the “horrescens” unknown).

**Distribution.**—Brazil.

**Remarks.**—Since this species is represented only by the single type collection, it is difficult to generalize on its affinities to other *Parmelinae*. It would probably be mistaken for *P. damaziana*, which has a different chemistry (“horrescens” unknown) and smaller spores. It is only one of three species in *Parmelina* with fatty acids, the others being *P. endoleuca* and *P. expallida*. *Parmelina heteroloba* has not been re-collected at Mt. Itatiaya, a well known site that has been visited by several experienced lichen collectors, and it may be an extinct species.

18. Parmelina horrescens

**Figure 14f**

*Parmelina horrescens* (Taylor) Hale, 1974:482.

*Parmelina horrescens* Taylor in Mackay, 1856:144 [type collection: Dunkerron Mountains, Kerry, Ireland, *Taylor* (FH-Tayl, lectotype)].

**Description.**—Thallus closely adnate to adnate on bark, rocks, or mosses over rocks, whitish to greenish mineral gray, 2–5 cm broad; lobes more or less dichotomously branched, sublinear, often crowded and imbricate, 0.5–2.0 mm wide, the margins cre-
nate, often becoming lobulate, ciliate, the cilia more or less evenly dispersed, black, simple, 0.3–0.8 mm long; upper surface shiny, emaculate, densely isidiate, the isidia cylindrical, often branched and apically spinulate or short-ciliate, in part becoming procumbent; medulla white; lower surface black, moderately rhizinate, the rhizines black, simple. Apothecia rare, sessile, 2–4 mm in diameter, the amphitheciun isidiate, the disc splitting at maturity; spores 8, 10–12 × 16–18 μm.

Chemistry.—Cortex K+ yellow (atranorin); medulla K−, C− or C+ faint rose, KC+ rose or red, P− (trace of gyrophoric acid, "horrescens" unknown falling above gyrophoric acid on chromatographic plates, and one or two other unidentified spots).

Distribution.—Pantemperate and montane pantropical.

Remarks.—As discussed under P. dissecta, this species only recently was differentiated correctly from P. dissecta (Hale and Kurokawa, 1962:2), an isidiate lichen with gyrophoric acid. Parmelina horrescens is characterized by dense fine isidia with greater or lesser development of short apical cilia (Figure 4c). The isidia sometimes become procumbent and lobulate. On the whole, the lobes are closely related depsides.

The chemistry of P. horrescens is now being studied by several lichen chemists. A number of unidentified spots appear in both hexane and benzene solvent systems, one of which is probably a trace of gyrophoric acid. The other spots fall above gyrophoric acid and seem to represent closely related depsides.

The parent morph of P. horrescens is probably extinct. Chemically identical P. damaziana, a non-isidiate Brazilian species, is larger and more robust although obviously from the same stock as the parent of P. horrescens. Among the parallel morphs, both pubulate-sorediate P. subfatisceiis and lobulate P. schindleri are very close in lobe configuration, adnation, and thallus texture.

Specimens Examined.—United States: Illinois, Shorepa 4627 (US); Kentucky, Hale 15743a; West Virginia, Hale 10612, 11772, 11878; Virginia, Hale 18388, 39153, Reed 9091 (Reed herbarium), Roller 400 (US); North Carolina, Calaburna 5114, 5706, 5744, 7134 (DUKE), Hale 18042, 15058, Imshaug 22174, 22178, 22555 (MSC, US); Tennessee, Hale 31106, 36921, 36959, 36970, Moore 284 (US), Phillips 328, 377 (US), Skorepa 5527 (US); South Carolina, Hale 7723; Georgia, Hale 7405, 7587, 16761, 16776, 30882, 30885; Alabama, Hale 7186, 7216, 31164, 35779, 35918, 34121, 34174, McCullough 2195 (US); Florida, Hale 21685 (for additional records see Moore, 1968:220). Mexico: Chiapas, Hale 20204, 20225, 20400a, 20414, 20529, 21086. Guatemala: Baja Vera Paz, Hale 45828. Pan- ama: Darien, Mori and Gentry 4309 (US); Panamá, Hale 38451. Cuba: Oriente, Imshaug 24737, 24810, 24932 (MSC). Jamaica: Imshaug 14216 (MSC). Dominican Republic: Cordil lera Central, Imshaug 23516 (MSC), Wetmore 3759 (MSC); La Vega, Allard 17695a (US). Haiti: Ouest, Fabius 2–4 (US), Imshaug 22768, 22837, 22860 (MSC, US), Wetmore 3222 (MSC); Sud, Imshaug 23283 (MSC, US); Venezuela: Distrito Federal, Dennis 2394 (BM), Santesson 6679 (S); Mirida, Hale 42038, 42067, 42952, 44121, 45201. Uruguay: Trientia y Tres, Osorio 5931 (MVM); France: Harmand (DUKE). Spain: Pontevedra, Schauer (M); Tenerife, Imshaug 34476, 35677 (MSC).


19. Parmelina immiscens

**Figure 16a**

Parmelina immiscens (Nylander) Hale, 1974:482.

Parmelina immiscens Nylander, 1885:606 [type collection: Orizaba, Mexico, Galeotti 6879 (PC, lectotype; islectotype in H, Nylander herbarium number 35674)].

Parmelina michoacanensis Bouly de Lesdain, 1914:7 [type collection: Jesús del Monte, Morelia, Michoacán, Mexico, Arsène 4156 (US, lectotype; islectotypes in COLO, DUKE, G, LE, and UPS)].

Description.—Thallus adnate on bark, pale tur- tle green, 5–10 cm in diameter; lobes subirregular and apically round, 2–6 mm wide, the marginal cilia mostly in the axils; upper surface plane, continuous, often pruinose near the tips; medulla sulphur yellow; lower surface densely rhizinate, short rhizinate and pale brown along the margins, the rhizines simple or squarrosely branched. Apothecia numerous, adnate, the disc pale, 2–7 mm in diameter; spores 8, 4–6 × 7–12 μm.

Chemistry.—Cortex K+ yellow (atranorin):
Figure 16.—Species of Parmelia: a, P. immiscens (Arsène 4456 in US); b, P. indica (Hale 43884); c, P. irrugans (Kurokawa 55342); d, P. jamesii (Du Rietz 3117:5 in US); e, P. leucotyliza (Hale 29402); f, P. lindmanii (Malme 450 in S). (Scale in mm.)
medulla K+, C+, KC+ more intensely yellow, P− (unidentified yellow pigments).

**Distribution.**—Mexico.

**Remarks.**—*Parmelina immiscens* is the only species in the genus endemic to Mexico. It occurs rather rarely on trees in open oak-pine forests in the arid highlands (2000–2400 m elevation). Although the medulla is distinctly yellow, no terpenes are produced. The pigment seems to be secalonic acid A but chromatographic tests are inconclusive. This species and its presumptive isidiate morph *P. Zindmanii*, therefore, are unrelated to *P. subaurulenta* and similar Asian species with a yellow medulla.

**Specimens Examined.**—Mexico: Durango, Cramer 1998 (KAN, US); Jalisco, Pringle 10706 (US); Oaxaca, Hale 20825.

### 20. Parmelina indica, new species

**Description.**—Thallus arcte adnatus, saxicola, obscure albo-cinereus, 2–3 cm latus, lobis sublinearisubus, contiguus, 0.8–1.2 mm latis, ciliis marginirregulariter dispersis, simplicibus, 0.1–0.3 mm longis, superne planus, continuus vel rimosus, nitidus, modice vel dense isidiatus, isidiis cylindricis vel leviter inflatis, praecipue simplicibus, usque ad 0.3 mm alitis; cortex superior 12 μm crassus, epicorticus, stratum gonidiale 15–18 μm crassum, medulla alba, 100–120 μm crassa, cortex inferior paraplectenchymatus, 12–14 μm crassus; subtus niger, dense rhizinosus, rhizinis nigris, simplicibus, 0.4 mm longis. Apothecia ignota.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin acid and associated terpenes, and secalonic acid A).

**Distribution.**—China and Japan.

**Remarks.**—This species has not been recognized by contemporary lichenologists or included in lists of Asian Parmelinae. It is characterized by the presence of the “aurulenta” terpene series, the thin, expanded thallus, and large apothecia (3–10 mm in diameter), invariably larger than those of *P. subaurulenta* (3 mm or less). The spores are slightly but not significantly larger than those in *P. subaurulenta*. As a rule, the size of apothecia will separate the two species. Two of Nylander's syntypes of *P. subaurulenta* (see “Specimens Examined” below) are actually *P. irrigans*.

*Parmelina irrigans* has a more restricted range than *P. subaurulenta*. It does not occur in India where *P. subaurulenta* is so common. It is, however, more frequent in Japan than one might expect from the specimens examined because I did not borrow the specimens at TNS for redetermination. Many annotated by me in 1964 in Tokyo as *P. homogenes* are probably this species.

**Specimens Examined.**—China: Montiguy (H. Nylander her-
22. *Parmelina jamesii*, new combination

**Figure 16d**


**Description.**—Thallus adnate on bark, rather fragile, whitish mineral gray, 5–10 cm broad; lobes sublinear, contiguous, 1.5–3.0 mm wide, the margins sparsely ciliate, the cilia irregularly dispersed, long; upper surface plane but becoming rugulose with age, shiny or becoming dull white pruinose at the tips, plane but soon becoming pustulate, the pustules breaking open and coalescing into large clumps without formation of soredia; medulla very pale salmon colored to white; lower surface black except for a dark brown zone at the tips, densely rhiizinate, the rhizines black and shiny, simple or sparsely squarrosely branched. Apothecia rare, substipitate, the amphithecum pustulate, 1–3 mm in diameter; spores 8, 6 × 11–12 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla K–, C–, KC–, P+ red (fumarprotocetraric acid and a trace of protocetraric acid).

**Distribution.**—Eastern Australia and New Zealand.

**Remarks.**—*Parmelina jamesii* is the only species producing β-orcinol depsidone fumarprotocetraric acid. It is also one of the few species endemic to the Australian region. It might be mistaken superficially for a *Hypotrachyna* except that the lobe margins are distinctly ciliate and the rhizines simple.

23. *Parmelina leucotyliza*

**Figure 16e**

*Parmelina leucotyliza* (Nylander) Hale, 1974:482.


**Description.**—Thallus adnate to loosely attached on bark or rocks, light greenish mineral gray, 8–12 cm broad; lobes sublinear to subirregular, contiguous, 2–4 mm wide, the marginal cilia mostly in lobe axils, about 0.5 mm long; upper surface shiny or becoming dull white pruinose at the tips, plane but soon becoming pustulate, the pustules squarrosely branched. Apothecia rare, substipitate, the amphithecium pustulate, 1–3 mm in diameter; spores 8, 6 × 11–12 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylin and related “subaurulenta” terpenes, secalonic acid A, and traces of unidentified substances).

**Distribution.**—Japan and Malaysia (Sabah).

**Remarks.**—Originally when studying the Japanese *Parmeliae*, I synonymized *P. leucotyliza* under *P. aurulenta*. These two species, however, are different in several important respects. First, they have different terpene chemistry. Second, the pustules of *Parmelina leucotyliza* do not become sorediate, whereas those in *P. aurulenta* are often densely sorediate. Lastly, *P. leucotyliza* is restricted to Japan except for a tentatively identified specimen from Sabah. It seems to be much more common than *P. aurulenta* in Japan, occurring on rocks and trees in open forests, trees along roads, and rocks in rice fields.

24. *Parmelina lindmanii*


**DESCRIPTION.**—Thallus adnate on bark, pale buff to yellowish mineral gray, 5–8 cm broad; lobes subirregular, apically rounded, 3–5 mm wide, the marginal cilia mostly in lobe axils, less than 0.5 mm long; upper surface plane to rugose with age, shiny, moderately to densely isidiate, the isidia cylindrical, unbranched, to 0.3 mm high; medulla uniformly pale sulfur-yellow tinged with orange; lower surface black except for a narrow marginal brown zone, moderately rhizinate, the rhizines black, simple. Apothecia rare, sessile, 2–5 mm in diameter; spores 8, 6–10 × 9–14 μm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla more intensely yellow with K and C, P– (probably secalonic acid A and unidentified pigments).

**DISTRIBUTION.**—Mexico and South America.

**REMARKS.**—This corticolous lichen is characterized by the pale yellow-orange medulla and the isidia. It is probably the isidiate morph of the Mexican endemic *P. immiscens*. When I first began study of *Parmelina*, I confused *Parmelina lindmanii* and *Parmelina endosulphurea* (= *Parmotrema endosulphureum*) (Hillmann) Hale (Hale, 1960:20). Both species have a yellow-orange medulla and isidia, but *P. lindmanii* has more adnate lobes, cilia in the axils, and no gyrophoric acid. Both species lack terpenes.


25. *Parmelina melanochaeta*

*Parmelina melanochaeta* (Kurokawa) Hale, 1974:485.

*Parmelia melanochaeta* Kurokawa in Hale and Kurokawa, 1964:133 [type collection: Santa Anna de Chapada, Mato Grosso, Brazil, *Malme* 2243 (S, lectotype; isolectotypes in UC, US)].

**DESCRIPTION.**—Thallus adnate on bark, turning olive-buff to cream-buff in the herbarium, 4–7 cm in diameter; lobes irregularly branched, sometimes sublinear-elongate, 2–6 mm wide, the margins more or less crenate, ciliate, the cilia black, mostly simple, 1–2 mm long; upper surface shiny, maculate, moderately to densely isidiate, isidia thin, cylindrical, usually branched, often with black spinules or short cilia; medulla white; lower surface black, dark to pale brown in a rather wide zone near the tips, moderately rhizinate, rhizines black to blackish brown, simple. Apothecia adnate to substipitate, 1–3 mm in diameter, the amphithecium isidiate, spinulate, the disc vandyke-brown; spores 8, 8–10 × 13–15 μm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla K–, C+, KC+ rose, P– (gyrophoric acid).

**DISTRIBUTION.**—South America.

**REMARKS.**—This species is very close to *P. dissecta* in general morphology and has the same chemistry. The lobes, however, are much broader, the isidia ciliate, the marginal cilia long and distinct, and the upper cortex strongly white-maculate. It occurs in a rather restricted area from Brazil into Paraguay with one specimen recorded from Colombia.


26. *Parmelina metarevoluta*


**DESCRIPTION.**—Thallus adnate on bark or rock, pale olive-buff, 2–6 cm in diameter; lobes dichotomously branched, sublinear-elongate, more or less ascending at the tips, 1–4 mm wide, lobules sometimes present on older lobes, the margins more or less crenate, narrowly black rimmed, ciliate, the cilia black, shiny, simple, 0.2–0.5 mm long; upper
Figure 17.—Species of Parmelina: a, P. melanochaeta (Malme 2243 in S); b, P. metarevoluta (Kurokawa 59180 in US); c, P. muelleri (Hale 42277); d, P. obsessa (Hale 19186); e, P. pastillifera (specimen in US); f, P. perisidians (Togashi in US). (Scale in mm.)
surface smooth and shiny, not maculate, more or less rugose on older lobes, sorediate, soralia subterminal, capitate, pale orange below; lower surface black, densely rhizinate; the rhizines black, shiny, simple, about 0.5 mm long. Apothecia very rare, adnate, 1–5 in diameter, the rim more or less crenate, sorediate, the disc dark brown; spores 8, 7 × 10–12 μm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla K+ reddish, C−, KC−, P+ orange (galbinic acid, rarely constictic acid, trace of salazinic acid, zeorin, leucotylin and associated terpenes, and secalonic acid A).

**DISTRIBUTION.**—Eastern United States, Japan, and China.

**REMARKS.**—As pointed out by Kurokawa (1968b: 351), this is the sorediate morph of *P. galbina*. It was first collected and correctly identified in the United States by Dr. Satoshi Nakanishi in 1971. Two additional collections have since been identified, one of them (Plitt 236) filed under Physcia orbicularis, which is very superficially similar in lobe configuration and capitate soralia. It has the same Arcto-Tertiary distribution pattern as *P. galbina* but is extremely rare in North America.

**SPECIMENS EXAMINED.**—United States: Ohio, Wetmore 18051 (MINN, US); Maryland, Plitt 236 (US); Tennessee, Nakanishi 238 (US); Japan: Prov. Bungo, Kurokawa 62529 (TNS); Prov. Ise, Asahina (TNS); Prov. Omi, Asahina (TNS); Prov. Shinano, Asahina (TNS). Kurokawa 59243 (TNS); Prov. Suruga, Asahina (TNS); Prov. Totomi, Asahina 160 (TNS); Prov. Yamashiro, Asahina (TNS). China: Manchuria, Asahina 29 (TNS).

27. **Parmelina muelleri**

![Figure 17c](image)


**Parmelina muelleri** Vainio, 1890:49 [type collection: Sitio, Minas Gerais, Brazil, Vainio in Lichenes Brasilienses Exsiccati 948 (TUR, Vainio herbarium number 2677, lectotype: isolecotypes in BM, FH, M, UPS)].

**DESCRIPTION.**—Thallus closely adnate on bark, lichen green, turning honey yellow in the herbarium, 5 cm or more in diameter; lobes irregularly branched, rounded at the tips, 2–3 mm wide, the margins evenly ciliate, the cilia simple or rarely branched, black, shiny, up to 1.5 mm long; upper surface strongly white-maculate, irregularly cracked on older lobes, sorediate, soredia laminal, more or less granular, the soralia round, separate; lower surface uniformly black, moderately rhizinate, the rhizines simple, black. Apothecia rare, sessile, the amphitheciun sorediate, disk brick red, 2–5 mm in diameter; spores 8, 7–10 × 12–15 μm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla K+ persistent yellow, C−, KC−, P+ pale orange (stictic acid with or without constictic acid).

**DISTRIBUTION.**—Mexico and South America.

**REMARKS.**—When I first collected this species on shade trees in a coffee plantation in Venezuela, I identified it tentatively as *P. pilosa* because of the laminal soralia and distinct white maculae. Chemical tests, however, showed that it contained stictic acid and would have to be identified with *P. muelleri*. After comparing the two species in the herbarium, I concluded that *P. pilosa* is larger and more robust on the average, but the two are very closely related. Vainio (1890) had in fact compared *P. muelleri* with Parmelia balansa f. sorediata (= Parmelina pilosa) which he distinguished with a negative K test. They have different geographic ranges, *P. muelleri* being more common in northern South America and possibly occurring at a higher elevation than *P. pilosa*. There is no esorediate, stictic acid-containing parent morph comparable to the *P. consors–P. pilosa* species pair.


28. **Parmelina obsessa**

![Figure 17c](image)


**Parmelina obsessa** Acharius, 1814:195. [type collection: North America (?Pennsylvania), Muhlenberg (H-Ach, lectotype; isolecotype in PH)].

**Parmelia finkii** Zahlbruckner in Hedrick, 1934:162 [type collection: Williamsville, Wayne County, Missouri, Russell (W, lectotype; isolecotype in MICHI)].

**DESCRIPTION.**—Thallus closely adnate on rock (rarely on bark), pale smoke gray to light mineral gray, 3–6 cm broad; lobes irregularly branched, sublinear, contiguous, 1–2 mm wide, the margins dissected, sparsely ciliate, especially in axils, the cilia black, simple, to 0.3 mm long; upper surface densely isidiate, the isidia cylindrical, sometimes
branched; medulla white to pale dull green-yellow; lower surface black, sparsely to moderately rhizinate, dark brown and short rhizinate near the tips, the rhizines simple. Apothecia adnate, 1–3 mm in diameter, the disc brown, the amphitheicum isidiate; spores 8, 4–5 × 6–10 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla K+, C+, KC+ red, P– (lecanoric acid).

**Distribution.**—Great Britain and Europe.

**Remarks.**—While this species has long been recognized as a distinct variety (Poelt, 1961:194), it was only recently raised to species level. Dobson and Hawksworth (1976) have compared it in detail with the normally isidiate *P. tiliacea*, finding that *P. pastillifera* has, on the average, somewhat narrower lobes (2–6 mm) than *P. tiliacea* (3–8 mm) and denser rhizines.2 *Parmelina pastillifera* also has a somewhat smaller, slightly more bluish thallus. The ecological differences are pronounced, for *P. pastillifera* occurred in England west of the 813 mm rainfall isopleth and the 2°C January mean isotherm. This agrees with Schauer’s (1965:80) definition of *P. pastillifera* as an oceanic species in central Europe.

**Specimens Examined.**—Europe: France, Lambinon in Lichenes Selecti Exsiccati 365 (LD, US); Germany, Schröppel in Lichenes Alpium 143 (US); Austria, Strasser in Cryptogamae Exsiccatae Vindobonensis 3062b (US); Yugoslavia, Vězda in Lichenes Selecti Exsiccati 762 (US).

30. Parmelina pastillifera

**Figure 17e**


*Parmelina pastillifera* (Nylander, 1900:6 [type collection: Rampodde, Ceylon, Almquist (S, lectotype; isolecotype in H, Nylander herbarium number 35673]).

*Parmelia subsulphurata* Asahina, 1951a:228 [type collection; Higashi-Shirakawa, Prov. Mino, Japan, Yasue (TNS, lectotype)].

**Description.**—Thallus adnate on bark, greenish mineral gray, 3–6 cm in diameter; lobes sublinear, 0.5–2 mm wide, the marginal cilia mostly in the axils; upper surface plane, continuous, densely isidiate, the isidia simple or branched; medulla sea-foam yellow; lower surface densely rhizinate, the rhizines black, simple or squarrosely branched. Apothecia adnate, 2–5 mm in diameter, the amphitheicum isidiate; spores 8, 5–7 × 7–11 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla K+, C+ KC+ more intensely yellow, P–, (zeorin, leucotylin and related terpenes, and secalonic acid A).

I wish to thank Dr. Hawksworth for allowing me to see his manuscript before publication.
DISTRIBUTION.—Southeast Asia from India to Japan.

REMARKS.—This densely isidiate species is closely related to *P. amagiensis* and may represent its isidiate morph, although differences in pigments, so far unresolved, may exclude this possibility. Both species have the typical “subaurulenta” terpene series. *Parmelina perisidians* has a broad distribution in the higher elevation forests of tropical Asia and the temperate forests of Japan.


31. *Parmelina phlyctina*

*Figure 18a*

*Parmelina phlyctina* (Hale), Hale, 1974:483.

*Parmelina phlyctina* Hale, 1959:129 [type collection: Blue Mountains, Jamaica, Imshaug 19908 (MSC, holotype: isotype in US)].

DESCRIPTION.—Thallus adnate to loosely adnate on bark, membranous and fragile, light mineral gray but turning pink in the herbarium if improperly dried, 5–15 cm broad; lobes subirregular, apically rotund, 5–10 mm wide, the margins entire to lobulate, sparsely ciliate in the lobe axils, the cilia up to 0.5 mm long; upper surface plane, smooth to rugose in older parts, upper cortex fragile and flaking off in small pieces, isidia and soredia lacking; lower surface black except for a narrow brown zone at the tips, sparsely rhizinate, the rhizines simple. Apothecia rare, adnate, 3–8 mm in diameter; spores 8, 3–5 × 7–8 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K+ yellow turning red, C−, KC−, P+ orange (norstictic and connorstictic acids).

DISTRIBUTION.—Mexico and the West Indies.

REMARKS.—Since my description of this species in 1959, additional collections have been made in Mexico, Cuba, and other islands in the West Indies. It occurs in wet upland rain forests or secondary mist forests. The main distinguishing features are the fragile thallus with a flaking cortex, presence of norstictic acid, and small spores. It is closely related to isidiate *P. antillensis* but is not the direct parent morph since *P. antillensis* has a continuous cortex. It is not, as implied in my original description, a member of *Amphigymnia* (= *Parmotrema*) because the thallus is adnate overall, cilia are produced in the axils, and the bare zone at the margins below is very narrow. Both *P. phlyctina* and *P. antillensis*, however, constitute an anomalous element in *Parmelina*, not only because of the somewhat amphigymnioid lobation but also because of the production of norstictic acid.


32. *Parmelina pilosa*

*Figure 18b*

*Parmelina pilosa* (Stizenberger) Hale, 1974:483.

* Parmelina pilosa* Stizenberger, 180:165 [type collection: Rhenoster River, Taibosch Kranz Mountains, Orange Free State, Union of South Africa, Rehmann (ZT, lectotype; isolecotype in H)].

*Parmelia balansae* var. *sorediata* Müller Argoviensis, 1888a:2 [type collection: Montevideo, Uruguay, Arechavaleta (G, lectotype)].

*Parmelia subbalansae* Gyelnik, 1931:288 (based on *Parmelia balansae* var. *sorediata* Müller Argoviensis).

DESCRIPTION.—Thallus adnate to loosely attached on bark, coriaceous, light buff mineral gray, 5–12 cm broad; lobes subirregular, apically subrotund, the marginal cilia coarse, becoming furcate, 0.5–1.0 mm long; upper surface shiny and heavily white-maculate, plane to minutely pitted, sorediate, the soralia orbicular, about 0.5 mm in diameter, separate or coalescing into extensive laminal sorediate areas; medulla white; lower surface black, densely rhizinate, coarse and fine rhizines intermixed, simple to sparsely furcate. Apothecia rare, substipitate; spores not seen.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla negative with color reagents (no substances demonstrated).

DISTRIBUTION.—South America and southern Africa.
Figure 18.—Species of Parmelina: a, *P. phlyctina* (Imshaug 13179 in US); b, *P. pilosa* (McOwan in US); c, *P. pruinata* (Kurokawa in *Lichenes Selecti Exsiccati* 81 in US); d, *P. quercina* (“carporrhizans” population) (Schröppel and Poelt in *Lichenes Alpium* 8 in US); e, *P. quercina* (Tavares 1082 in US); f, *P. rhytidodes* (Kurokawa 58601 in US). (Scale in mm.)
**Remarks.**—*Parmelina pilosa* is the sorediate morph of *P. consors*. It occurs on a variety of trees (*Celtis, Erythina, Scleria*), even on fence posts, and in open or secondary habitats up to 2000 m elevation. It must be distinguished carefully from *P. muelleri*, which rarely occurs in this range and contains stictic acid.

Specimens Examined.—Ecuador: Pichincha, Wiggins 38945 (COLO). Uruguay: Canelones, Felippeone 343 (G); Durazno, Osorio 2979 (DUKE); Flores, Osorio 3519 (MVM, US); Florida, Osorio 1299 (F); Minas, Osorio 2049, 2056 (MVM, US); Soriao, Rosengurth (H). Argentina: Buenos Aires, Grassi 719 (US), Santesson 75 (S), Schnyder (G), Venturi 2853 (SI); Cordoba, Giardelli 1025 (SI), Petersen 23 (S); Entre Rios, Santesson 126 (S, US); Salta, Fries 21 (S, James (BM), Lorentz (M). Chile: Valparaiso, Santesson 3084 (S). Kenya: Nyanza Province, Maas Geesteranus 4957 (L, US). Rhodesia: Höeg (TRH). Union of South Africa: Basutoland, Kofter (LD); Cape Province, Höeg (LD, TRH), Kofter (LD), McOwan (BM, US); Natal, Höeg (TRH).

### 33. Parmelina pruinata

**Figure 18c**


**Description.**—Thallus closely adnate on twigs, ashy white, 1–5 cm broad; lobes sublinear-elongate, variable, 1–3 mm wide, marginal cilia sparse, mostly in lobe axils, up to 0.5 mm long; upper surface plane to convex, rugulose, more or less pruinose; medulla white; lower surface black, sparsely rhi-zinate, the rhizines black, simple. Apothecia conspicuous, adnate, 2–4 mm in diameter, the disc often pruinose; spores 8, 7–8 × 10–12 µm.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla K–, C+, KC+ red, P– (lecanoric acid).

**Distribution.**—Australia and New Zealand.

**Remarks.**—This species is rather variable in lobe configuration and width but typically grows closely adnate on small twigs and branches of trees in arid scrub land. It has no apparent relation with *P. quercina*, the only other nonsorediate, lecanoric acid-containing species in the genus, characterized by much coarser lobes and white maculae in the cortex. Müller mentions “subtus alba” in his original description, but he was actually describing a *Physcia* species growing intermingled with the type. The marginal cilia are sparse and sometimes difficult to determine. It could, in fact, be misidentified as a *Pseudoparmelia* but no corticolous nonisidiate species of that genus with lecanoric acid are presently known.

**Specimens Examined.**—Australia: Australian Capital Territory, Kurokawa in *Lichenes Rariores Selecti Exsiccati* 81 (US), Leuthner (US); New South Wales, Boorman 1387, L1389 (NSW), Doing (L, US), McFean 6358 (COLO), Weber and McFean L–47913, L–49886 (COLO, US). Wilson 96 (NSW); Queensland, Guythert (BM); South Australia, Rogers 886 (US); Tasmania, Brait 1500b (US), James 2117 2125 (BM, US), Weymouth 65 (BM, US), 432 (BM); Victoria, Fison 6639, 7004 (US), James 223 (BM, US). New Zealand: Mason 90 (BM).

### 34. Parmelia quercina

**Figure 18d,e**


**Description.**—Thallus closely adnate on bark, rarely on rock, rather coriaceous, light olive-gray, sometimes turning olive-buff in the herbarium, 5–10 cm broad; lobes dichotomously or irregularly branched, sublinear, separate or becoming imbricate, 1.5–4.5 mm wide, the margins smooth to more or less crenate, often narrowly black rimmed,
moderately to densely ciliate, the cilia black, simple, 0.2–1 mm long; upper surface smooth and shiny, faintly to strongly white-maculate, irregularly rugose and cracked on older lobes, sometimes partly pruinose, isidia and soredia lacking; lower surface black, densely rhizinate, the rhizines black, shiny, simple or more rarely squarrose, 1–3 mm long. Apothecia numerous, substipitate, 1.5–5 mm in diameter, the amphithecium smooth or retrorse-rhizinate, the disc burnt umber; spores 8, 5–7 × 6–10 μm.

CHEMISTRY.—Cortex K+, yellow (atranorin); medulla K-, C+ KC+ red, P- (lecanoric acid).

DISTRIBUTION.—California, Europe, Pakistan, Nepal, eastern Asia, and Australia.

REMARKS.—As a common member of the European foliose lichen flora this was one of the first species of Parmelia to be described. The records from eastern North America previously identified as Parmelia quercina are now recognized as Parmelia gallina or Hypotrachyna livida (Taylor) Hale. The interesting distribution pattern, centered in western North America and Europe, is typical of the Mediterranean type, although the species occurs less commonly in eastern Asia and Australia. Still this is a remarkably broader range than its isidiate morph P. tiliacea.

The development of rhizines on the lower side of the apothecia has been used to justify a separate population, called Parmelia carporrhizans. As W. Culberson (1961:168) points out, however, virtually all specimens in California have these rhizines, and many European specimens identified as P. quercina are often found to have them, sometimes only very sparsely developed (Dobson and Hawksworth, 1976). This trait does not seem to warrant specific status, although Schauer (1965:71) found this population to have a strongly oceanic distribution pattern in western Europe. The problem will have to be solved through careful field studies in Europe.


Mostly with Retorse Rhizines on the Apothecia: United States: See W. Culberson (1961:172) for a list of specimens examined and a distribution map. Europe: England, Borrer (US), Crombie (BM, US), Holl 15 (BM), James 75 (BM); France, Crosals (US), Rondon in Lichenes Selecti Exsiccati 268 (US); Spain, Bausa (LD); Portugal, Tavares in Lichenes Lusitaniae Selecti Exsiccati 217 (US); Germany, Poelt in Lichenes Alpium 8; Switzerland, Barkman 3294a (US); Austria, Steiner in Cryptogamae Exsiccatae Vindobonensi 4134 (F, NY); Italy, Almborn (LD), Baumgartner in Cryptogamae Exsiccatae Vindobonensi 3165 (NY, US). Tunisia: Runemark (LD).

35. Parmelina rhytidodes, new species

FIGURE 18f

DESCRIPTION.—Thallus adnatus vel laxe adnatus, corticola et saxicola, pallide olivaceo-cinereus, 8–12 cm latus, lobis subirregularibus, imbricatis congestisque, 2–4 mm latis, margine irregulariter ciliatis, ciliis nigris, 0.3–0.6 mm longis; superne nitidus vel apicem versus albo-pruinosis, primum planus sed mox dense et omnino rugosus (Figure 16f), rugis non eruptentibus, cortice integro vel rare rumpente; cortex superior 12–14 μm crassus, epicorticatus, stratum gonidiale 14–16 μm crassum, medulla pallide salmonea, 110–150 μm crassa, cortex inferior brunneus, paraplectenchymatus, 15–17 μm crassus; subtus niger, dense rhizinosus, rhizinis nigris vel apice brunneis, simplicibus vel sparse squarrosamosis. Apothecia numerosa, sessilia vel substipitata, disco plano, 3–8 mm diametro; sporis 8, 9–11 × 12–14 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla more intensively yellow with color tests (zeorin, leucotylic acid and related terpenes, secasmonic acid A, and traces of unidentified substances).


DISTRIBUTION.—Japan and Nepal.

REMARKS.—After I had examined specimens identified as Parmelina entotheiochroa with thin-layer chromatography, there remained a small group with the "aurulenta" terpene profile. On further study I found that these are morphologically different from typical P. entotheiochroa in that the ridges which develop very densely do not burst open or
flake off. While *P. rhytidodes* can be recognized with practice from the external morphology alone, a chemical test is desirable for confirmation. The species is probably not as common in Japan as *P. entotheiochroa*, but I have not had the opportunity to re-examine the numerous specimens in TNS with chromatography. The collections made by Poelt in Nepal are tentatively placed here. They are very densely rugose and have crowded lobes, modified ecologically by the high exposed elevation where they were collected. *Parmelina rhytidodes* is apparently an offshoot with sorediate *P. aurulenta* from *P. irrugans* or a now extinct parent morph similar to it.


### 36. Parmelina schindleri, new species

**FIGURE 19a**

**DESCRIPTION.**—Thallus adnatus vel appressus, fragilis, corticola, pallide albo-cinereus, 2–4 cm latus, lobis sublinearibus, brevibus, contiguis, ca. 1–1.5 mm latis, margine ciliatis, ciliis 0.2–0.4 mm longis, simplicibus, margine et pro parte superficie lobulatis, lobulis congestis, suberectis, ramosis, 0.1–0.2 mm latis et usque ad 1 mm longis, margine breve ciliatis; superne nitidus, planus; cortex superior 14–15 µm crassus, epicorticus, stratum goniidiale 12 µm crassum, medulla alba, 50–65 µm crassa, cortex inferior paraplectenchymatus, 12 µm crassus; subtus niger, modice rhizinosus, rhizinis nigris, simplicibus vel sparse furtatis. Apothecia rara, sessilia, 3–4 mm diametro, sporis 8:nae, 4 x 6 µm. Apothecia rara, sessilia, 3–6 mm in diameter; spores 8, 4 x 6 µm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla K+, C-, KC-, P+ orange (salazinic acid).

**DISTRIBUTION.**—South India.

**REMARKS.**—*Parmelina schindleri* has a rather leathery thallus and very sparsely developed axillary cilia. As with many other Indian lichens it does not exhibit clear-cut traits that enable one to place it immediately in a particular genus. I had mentioned a possible relationship to isidiate *P. wallichiana*, which has much larger spores and a more membranous thallus, but these two species are not at all related. *Parmelina schindleri* grows on roadside trees in the Western Ghats region of India where an intense monsoon season from June to September alternates with a long period of almost total drought. *Parmelina wallichiana*, on the other
Figure 19.—Species of Parmelina: a, P. schindleri (Vainio 1284 in BM); b, P. simplicior (Awasthi 4056 in US); c, P. spathulata (Almborn 9516 in US); d, P. spumosa (Hale 42934a); e, P. subaurulenta (Hale 43703); f, P. subfattiscens (Hale 35094). (Scale in mm.)
hand, occurs at higher elevations with less climatic stress.

**Specimens Examined.**—India: Maharashtra, Hale 40004, 40007, 40046, 40090, 48972.

### 38. Parmelina spathulata

*Parmelina spathulata* (Kurokawa) Hale, 1974:483.

**Description.**—Thallus adnate on bark, pale whitish glaucous-green, fragile, 2–5 cm broad; lobes sublinear, crowded, 1–3 mm wide, the marginal cilia evenly dispersed, about 0.5 mm long; upper surface plane, continuous, moderately isidiate, the isidia initially cylindrical and erect but soon becoming procumbent and flattened; lower surface simple to rarely furcate. Apothecia not seen.

**Chemistry.**—Cortex K+ yellow (atranorin); medullula K−, C+ rose, KC+ red, P−, (gyrophoric acid, an unidentified pigment, and frequently a white fluorescent spot).

**Distribution.**—Pantropical at higher elevations.

**Remarks.**—This widespread but rather rare species is characterized by the dense, erupting but nonsorediate pustules (Figure 5e,f) and the pale yellowish medulla. The main constituent, gyrophoric acid, places it in the *P. dissecta* group, but it probably represents a different line of evolution from a now extinct parent morph (Figure 9). The chemistry is somewhat aberrant from *P. dissecta* and related species judging by the presence of a white UV-fluorescent spot in more than half of the specimens (including the lectotype) from both the New World and the Old World. The spot is not reactive with H₂SO₄, and its identity is not known.

**Parmelina spumosa** has ecological requirements similar to those of *P. dissecta* and *P. horrescens*. Much less common at temperate latitudes than the latter two, it grows throughout the tropics on exposed trees (hardwoods and conifers) and more rarely on rocks in forests up to 2500 m elevation.


### 39. Parmelina spumosa


**Description.**—Thallus closely adnate on bark, fragile, pale olive gray, 2–6 cm in diameter; lobes sublinear, 0.5–2 mm wide, the marginal cilia distinct and evenly dispersed, about 0.5 mm long; upper surface plane, continuous, emaculate, densely pustulate-isidiate, the pustules bursting but not becoming sorediate; medulla faintly yellow; lower surface moderately rhizinate, black, the rhizines simple or furcate. Apothecia rare, adnate, 1–5 mm in diameter, the amphithecial pustulate; spores 8, 7–8 × 12–14 μm.

**Chemistry.**—Cortex K+ yellow (atranorin); medullula K−, C+ rose, KC+ red, P−, (gyrophoric acid, an unidentified pigment, and frequently a white fluorescent spot).

**Distribution.**—Pantropical at higher elevations.

**Remarks.**—This widespread but rather rare species is characterized by the dense, erupting but nonsorediate pustules (Figure 5e,f) and the pale yellowish medulla. The main constituent, gyrophoric acid, places it in the *P. dissecta* group, but it probably represents a different line of evolution from a now extinct parent morph (Figure 9). The chemistry is somewhat aberrant from *P. dissecta* and related species judging by the presence of a white UV-fluorescent spot in more than half of the specimens (including the lectotype) from both the New World and the Old World. The spot is not reactive with H₂SO₄, and its identity is not known.

**Parmelina spumosa** has ecological requirements similar to those of *P. dissecta* and *P. horrescens*. Much less common at temperate latitudes than the latter two, it grows throughout the tropics on exposed trees (hardwoods and conifers) and more rarely on rocks in forests up to 2500 m elevation.


### 40. Parmelina subaurulenta

**Parmelia subaurulenta** Nylander, 1885:606 [type collection: Narkanda, N. W. Himalayas, India, Skotlichza (H, Nylander herbarium number 35672, lectotype)].

**Parmelia homogenes** Nylander, 1885:607 [type collection: India, Hooker and Thomson 1942 (H, Nylander herbarium number 35664, lectotype)].

**Parmelia conspicua** Hue, 1899:145 [type collection: Kiao Che-Tung, above Kiang-Yn, Yunnan, China, Delavay (PC, lectotype)].

**Parmelia homalotera** Hue, 1899:159 [type collection: above Mo-So-Yn, Yunnan, China, Delavay (PC, lectotype)].

**Parmelia secunda** Hue, 1899:169 [type collection: Ta-Pin-Tze, Yunnan, China, Delavay 5 (PC, lectotype)].

**Parmelia subcrenata** Zahlbruckner, 1934b:208 [type collection: Between Muli Gomba, Baorong, and Wa-Erh-Dje, Setchwan, China, Rock 16720 pro parte (W, lectotype)].

**Parmelia subaurulenta** var. myriocarpa Asahina, 1951a:227 [type collection: Mt. Koya, Prov. Kii, Japan, Inumaru 1232 (TNS, lectotype)].


**Parmelia myriocarpa** (Asahina) Chao, 1964:149.

**Parmelia homogenes** (Nylander) Hale, 1974:482.

**Description.**—Thallus adnate to closely adnate on bark, light greenish mineral gray, rather fragile, 4–10 cm broad; lobes sublinear, subimbriicate, 2–4 mm wide, the marginal cilia quite dense in the axils, irregularly dispersed at the lobe tips, 0.4–0.7 mm long; upper surface plane, faintly maculate, shiny, isidia and soredia lacking; medulla pale orange-yellow; lower surface densely rhizinate, the rhizines simple or becoming squarrosely branched. Apothecia very numerous, adnate, 1–3 mm in diameter; spores 8, 6–10 × 8–14 μm, usually abundantly developed.

**Chemistry.**—Cortex K+ yellow (altrnorin); medulla more intensively yellow with color tests (zeorin, leucotylin and associated terpenes, secalonic acid A, and traces of unidentified substances).

**Distribution.**—Eastern Asia from India to Japan.

**Remarks.**—**Parmelia subaurulenta** is characterized by a thin thallus (average thickness for 20 specimens 154 μm), numerous apothecia rarely exceeding 3 mm in diameter, and well developed spores 6–9 × 8–12 μm. Nylander (1885:607) described **Parmelia homogenes** at the same time on the basis of a single specimen, citing as the main difference spore size ("similis subaurulenta ... sed sporis majoribus"). Nylander measured spores 8–10 × 14–16 μm but my own measurements on the type specimen gave 7–8 × 12–13 μm, putting it well within the range of spore size for **Parmelia subaurulenta**. Without a significant difference in spore size, **P. homogenes** must be regarded as a synonym of **P. subaurulenta**.

The species most often confused with **P. subaurulenta**, especially outside of India, is **P. irrigans**, which has consistently larger apothecia (up to 10 mm in diameter), somewhat larger spores, and the "aurulenta" terpene series. Two of Nylander's syntypes for **Parmelia subaurulenta** are, in fact, **P. irrigans**, as discussed above under that species. All specimens should be tested with chromatography, although diameter of the apothecia is often adequate to separate the species in this group. All type specimens listed in the synonymy above were tested with thin-layer chromatography except for **Parmelia conspicua** Hue, which is placed here on the basis of the small apothecia.

**Specimens Examined.**—Nepal: Poelt 156 (M), India: Sikkim, Hava et al. (TNS, US); Tamil Nadu. Degelius As-552 (Degelius herbarium). Hale 40214, 43705, 43761, 43834.


### 4.1. Parmelia subfascicata

**Figure 19f**

**Parmelia subfascicata** (Kurokawa) Hale, 1974:483.


**Description.**—Thallus closely adnate on bark, fragile, whitish mineral gray, 3–7 cm broad; lobes sublinear-elongate, separate to contiguous, 0.5–1.5 mm wide, the marginal cilia distinct, simple to 1.0 mm long; upper surface plane, shiny, continuous, pustulate laminally and subterminally (Figure 5c), exposed medulla in center of pustules turning black, pustules remaining entire or producing very coarse sorediate or isidiate-sorediate masses, often short ciliate in African material but very rarely so in the New World; medulla white; lower surface black, densely rhizinate, the rhizines simple, black. Apothecia rare, adnate, 1.5–4.0 mm in diameter; spores 8, 8–9 × 12–14 μm.
48. Parmelina swinscowii

**Figure 20a**

*Parmelina swinscowii* (Hale) Hale, 1974:488.

**Description.**—Thallus growing on soil or over mosses on soil, loosely attached, whitish mineral gray or darkening, fragile, 3–5 cm broad; lobes sublinear-elongate, imbricate, 1.5–2.0 mm wide, the margins sparsely ciliate, the cilia black, simple, about 0.5 mm long; upper surface plane to convex, shiny, becoming rugose and cracked toward the lobe tips, the tips remaining entire or becoming minutely dissected, turning coarsely pustulate-sorediate; medulla white; lower surface black, densely rhizinate, the rhizines black, simple. Apothecia unknown.

**Chemistry.**—Cortex K+ yellow (atranorin); medulla K−, C−, KC+ rose, P− (trace of gyrophoric acid and the “horrescens” unknown substances).

**Distribution.**—South Africa and the Caribbean region.

**Remarks.**—The pustules of *P. subfatiscens* (Figure 5c) often erupt, leaving a central area of exposed medulla that blackens. Other pustules become coarsely sorediate with the soredia sometimes assuming the form of tiny isidia-like masses. The specimens from Africa usually produce short cilia on these isidioid masses and on the surface of the pustules. The tropical American population very rarely has any cilia. The chemistry of the neotropical and African populations is, as far as I can determine, within the limits of the solvent systems available, identical and equivalent to that in *P. horrescens*. Dey (1975:483) suggests that the neotropical specimens, along with some from the southern Appalachian Mountains in the United States, may represent a new species, based in part on the absence of cilia on the pustules. It is also true that the ecological requirements seem to be different. The neotropical specimens were all collected in upland virgin rain forest at or above 500 m elevation, whereas the African localities are in much drier forests. I prefer to keep a broader species concept until more complete morphological and ecological data can establish the case one way or the other.

**Specimens Examined.**—Panama: Cocle, Hale 43564. See Hale (1971a:24) for additional records from Dominica.

**43. Parmelina tiliae**

**Figure 20b**


**Lichen tiliae** Hoffmann, 1784:96, pl. 16: fig. 2 [type collection: Europe (not seen but illustrated in Hoffmann)].

**Lichen scorteus** Acharius, 1798:119 [type collection: Sweden (H-Ach, lectotype)].

**Parmelina tiliae** (Hoffmann) Acharius, 1803:215.

**Imbricaria tiliae** (Hoffmann) Koerber, 1855:70.

*Parmelia quericitata* var. *microphylla* Massalongo, 1856:175 [type collection: Campofontana, Verona, Italy, Massalongo in *Lichenis Ital.* 329 (UPS, lectotype)].


Figure 20.—Species of Parmelia: a, P. swinscowii (Swinscow K 3133 in US); b, P. tiliacea (Sampaio in Lichenes de Portugal 250 in US); c, P. usambarenisis (Santesson 10632 in US); d, P. versiformis (Lorentz and Hieronymus in MI); e, P. wallichiana (Santesson 21339 in US); f, P. xantholepis (Hale 43862). (Scale in mm.)
DESCRIPTION.—Thallus adnate on bark or rock, light mineral gray to mineral gray, turning olive-buff to deep olive-buff in the herbarium, 5–15 cm or more in diameter; lobes irregularly branched, sublinear-elongate, often imbricate, rounded at the apices, 2–6 mm wide, the margins more or less crenate and undulate, sometimes narrowly black rimmed, ciliate, the cilia black, coarse, shiny, simple, 0.2–0.7 mm long; upper surface more or less shiny, white maculate, usually partly pruinose, irregularly cracked on older lobes, densely isidiate, the isidia cylindrical, short, rarely branched, usually blackening at the tips; medulla white; lower surface black, moderately to densely rhizinate, rhizines black, simple, 1–2 mm long. Apothecia rare, adnate, sometimes retrolessly rhizinate, to 4 mm in diameter; spores 8, 5–6 × 8–11 μm.

CHEMISTRY.—Cortex K+ yellow (atranorin); medulla K−, C+, KC+ red, P− (lecanoric acid).

DISTRIBUTION.—Europe to western India.

REMARKS.—This classical European species was the first Parmelina to be described. Except for the nomenclatural confusion with Acharius’ Parmelia scorta, it has been correctly identified by all lichenologists, excluding, of course, those in America, who used the name for Parmelina galbina. Hypotrachyna liuida (Taylor) Hale, and other narrow-lobed lichens.

Parmelina tiliaeae is the isidiate morph of P. quercina, which, surprisingly, has a much broader geographic range, contrary to the situation for most species pairs. A close relative in Britain and Europe is P. pastillifera, which has peltate isidia and different ecological requirements (Dobson and Hawksworth, 1976). Taken together, the three species form a distinct group in Parmelina characterized by the white maculae and presence of lecanoric acid. Only one other species in the genus, P. pruinata, contains this acid.

As one of the commonest Parmelinioid lichens in Europe, P. tiliaeae has been mentioned and studied in detail by many workers. Sernander-Du Rietz (1926), for example, found that it tends to occur in ornithocorous or dust-laden habitats in Scandinavia. She later conducted a careful study of apothecial formation, showing that growth of new apothecia could be correlated with heavy precipitation in warm periods of the summer (Sernander-Du Rietz, 1957).

SPECIMENS EXAMINED (selected).—Europe: England, Crombie (BM), Davies (BM), Larbalesitter 292 (BM); Norway, Höeg (US), Magnusson 9195 (US); Sweden, Almborn (LD), Asplund (US), Blomberg in Lichenes Sueciae Exsiccati 64 (LD), Sanesson 12711 (US), Prang in Kryptogamae Exsiccatae Vindobonensi 5718 (LD, US); Finland, Kari in Lichenes Fenniae Exsiccati 194, 1103 (H), Linkola in Lichenes Fenniae Exsiccati 992 (H, US); Poland, Glanc in Lichenotheca Polonica 171 (UPS); Russia, in Lichenotheca Rossica 17 (WIS), Oxner (US); Bulgaria, Satala (US); France, Crousals (US), Rondon in Lichenes Selecti Exsiccati 440 (US); Germany, Erichsen (US), Hillmann in Kryptogamae Exsiccatae Vindobonensi 3062 (US), Paul and Schröppel in Lichenes Alpini 9 (US); Czechoslovakia, Pištut in Lichenes Slovakiæ Exsiccati 75 (US); Spain, Coberson 11594 (DUKE, US); Portugal, Sampio in Lichenes de Portugal 250 (US); Italy, Steiner in Kryptogamae Exsiccatae Vindobonensi 4527 (US). Israel: Pharal 11 (US), Tunisia: Runemark (LD). Morocco: Ernst 2206 (US), Newboulia 198 (BM). Bahrain: Ahmad L-162 (L, US). Pakistan: Iqbal 180 (L), 511,540 (US). India: Kashmir, Kapoor 991 (Awasthi herbarium), Kaul 4006 (Awasthi herbarium), Watt 117, 455 (BM).

44. Parmelina usambarensis

Figure 20c

Parmelina usambarensis (Steiner and Zahlbruckner) Hale, 1964:483.

Parmelina usambarensis Steiner and Zahlbruckner in Zahlbruckner, 1926:524 [type collection: Lutindi, Tanzania, Brunnthaler (W, lectotype)].

Parmelina laevigatae des Abbayes, 1951:970 [type collection: Fouta-Djalon, Dalaba, Guinea, des Abbayes (REN, lectotype)].

DESCRIPTION.—Thallus loosely attached on rock, whitish mineral gray, to 10 cm broad; lobes broadly sublinear, divergent to contiguous, 2–5 mm wide, the marginal cilia irregularly dispersed but mostly in the lobe axils, up to 1 mm long; upper surface shiny, plane, continuous or cracking in older parts, sparsely to densely isidiate, the isidia cylindrical, simple to branched, to 0.4 mm high; medulla white; lower surface black and shiny except for a narrow dark brown zone at the tips, moderately to sparsely rhizinate, the rhizines black, simple, 1 mm or more long. Apothecia rare, substipitate, the amphitheciun isidiate, 2–8 mm in diameter; spores 8, 6 × 12 μm.

REMARKS.—Parmelina usambarensis is a rather large, loosely attached, saxicolous lichen. The isidia are often quite sparse. It does not conform perfectly to the concept of Parmelina as I define the genus, but the simple rhizines and coarse, long marginal
cilia at least remove it from Hypotrachyna (Vainio) Hale. On the other hand, it cannot be accommodated in Parmotrema Massalongo because of the sublinear subdivaricate lobes. There are no close relatives, except very superficially, the African endemic Parmelina enormis.


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**45. Parmelina versiformis**

**Figure 20d**


Parmelina mutata Vainio, 1890:99 [type collection: Sitio, Minas Gerais, Brazil, Vainio in Lichenes Brasilienses Exsiccati 539 (TUR, lectotype: islectotypes in BM, FH, UPS)].

Parmelia catharinensis Müller Argoviensis, 1891:259 [type collection: Near Santa Catarina, Brazil. Ule 1891 (G, lectotype: islectotype in G)].

Parmelia weiststeinii Zahlbruckner, 1900:173 [type collection: Near Taipas, São Paulo, Brazil, Schiffner and Wettstein (W, lectotype: islectotype in G)].

**Description.**—Thallus adnate to loosely adnate on bark, turning deep olive-buff in the herbarium, about 8 cm in diameter; lobes irregularly branched, sublinear-elongate, more or less imbricate, 2–8 mm wide, the margins crenate, ciliate mostly in lobe axils, the cilia often sparse, to 0.5 mm long; upper surface more or less shiny, not maculate, wrinkled and irregularly cracked on older lobes, soredia and isidia lacking; medulla white; lower surface dark brown to black rather than entirely black. The closest relative appears to be the Asian Parmelia weiststeinii, an isidiate species with smaller spores (Kurokawa, 1968a:192). Although Parmelia versiformis occurs in a botanically well-known region, it has not been collected since 1901.

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**46. Parmelina wallichiana**

**Figures 20e, 21**


Parmelia tiliae var. eximia Steiner, 1888:138 [type collection: Usambara, Tanzania, Meyer (G, lectotype)].

Parmelia junodii Steiner, 1907:640 [type collection: Sana-torium, Cape Province, Union of South Africa, Junod 978 (G, lectotype)].

Parmelia nimandairiana Zahlbruckner, 1934a:55 [type collection: Mt. Arisan, Taiwan, Asahina 63 (W, lectotype: islectotype in TNS)].


**Description.**—Thallus adnate to loosely adnate on bark or rock, yellowish glaucous to pale glaucous-green, 5–20 cm in diameter; lobes irregularly branched, apically rotund, 3–10 mm wide, the margins more or less crenate, lobulate with age, short ciliate, especially in the axils, the cilia about 0.5 mm long; upper surface shiny, not maculate, irregularly cracked on older lobes, sparsely isidiate, spores 8, 8–10 μm thick. Parmelia weiststeinii, an isidiate species with very unusual in having very large spores with a thick episporium as well as a lower surface that is dark brown to black rather than entirely black. The closest relative appears to be the Asian Parmelia weiststeinii, an isidiate species with smaller spores (Kurokawa, 1968a:192). Although Parmelia versiformis occurs in a botanically well-known region, it has not been collected since 1901.

**Distribution.**—South America.

**Remarks.**—This is the only species of Parmelina in the New World with salazinic acid, excepting rare Parmelina wallichiana. It is also unusual in having very large spores with a thick episporium as well as a lower surface that is dark brown to black rather than entirely black. The closest relative appears to be the Asian Parmelia weiststeinii, an isidiate species with smaller spores (Kurokawa, 1968a:192). Although Parmelia versiformis occurs in a botanically well-known region, it has not been collected since 1901.

**Distribution.**—Africa and Asia (Figure 21).

**Remarks.**—This is the most widespread and com-
monly collected *Parmelina* in the Old World. It is easily recognized by the adnate, moderately isidiate thallus that grows in a variety of habitats in the highlands of Africa, India, and eastern Asia, ranging from temperate Japan to both higher elevations in the tropics and to rather low elevations near the equator in Guinea and the Ivory Coast. The parent morph is no longer extant nor are the parallel sorediate or pustulate morphs.

47. *Parmelina xantholepis*

**FIGURE 20f**

*Parmelina xantholepis* (Montagne and van den Bosch) Hale, 1974:438.

*Parmelina xantholepis* Montagne and van den Bosch, 1855:428 [type collection: Gode, Java, Teydom (L, lectotype)].

*Parmelia biformis* Vainio f. dataensis Vainio [= f. biformis], 1909:660 [type collection: Mt. Data, Luzon, Philippines, Merrill 4987 (TUR, Vainio herbarium number 2607, lectotype)].

*Parmelia biformis* f. pauniensis Tainio, 1909:660 [type collection: Pauai, Benguet, Luzon, Philippines, Mearns 4454 (TUR, Tainio herbarium number 2605, lectotype)].

**DESCRIPTION.**—Thallus adnate on bark or rock, yellowish mineral gray, very fragile, 4–15 cm broad; lobes sublinear to subirregular, 1–3 mm wide, crowded, dissected, the marginal cilia coarse, 0.2–0.8 mm long; upper surface plane, maculate, becoming densely lobulate toward the lobe margins, isidia and soredia lacking; medulla barium yellow; lower surface black, densely rhizinate, the rhizines black, long, simple or squarrose. Apothecia adnate, 1–3 mm in diameter; spores 6–8 × 9–13 μm.

**CHEMISTRY.**—Cortex K+ yellow (atranorin); medulla more intensively yellow with K and C, P- (zeorin, leucotylin and related terpenes, and seca-lionic acid A.)

**DISTRIATION.**—India and Nepal to the Philippines.

**REMARKS.**—This species is easily identified by the fragile, lobulate thallus with a pale yellow-orange medulla. It is closely related to the *P. amagiensis-P. denegans* series, definitely in chemistry but less so in thallus texture. It is usually collected at the base of trees or on rocks, often growing among mosses, at higher elevations (1000–2300 m) in evergreen hardwood cloud forests.


**Doubtful and Rejected Names**

*Parmelia coilocarpa*

*Parmelia coilocarpa* Stirton, 1877-78:202 [type collection: Fernando Po, West Africa. G. Thomson (BM, lectotype; GLAM, islectotype)].

The type material is too fragmentary for adequate study. It is a nonsorediate, nonisidiate, subirregularly lobed species with a black lower surface, simple rhizines, and numerous marginal cilia. The spores are large, 15 × 28 μm. Atranorin and salazinic acid are present. It is almost certainly a *Parmelina*, and its status will only be clarified as more collections are made in West Africa.

*Parmelia orchidophila*

*Parmelia orchidophila* Dodge, 1953:374 [type collection: Nyinabitsa, Western Province, Uganda, Onasiti 1184 (BM, lectotype)].

The type collection is too fragmentary for study. Salazinic acid was proved microchemically. It may be *Parmelina wallichiana* (Taylor) Hale.

*Parmelia tilicea* var. *leucina*

*Parmelia tilicea* var. *leucina* Müller Argoviensis, 1880:267 [type collection: Near Petropolis, Brazil, Deventer (G, lectotype)].

This variety is equal to *Hypotrachyna dactylifera* (Vainio) Hale (Hale, 1975a:30).

*Parmelia tilicea* var. *rimulosa*

*Parmelia tilicea* var. *rimulosa* Müller Argoviensis, 1882:458 [type collection: Socotra, Balfour (G, lectotype)].

No type specimen could be located at Geneva. One of two specimens so labeled by Müller is *Parmotrema reticulatum* (Taylor) Choisy, and the other is *Pseudoparmelia carneopruinata* (Zahlbruckner) Hale.

*Parmelina baguiensis*

*Parmelina baguiensis* (Hale) Hale, 1974:482 [type collection: Baguio, Mountain Province, Philippines, Hale 26768 (US, holotype)].

Closer examination of this sorediate species convinced me that it is a member of the genus *Hypotrachyna* (*H. baguiensis* (Hale) Hale, new combination). The rhizines are rather sparse but clearly
dichotomously branched at maturity. In any event, the chemistry—fumarprotocetraric acid—was anomalous for Parmelina, and this was the first clue to its correct generic status.

**Parmelina carporrhizans**

*Parmelina carporrhizans* (Taylor) Hale, 1974:482.

I now consider this to be a synonym of *Parmelina quercina*.

**Parmelina crystallorum**

*Parmelina crystallorum* (Lynge) Hale, 1974:482.

This species is synonymized under *Parmelina damaziana*.

**Parmelina homogenes**

*Parmelina homogenes* (Nylander) Hale, 1974:482.

I have placed this species in synonymy under *Parmelina subaurulenta*.

**Parmelina nylanderi**

*Parmelina nylanderi* (Lynge) Hale, 1974:483.  
*Parmelina nylanderi* Lynge, 1914:82 [type collection: Near São Jeronymo, Serra da Chapada, Mato Grosso, Brazil, Malme 2747 (S, lectotype)].

I originally considered this loosely attached saxicolous lichen to be a member of *Parmelina*, but after examining a second collection (*Eiten 3429* (US) from São Paulo, Brazil), I now feel that the chemistry (usnic acid in the cortex and salazinic and gyroploric acid in the medulla) and general habit, in spite of the narrow ciliate lobes, place it more appropriately in *Parmotrema* (*P. nylanderi* (Lynge) Hale, new combination). It is related to the much broader lobed *P. delicatulum* (Vainio) Hale group so common on sandstone in South America.
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