A MONOGRAPH OF PARMELIA SUBGENUS AMPHIGYMNIA

By Mason E. Hale, Jr.

Introduction

Parmelia has strangely been overlooked in the recent burst of monographic activity in lichens. It is a common, easily recognized foliose genus, well represented in most herbaria, with over 1,000 names in the literature. Traditionally the European lichenologists have passed it over as an "easy" genus and concentrated on the more difficult crustose groups. It must be understood, of course, that Europe has a very poor *Parmelia* flora, especially in Amphigymnias, certainly not one to attract the attention of a serious monographer.

This monograph deals only with subgenus *Amphigymnia* (Vain.) Dodge, a remarkably homogeneous group of 106 species. Studies are concurrently under progress on subgenus *Parmelia* (Hale & Kurokawa, 1964) and subgenus *Xanthoparmelia* (Vain.) Hale, two distinct groups with approximately 275 and 80 species, respectively. As here delimited, *Amphigymnia* is characterized by broad, more or less rotund lobes, 6 to 20 mm. wide, bearing unbranched, often sparse and coarse rhizines on the lower side, with a broad distinct bare zone around the margins. The apothecia are typically pedicellate and rather often have perforate discs, characters virtually unknown in other groups of the genus. The species are not difficult to separate; characters of an absolute or qualitative nature predominate. There is little of the troublesome intergradation between species that makes genera such as *Usnea* or *Collema* so difficult.

Some overlap and intergradation occurs between a few *Amphigymnia* species and those of subgenus *Parmelia*, especially sections *Irregulares* (Vain.) Vain. and *Cyclocheila* (Vain.) Räs., which may have rotund (not linear) lobes and a distinct though narrow, bare zone below. An excellent example is *P. caperata* (L.) Ach., a well-known species formerly placed in subgenus *Amphigymnia* but apparently better put into subgenus *Parmelia* (cf. Hale & Kurokawa, 1964). As a result, we have relieved ourselves of these problems here and concentrated in subgenus *Amphigymnia* a very homogeneous group of species.

The methods of study in this monograph were first to survey the literature as completely as possible and second to examine as many holotypes as possible. Most of the original descriptions were reproduced by photostat and assembled in notebooks for rapid reference. All references were taken from the original publications. Proper citations of the specimens and the location of the types were determined and the available type specimens examined.

Personal fieldwork has included studies of the flora in much of the United States, especially from Virginia to Texas, eastern Canada, and southern Mexico. About half of the 106 species were actually observed in the field. Fortunately, contemporary lichenologists have made extensive and excellent collections in the West Indies (Plitt, Imshaug, Wetmore), Chile (Santesson), Africa (Almborn, Degelius, des Abbayes, Maas Geesteranus, Höeg), Java (Groenhart), and Japan (Asahina, Kurokawa). The most serious gaps are in tropical South America, Australia, the Philippines, Borneo, New Guinea, and China. It is estimated that exhaustive fieldwork would turn up another 10 or 20 new species, but it is doubtful that the subgenus will ever be found to contain more than 130 species, at least as delimited by the presently used taxonomic criteria.

The following curators and directors have kindly loaned type specimens and other valuable collections: Dr. Sten Ahlner (Naturhistoriska Riksmuseet, Stockholm), Dr. Reino Alava (Botanical Institute, Turku), Dr. Ove Almborn (Botanical Museum, Lund), Dr. Y. Asahina (Research Institute for Natural Resources, Tokyo), Dr. Charles Baehni (Conservatoire et Jardin Botaniques, Geneva), M. P. Bourrelly (Muséum National d'Histoire Naturelle, Paris), E. H. Bryan (Bernice P. Bishop Museum, Honolulu), Dr. A. Burkart (Instituto de Botánico Darwinion, San Isidro), M. Choisy (Lyon), M. Skytte Christiansen (Botanical Museum, Copenhagen), Dr. G. Cufodontis (University of Vienna, Vienna), Dr. W. L. Culberson (Duke University, Durham), Dr. H. des Abbayes (Université de Rennes, Rennes), Dr. Henry Imshaug (Michigan State University, East Lansing), Mr. Peter James (British Museum, London), Dr. A. Kostermanns (Herbarium Bogoriense, Bogor), Dr. I. M. Lamb (Farlow Herbarium, Cambridge), Dr. R. A. Maas Geesteranus (Rijksherbarium, Leiden), Dr. P. J. Greenway (The East African Herbarium, Nairobi), Dr. J. Millar (Chicago Natural History Museum, Chicago), Dr. G. Moggi (Istituto Botanico, Firenze), Dr. E. Müller (Institut für Spezielle Botanik, Zürich), C. E. Palmar (Glasgow Art Gallery and Museums, Glasgow), Dr. J. Poelt (Botanische Staatssammlung, Munich), Dr. K. Rechinger (Naturhistorisches Museum, Vienna), Dr. C. Rizzini (Jardim Botanico, Rio de Janeiro), Dr. W. Robyns (Jardin Botanique, Bruxelles), Dr. C. Rogerson (New

York Botanical Garden, New York), Dr. H. Roivainen (Botanical Museum, Helsinki), Dr. Rolf Santesson (Institute for Systematic Botany, Uppsala), Dr. R. Shaffer (University of Michigan, Ann Arbor), Sir George Taylor (Royal Botanic Gardens, Kew), Dr. J. W. Thomson (University of Wisconsin, Madison), Dr. K. Verseghy (Museum of Natural History, Budapest), Dr. R. Vincenzo (Istituto Botanico, Rome), Dr. E. F. Warburg (Oxford University, Oxford), and Dr. R. Woodson (Missouri Botanical Garden, St. Louis). Dr. Ove Almborn kindly forwarded to me for study loans from the National Herbarium, Pretoria, and from the Botanical Department, Trondheim.

In addition Drs. G. Degelius, T. Seshadri, and D. D. Awasthi (abbreviated DEGEL, SESH, and AWAS, respectively, in the list of species) have loaned us their valuable private collections.

I have had profitable exchanges of information and unpublished data with Drs. H. des Abbayes and Y. Asahina. Dr. Syo Kurokawa has aided in the chemical testing of many collections. Dr. J. L. Ramaut has also carried out chemical investigations of some of the species and kindly communicated his results to me.

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Historical Survey

Taxa properly assigned to subgenus *Amphigymnia* have been described by at least 54 different lichenologists. This effort, starting with Hudson in 1762, has resulted in some 350 names of various taxonomic rank, of which 83 are accepted in this monograph. Because of the scattering of efforts by so many lichenologists, detailed summaries of the contributions of each worker will not be attempted here, but the following overall survey may be helpful in understanding the development of the subgenus.

Before Acharius proposed the genus *Parmelia* in 1803, only two species now recognized as Amphigymnias had been described, *Lichen perforatus* Jacq. and *L. perlatus* Huds. Between 1803 and the beginning of Nylander's work in 1860, the most important workers were Sprengel, E. Fries, Eschweiler, Fée, Taylor, Hepp, and Montagne. During this period of early explorations about 10 new species now recognized as valid were described.

From about 1860 to 1900 there was a period of intense activity by Nylander, Müller-Argau, Krempelhuber, Stirton, Tuckerman, Laurer, and others, during which more than 120 new names were created. Of these, about 30 are still accepted as valid. Müller and Nylander,

the giants of this period, were complete opposites in methods and species concepts. Nylander perfected color tests and had a narrow refined species concept. Of the 30 names in *Amphigymnia* that he proposed, 15 are still valid, a very low percentage of synonymy indeed. Müller, on the other hand, did not use chemistry and had a distressingly broad species concept. He described many varieties and forms, none of which are presently recognized. Of the 45 taxa he proposed, in fact, only six are accepted in this monograph. Krempelhuber made some very valuable investigations of the South American Parmelias which were largely overlooked by later workers. Stirton described a number of exotic species. Contributions by Tuckerman, Laurer, and others, were much smaller but nevertheless significant. Nearly all of the publications in this period were in the form of short floristic notes.

From about 1900 to 1930 another group of lichenologists carried on the impetus of the previous period. The most active workers were Vainio, Zahlbruckner, Hue, Lynge, Du Rietz, Steiner, Harmand, Bouly de Lesdain, Choisy, and Cengio-Samba. Vainio on the whole was a careful worker, proposing 26 names, of which 12 are valid species. His specimens, however, are notoriously scrappy, although well preserved. Zahlbruckner proposed 27 names in *Amphigymnia*, of which only 6 are accepted here. Lynge wrote the most valuable tropical flora, based on the rich Regnell collections from Brazil (cf. Hale, 1960). He proposed 22 names, of which 3 are acceptable. Hue was a prolific worker, describing some 23 taxa from tropical areas, 6 of them good species. Altogether, from the late 1890's to about 1930, somewhat over 100 new names were proposed and about 30 of these are accepted in this monograph. The floristic lists by these workers tend to be more comprehensive than those published before 1900, but fragmentary floristic notes still predominated.

The period since 1930 has marked the beginning of a modern synthesis of *Parmelia* on a worldwide scale and full acceptance of the International Code of Botanical Nomenclature. Major floristic works have been published by des Abbayes (1958, 1961) for Madagascar and western Africa and by Dodge (1953, 1959) for eastern and South Africa. There have been comprehensive floristic treatments of the European species (Hillmann, 1934; Maas Geesteranus, 1947; Tavares, 1945) and of the Japanese species (Asahina, 1952). The North American species were studied by Berry (1941). In the absence of a world monograph, however, many of the new species described since 1930 have only increased the already overburdened synonymy. Of nearly 100 taxa proposed in this period, only some 15 are accepted in this monograph.

Nomenclature

Lichenologists have been slow to appreciate the importance of nomenclature. Even now that the International Code has been universally accepted, some lichenologists are still publishing new species without designating holotypes and making new combinations without citing the basionyms. The concept of absolute priority regardless of rank was strong among older workers and has not yet completely died. This general lack of precision has resulted in endless confusion in floristic lists and the faithful perpetuation of serious errors in identification.

All too many of the older lichenologists failed to designate holotypes but listed two or more syntype specimens, leaving to later workers the important task of selecting lectotypes. Fortunately this practice is no longer permissible under the Code. The type method is based strongly on priority, and admittedly it becomes difficult to apply when holotypes are lost, unavailable for loan, or too fragmentary for recognition. The use of descriptions alone to characterize lichens has proved to be far less reliable than in other groups of cryptogams. When a type is unavailable, we have two choices, to ignore the name and list it as a nomen inquirendum or to select a neotype.

Neotypes are definitely problematic in lichenology because original descriptions are often wholly inadequate and illustrations are rarely made. Fortunately, we have as a sound precedent the careful work of Santesson (1952), who proposed a number of neotypes for the foliicolous lichens. Neotypes at their best are indispensable sources for the stabilization of names. In *Parmelia* and many other genera they are particularly valuable in establishing the chemical components of the type of the species. At their worst, neotypes are merely new species in disguise. The Code does not require a taxonomist to create neotypes merely because untypifiable names exist. If creation of a neotype deliberately displaces a later typifiable name, I believe it should be made with great hesitation. It has been necessary in subgenus *Amphigymnia* to select three neotypes, those for *P. subcrinita* Nyl., *P. sulphurata* Nees & Flot., and *P. perforata* (Jacq.) Ach. All other species or varieties without type specimens are ignored for the present (see list of nomina inquirenda on p. 343).

Mention should be made here on the recognition of synonyms. The mere listing of a name as a synonym has too often been taken as prima facie evidence of identity. In reality, judgment of synonymy is often a personal decision that parallels a lichenologist's species concept. For

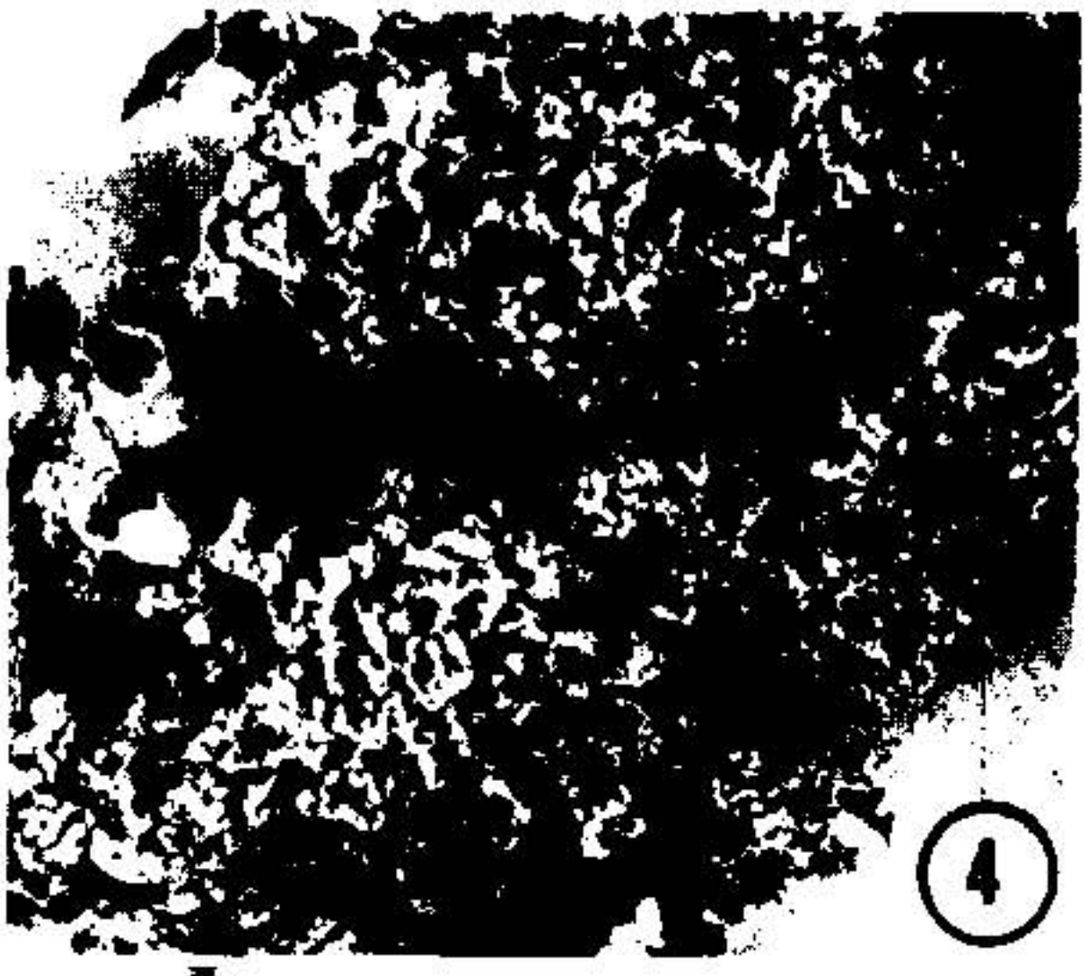
example, Müller-Argau had an extremely broad species concept, and when he made studies of the important tropical species described by Fée, Eschweiler, and Taylor, he reduced many names to synonymy. These were listed as synonyms by Zahlbruckner in his Catalogus Lichenum Universalis and have been so considered without further study by succeeding lichenologists. Actually, although many of these names represent valid species, they have been effectively lost in the literature, and progress in tropical lichen study has been held back because of this.

A listing of synonymy in this monograph indicates as nearly absolute identity in morphology and chemistry as is possible to determine with the methods at hand. We have tended therefore to follow a relatively narrow species concept. It is a simple matter for other lichenologists to combine names they feel are synonyms, but at least until more adequate field collections are available, many of them must stand as distinct species. It seems probable that a much finer species concept will prevail in 50 years, with greater emphasis on now unrecognized or unappreciated morphological and chemical characters.

Morphological Characters

Parmelia subgenus *Amphigymnia* is fortunately rich in distinct and easily recognized taxonomic characters. However, there has been no general agreement as to the value and importance of these characters nor have lichenologists consistently reported them with equal clarity when describing species. Descriptions in the literature run the gamut from Zahlbruckner's exhaustive, though not always pertinent, full-page descriptions to Gyelnik's or Nylander's one sentence statements. Asahina (1952) is one of the few lichenologists who has categorically listed the fundamental species characters for *Parmelia*. These are, in his opinion, cilia, soredia, isidia, spore size, pseudocyphellae and maculae, and chemical components.

Neither Asahina nor other lichenologists have tried to justify their selection of various morphological characters. It is assumed that most are based on taxonomic intuition, a notoriously variable factor. Obviously the most easily recognized traits, cilia, soredia, and isidia, are first selected as species characters, and the more subtle, less easily recognized traits are either overlooked or given some rank according to each taxonomist's judgment. It would be advantageous to be able to evaluate each taxonomic character quantitatively so that some objective measure of its importance can be arrived at. For example, are soredia and isidia of comparable value as species characters? Do cilia on the margin of the amphithecium have any taxonomic value?



1. Isidia of *Parmelia cristata* Ach. (*Fink* 114, US). 2. Sorediate isidia of *P. mellissii* Dodge (*Imshaug* 14235, US). 3. Isidia of *P. pseudotinctorum* des Abb. (*des Abbayes*, US). 4. Coralloid isidiate outgrowths of *P. ramuscula* Hale (holotype, BM). 5. Marginal soredia of *P. cristifera* Tayl. (*Hale* 20073, US). 6. Pustules of *P. rimulosa* Dodge (*Imshaug* 1897, LD). All photographs enlarged 4.

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7. Apothecia of *Parmelia hanningtoniana* Müll. Arg. (*Dextias*, Feb. 16, 1980, US) (× 1). 8. Lower side of *P. perforata* (Jacq.) Ach. (*Hale* 21737, US) (× 2). 9. Lower side of *P. tinctorum* Nyl. (*Hale* 17068, US) (× 2). 10. Maculae on the upper cortex of *P. perforata* (Jacq.) Ach. (× 5). 11. *P. wainii* A. L. Sm. showing marginal cilia (isotype, US) (× 1). 12. Lower side of *P. subtinctoria* Zahlbr. (*Hale* 16649, US) (× 2).

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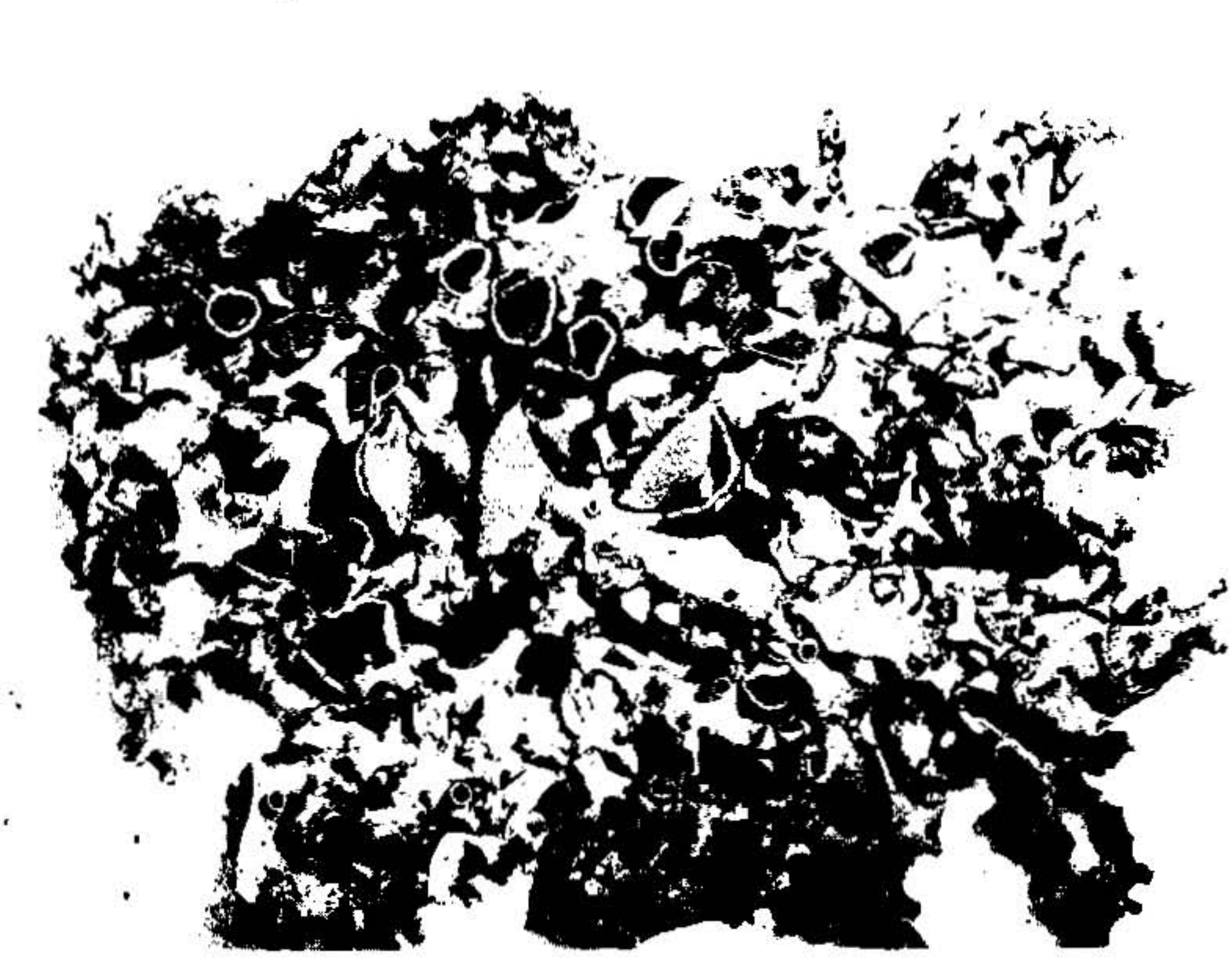
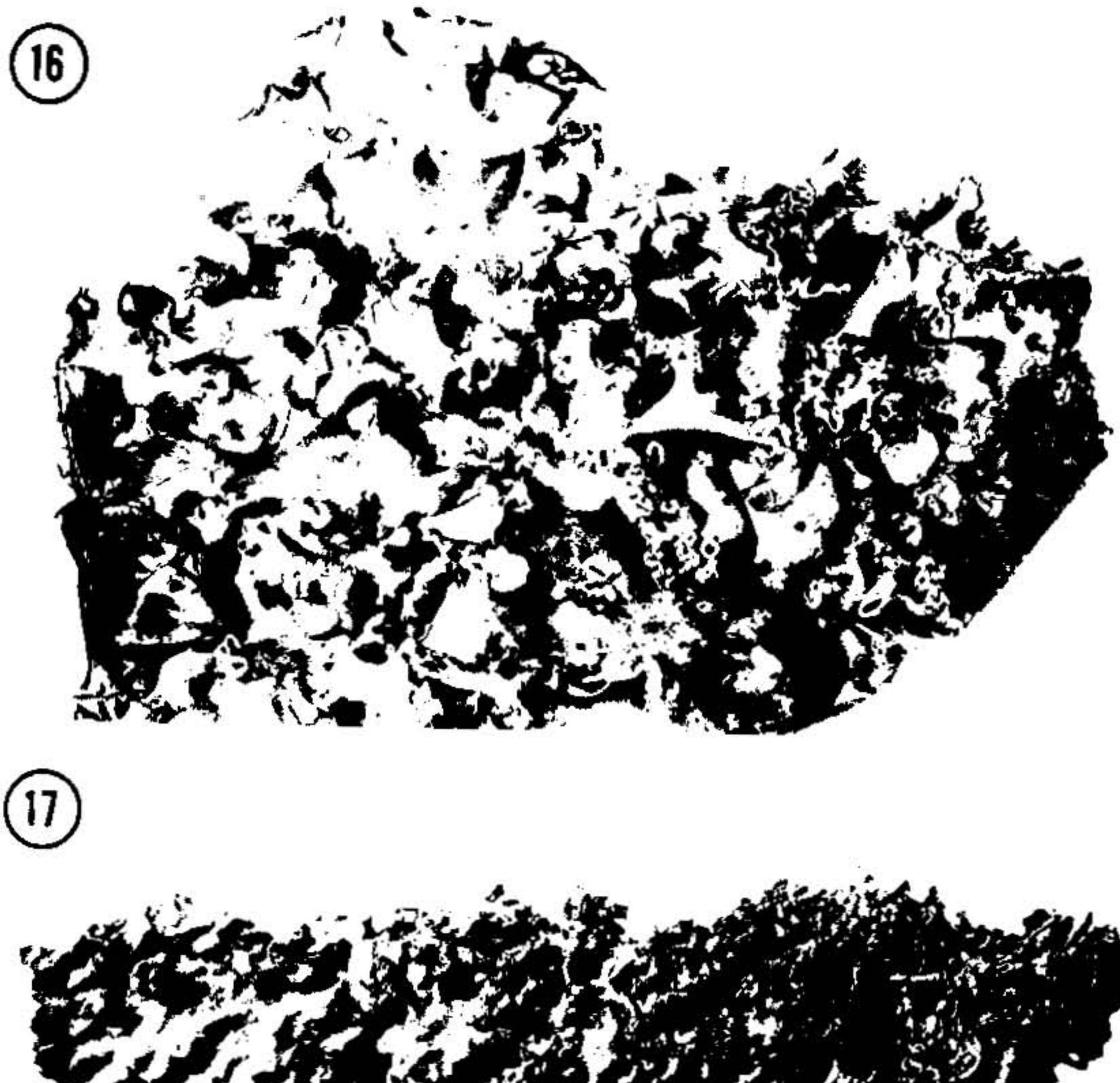


13. *Parmelia eborina* Hale (isotype, US). 14. *P. dominicana* Vain. (*Allard* 15958, US).
15. *P. myelochroa* Hale (holotype, US). All photographs × 1.



16. *Parmelia cristifera* Tayl. (*Ozata* s.n., US). 17. *P. rubifaciens* Hale (holotype, US). Both photographs × 1.

18. *Parmelia peralbida* Hale (holotype, FH). 19. *P. praesorediosa* Nyl. (holotype, H). Both photographs ×1.

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20. *Parmelia sollingeri* Hepp (holotype, L) (1). 21. *P. dasoclina* Hale (isotype, US) (2).

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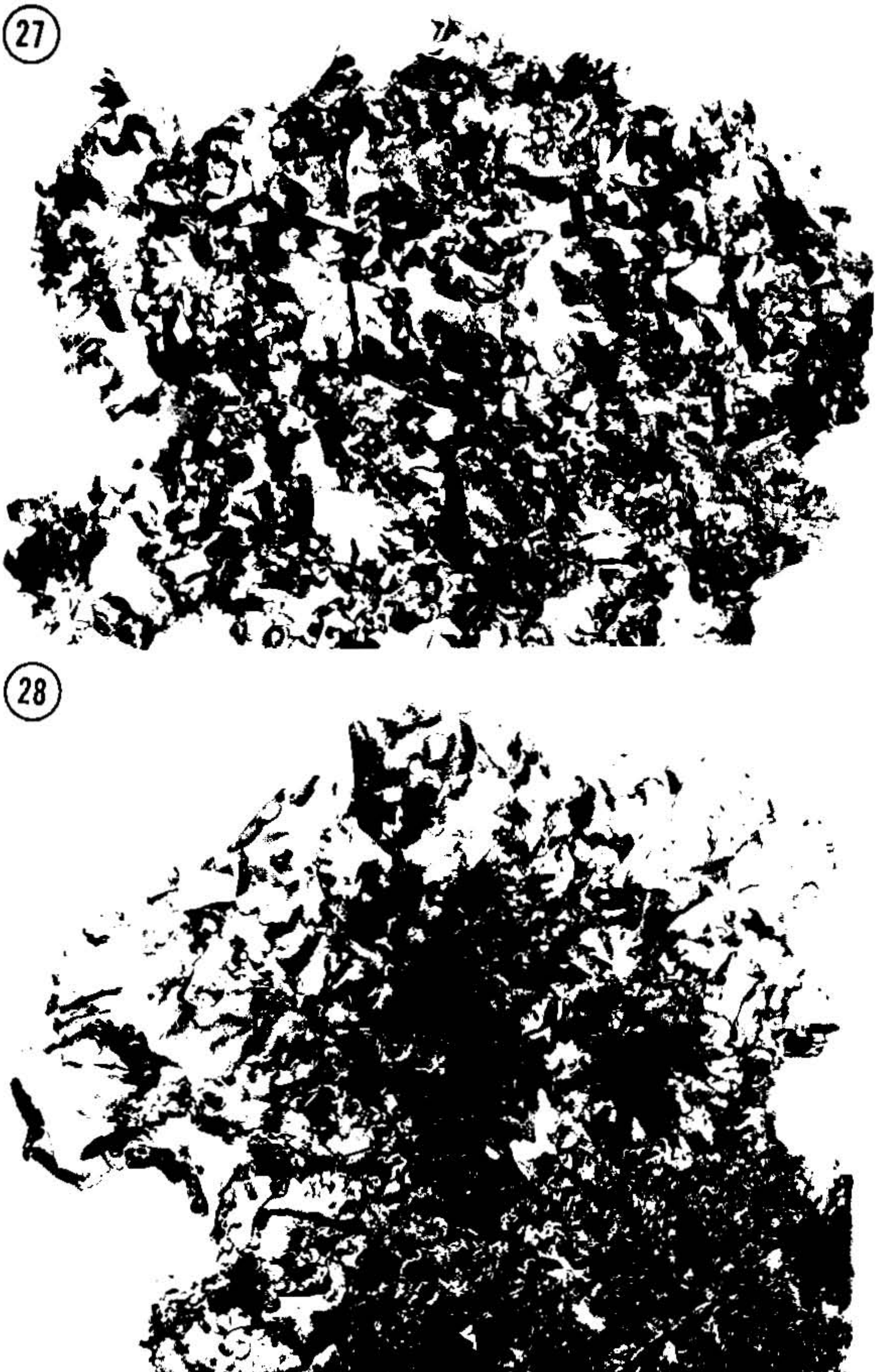
22. *Parmelia abnuens* Nyl. (lectotype, H). 23. *P. maclayana* Müll. Arg. (isotype, G).
24. *P. amboinensis* Dodge (*Gosswciler* 10008, US). All photographs ×1.

25. *Parmelia merrillii* Vain. (*Masuda* F456, TNS). 26. *P. curysaca* Hue (holotype, P). Both photographs × 1.



27. *Parmelia margaritata* Hue (holotype, P). 28. *P. stuppea* Tayl. (*Maury* 3318, P). Both photographs ×1.

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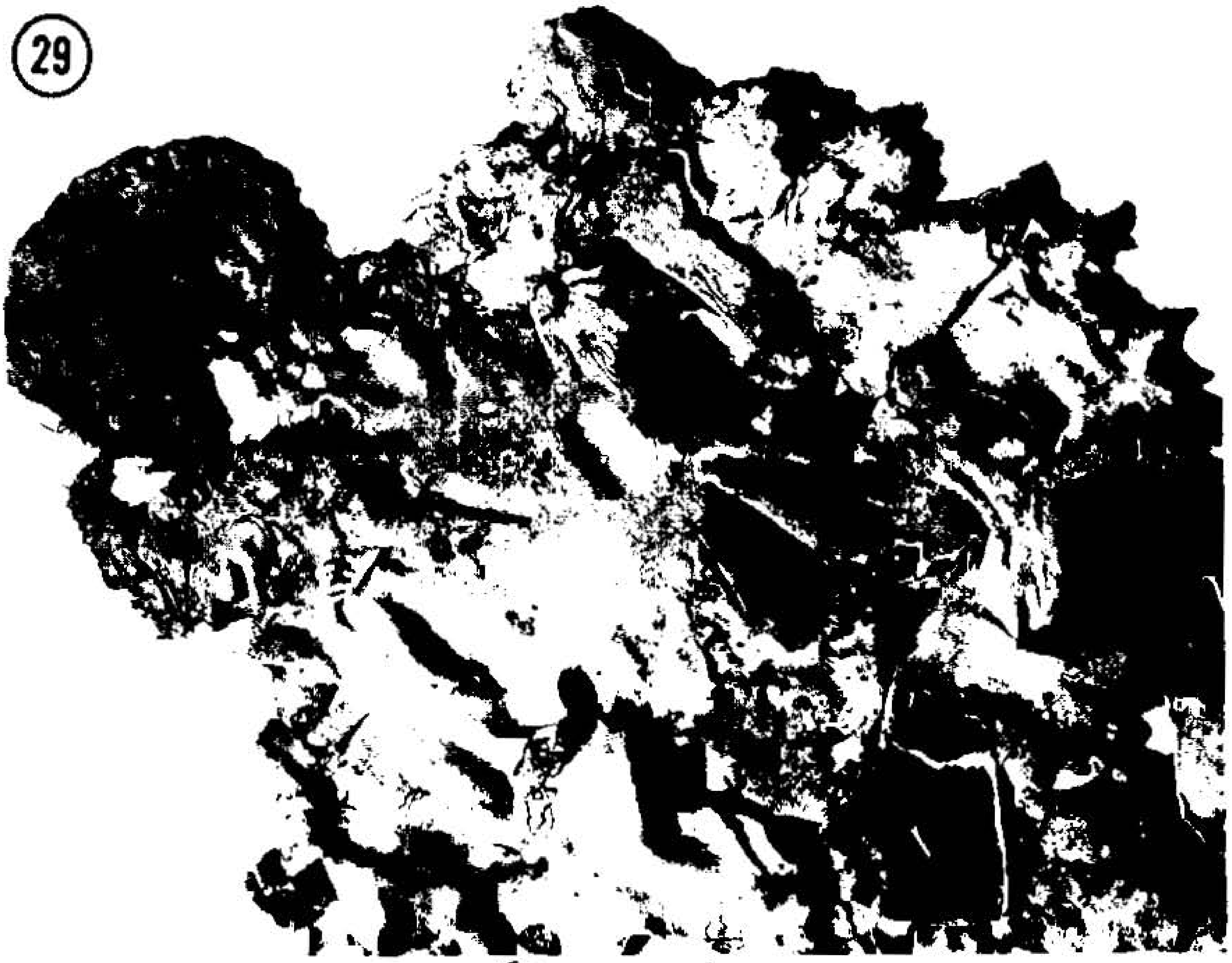

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29. *Parmelia procera* Stein. & Zahlbr. (*Greenway* 1001, K). 30. *P.* [illegible] Hale (isotype, US). Both photographs ×2.

31. *Parmelia miranda* Hale (holotype, US) (×2). 32. *P. flavescens* (Krempelh.) Nyl. (holotype, M) (×1).

33. *Parmelia subtinctoria* Zahlbr. (holotype, W). 34. *P. subsumpta* Nyl. (holotype, H). 35. *P. subcaperata* Krempelh. (*Flora* 1859, H). All photographs ×1.

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36. Parmelia pseudoilgherrensis Asah. (holotype, TNS). *37. P. diacidula* Hale (holotype, LD). *38. P. cooperi* Stein. & Zahlbr. (holotype, W). All photographs ×1.

39. *Parmelia reparata* Stirt. (*Hale* 19406, US). 40. *P. coralliformis* Hale (holotype, US). Both photographs × 1.

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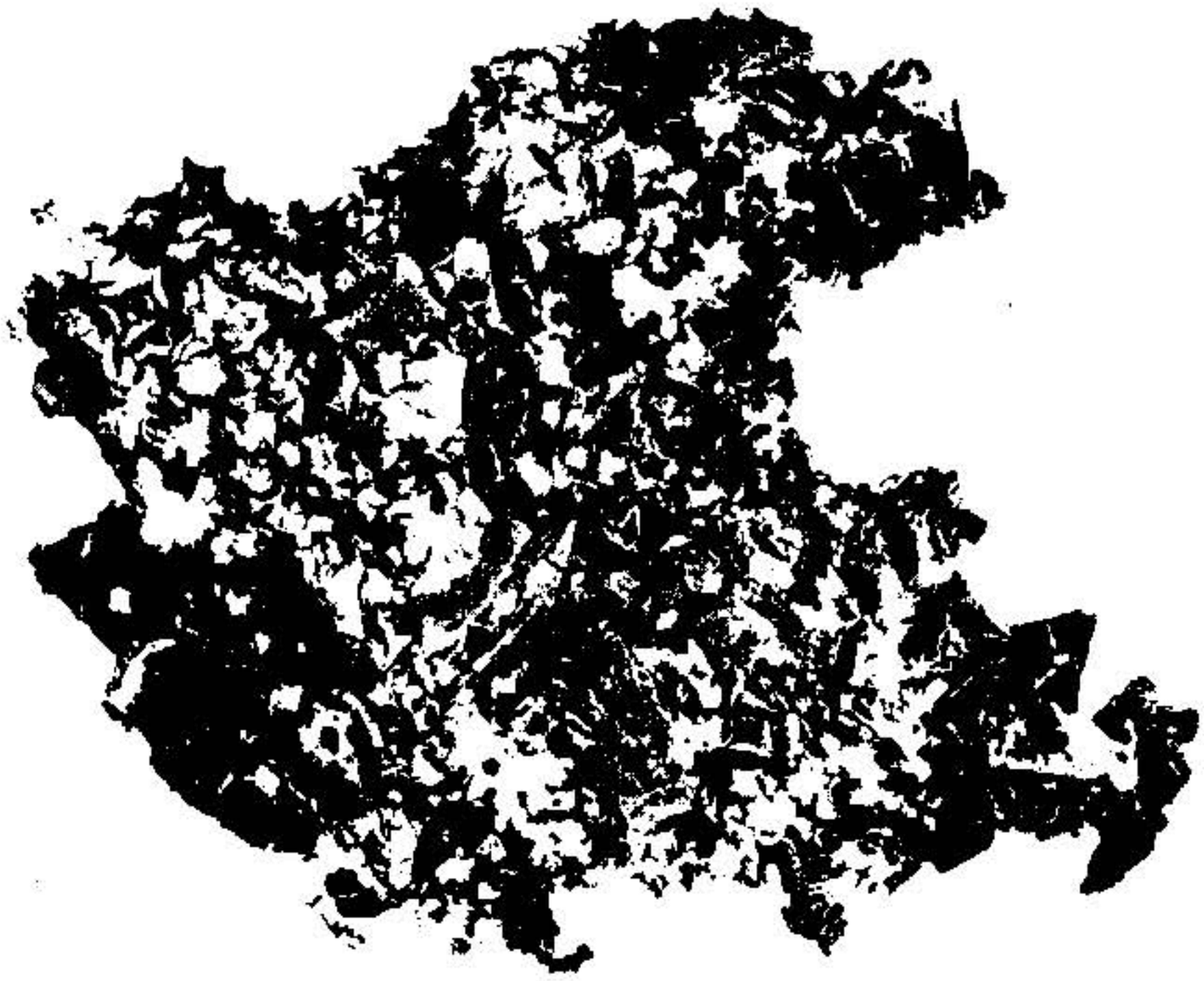

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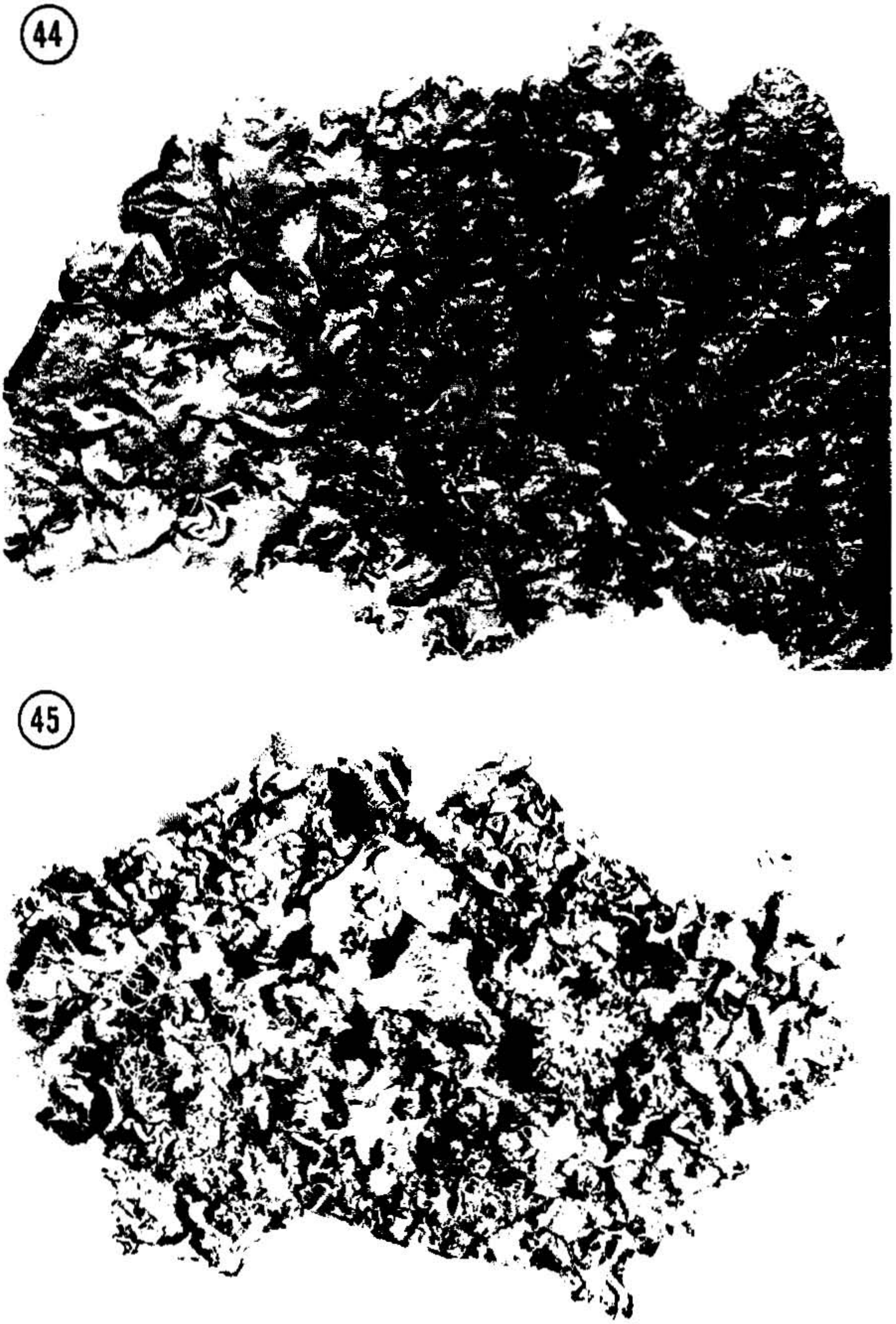
41. *Parmelia chiapensis* Hale (isotype, US). 42. *P. hababiana* Gyel. (lectotype, G). 43. *P. argentina* Krempelh. (isotype, US). All photographs ×1.



44. *Parmelia leucosemoidea* Hue (holotype, P). 45. *P. subrugata* Krempih. (holotype, M). Both photographs × 1.

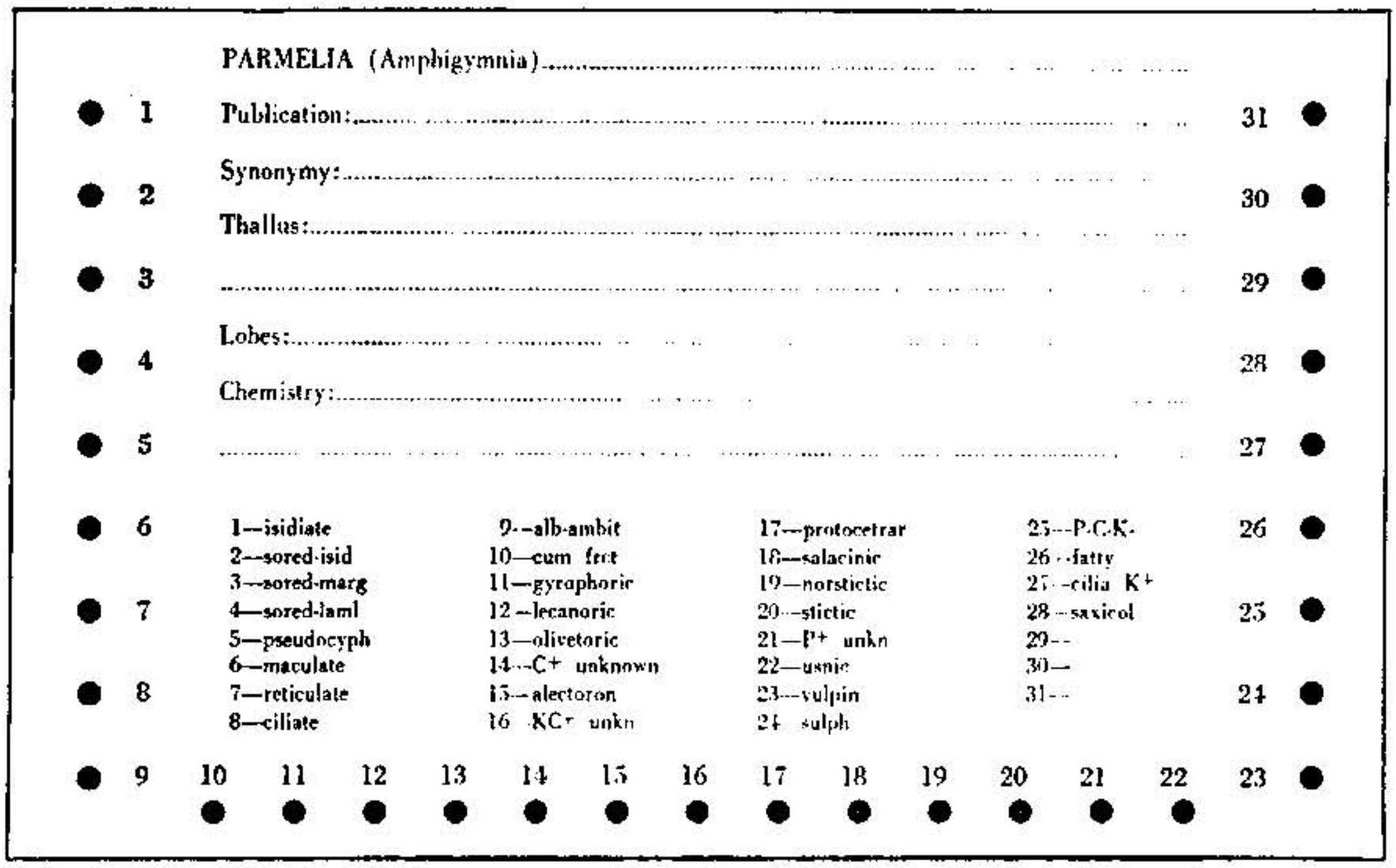


FIGURE 1.—Marginal punch card (5×8 inches) used to record data for each species.

Because we have had available data on all known species of *Amphigymnia*, we have taken this opportunity to present below not only descriptions of the major characters but also their frequency and degree of association with each other, in order to evaluate their relative taxonomic importance. The data for each species were reproduced on marginal punch cards (fig. 1) to facilitate rapid calculation of frequencies and association. All data were derived first from the type specimen and supplemented by studies of herbarium specimens compared with types.

ISIDIA AND SOREDIA

Isidia are one of the major characters useful at the species level. They occur in 25 of the 106 species of *Amphigymnia*. There is considerable variation in the structure and development of isidia. Sixteen species have normal cylindrical isidia, ranging from simple to more or less branched with a diameter of 0.04–0.10 mm. (pl. 1). These isidia may be short-ciliate in robust specimens of *P. aberrans*, *P. crinita*, *P. pseudocrinita*, *P. subcrinita*, and *P. xanthina*. The isidia of *P. pseudotinctorum* are exceptionally large and thickened, up to 0.3 mm. in diameter (pl. 1). In *P. mellissii*, *P. paulensis*, and *P. subcorallina*, the isidia are in part granular or sorediate, but always recognizable as isidia (pl. 1). In *P. lophogena* and *P. setchellii* the isidia are irregularly thickened and at length pustular, without developing soredia. These latter structures are classified as isidia here only as a matter of convenience; they may represent a structure quite distinct from isidia. The most peculiar isidia, if indeed they are

isidia, are the coralloid outgrowths of *P. flavotincta*, *P. fasciculata*, *P. coralliformis*, and *P. ramuscula* (pl. 1). These are very large coralloid structures, produced laminally and marginally from small laciniae, which apically become irregularly thickened and at times pustulate or sorediate.

Soredia occur in 34 species. Soredia are much less variable than isidia and usually differ only in position on the thallus. The most typical position in *Amphigymnia* is strictly marginal in linear soralia, characteristic of 25 of the 34 species. Well-known examples are *P. austrosinensis*, *P. cristifera*, and *P. stuppea* (pl. 1; fig. 2). In older thalli marginal soralia may eventually cause the lobe margins to become involute. Two species, *P. hypomiltoides* and *P. natalensis*, have marginal as well as extensive laminal soralia, with laminal soralia predominating. Four species have soredia which originate submarginally; that is, the soredia originate just back from the thallus margin. The soralia may be linear and, advancing on a broad front, soon cause the lobes to become strongly revolute (fig. 2), as in *P. perlata* and *P. ochroglauca*. In *P. arnoldii* and *P. margaritata*, the soralia are mostly orbicular and originate on short marginal laciniae which also become revolute (fig. 2). *Parmelia bangii*, *P. crypotoxantha*, *P. fracta*, and *P. rimulosa* (pl. 1) have strictly laminal,

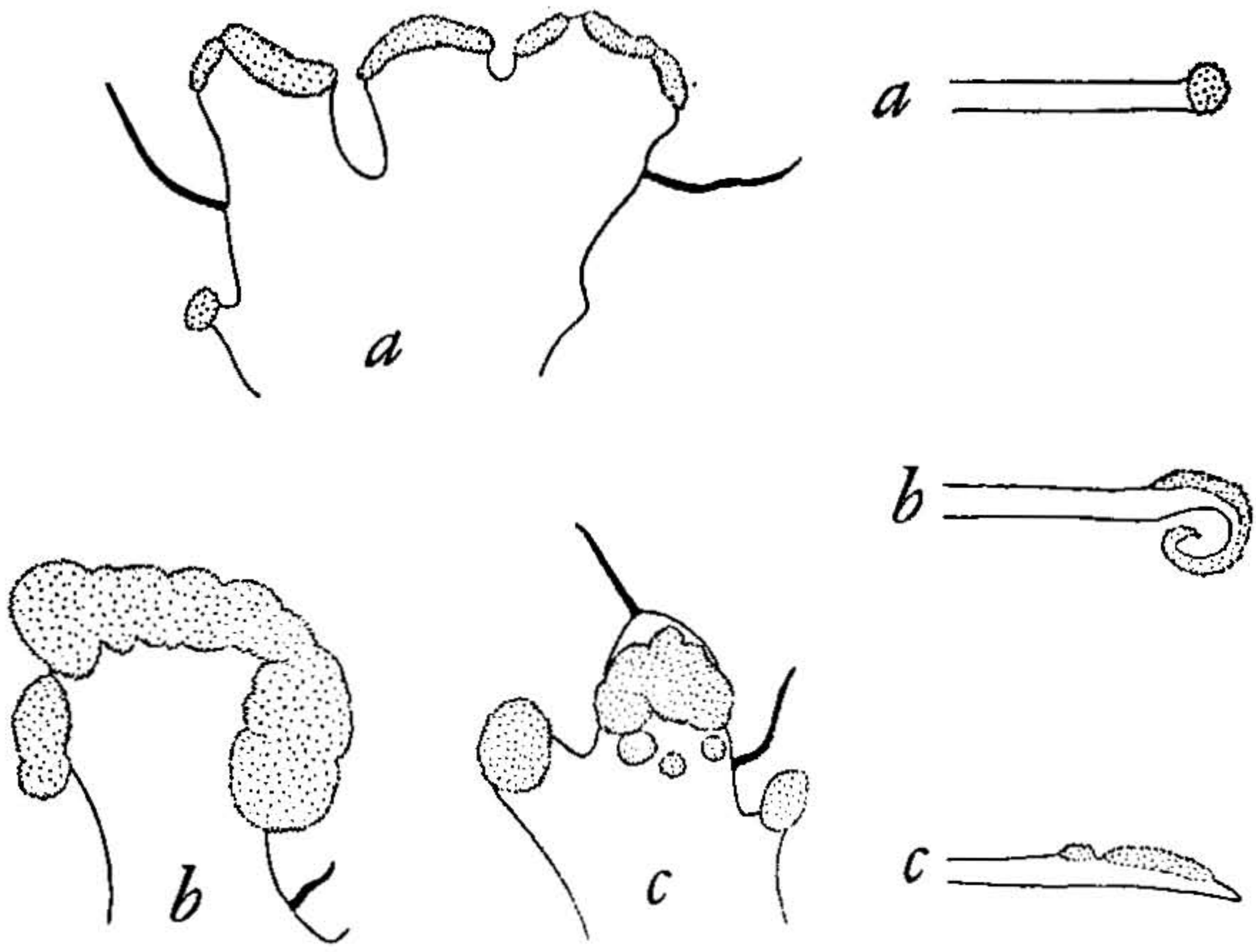


FIGURE 2a–c.—Soredial formation in *Amphigymnia: a*, *Parmelia stuppea* Tayl.; *b*, *P. perlata* (Huds.) Ach.; *c*, *P. margaritata* Hue.

irregular soralia which originate from cracks or pustules. These intergrade to a certain extent with sorediate or pustulate isidia but are probably best considered as a modification of soredia.

Plants which lack soredia or isidia comprise the remaining 47 species. These plants may have lobules or a rugose upper cortex, but they are always distinguishable from sorediate or isidiate plants.

The degree of association between isidia, soredia, and lack of soredia and isidia (abbreviated NIS) is shown in table 1. This table, as an example, shows that of the 25 isidiate species, 68% have cilia; that of the 34 sorediate species, 77% have cilia; and that of the 47 species lacking soredia or isidia, 72% have cilia. Such close percentages may be interpreted to mean that there is little significant association between soredia, isidia, and lack of soredia and isidia.

TABLE 1.—*Percentage of isidiate, sorediate, and nonsorediate-nonisidiate (NIS) species with each of 16 different traits.*

Trait (Number of species)	Isidiate (25)	Sorediate (34)	NIS (47)
gyrophoric acid	12	12	4
lecanoric acid	8	9	6
alectoronic acid	8	21	26
cryptochlorophaeic acid	4	3	4
protocetraric acid	28	15	13
salacinic acid	16	18	13
norstictic acid	0	6	6
stictic acid	8	3	2
usnic acid	20	15	2
maculae	12	27	38
cilia	68	77	72
white rim below	0	9	15
perforate disc	6	30	43
small spores	53	55	47
intermediate spores	24	30	26
large spores	24	15	26

It is noteworthy that in the case of alectoronic acid, protocetraric acid, maculae, white rim below, and perforate apothecia, the sorediate–NIS species have similar percentages of association, in each case more or less obviously different from the isidiate species. There is only one example, usnic acid, where isidiate and sorediate plants share a similar percentage of association measurably different from that of NIS plants and no outstanding example for isidiate–NIS. These observations suggest that sorediate–NIS species are closely, perhaps genetically, related and that isidiate plants belong to an entirely different lineage. There is good grounds then for believing that isidia are good species characters and that two otherwise identical plants differing chiefly in the presence or absence of isidia are separate species.

Further confirmation of the distinctness of isidia can be gained by taking the isidiate species one by one and searching among the nonisidiate species for "counterparts," species which seem to be identical in every character except for the absence of isidia. Obviously some degree of personal judgment is called for in this selection, but on the whole we have used the narrowest possible interpretation of identity. For example, there are 2 isidiate species which have both sorediate and NIS counterparts.

Isidiate	Sorediate	NIS
P. endosulphurea	*P. araucariarum*	*P. myelochroa*
P. subtinctoria	*P. subsumpta*	*P. subcaperata*

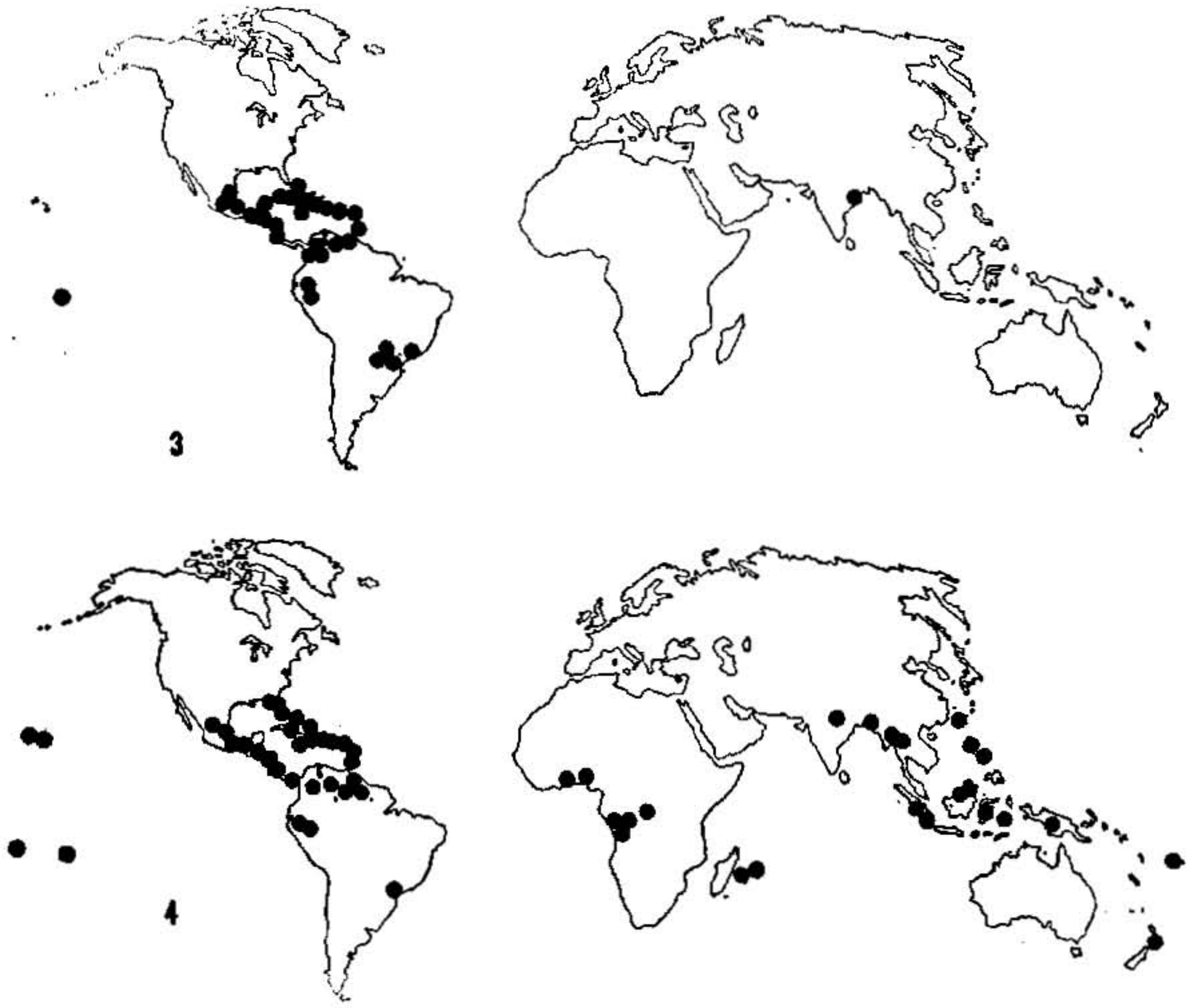
Two species appear to have sorediate counterparts only: *P. crinita–P. perlata*, and *P. erasmia–P. hypomiltoides*. There is only one isidiate species with an apparent NIS counterpart: *P. paulensis–P. melanothrix*. The remaining 20 isidiate species have no obvious counterparts. Most species pairs that look promising are found to differ in spore size, perforation of apothecia, or other characters.

If we proceed now to a similar analysis of sorediate species, we find many species with counterpart nonsorediate species, as follows:

Sorediate	Nonsorediate
P. cristifera	*P. latissima*
P. dilatata	*P. zollingeri*
P. austrosinensis	*P. andina*
P. cooperi	*P. hololoba*
P. hypotropa	*P. perforata*
P. hababiana	*P. abessinica*
P. reparata	*P. leucosemotheta*
P. pseudonilgherrensis	*P. nilgherrensis*
P. praesorediosa	*P. mesotropa*
P. defecta	*P. soyauxii*

Combining these with previously mentioned cases, about 14 of the total 34 sorediate species are counterparts of nonsorediate species. This comparison, along with the frequency data (table 1) already mentioned, suggests that presence of soredia is a significantly weaker species character than isidia. We may be dealing simply with species that may or may not produce soredia or produce them only rarely or under special conditions.

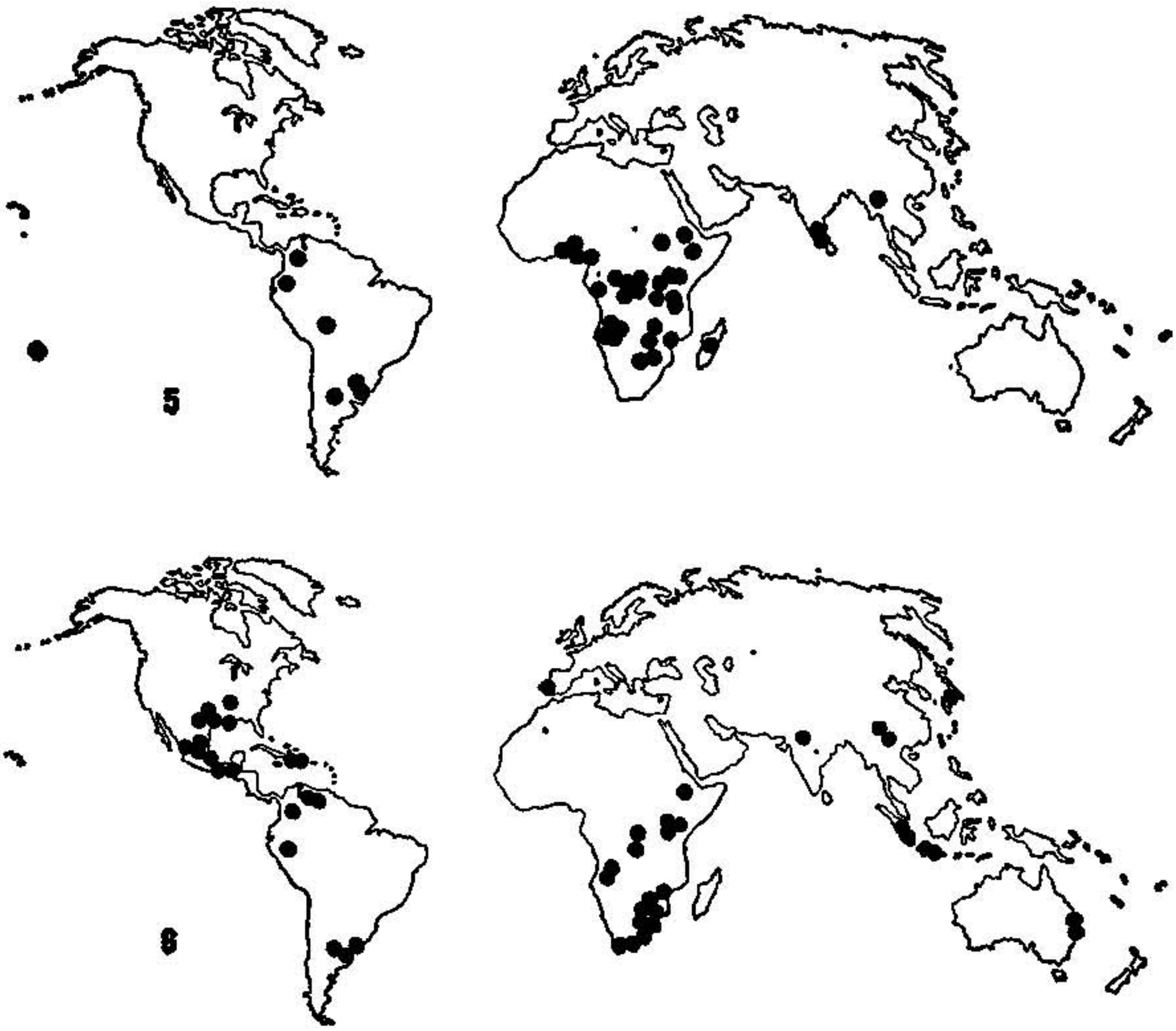
On the whole, however, counterpart sorediate species have a more northerly range (or in the Southern Hemisphere more southerly) than the nonsorediate species. For example, *P. latissima* (fig. 3) is strictly tropical in distribution. It is common in Cuba but does not occur in southern Florida, only 140 km. distant. On the other hand, the sorediate counterpart, *P. cristifera*, has a much broader distribution; it occurs not only in Cuba but also as far north as South



FIGURES 3–4.—Distribution: 3, *Parmelia latissima* Fée; 4, *P. cristifera* Tayl.

Carolina and Georgia in the United States (fig. 4). In South Africa *P. andina* is almost completely lacking south of the Tropic of Capricorn (fig. 5), whereas sorediate *P. austrosinensis* is extremely common on both sides of this line (fig. 6). Furthermore, *P. andina* is completely absent in North America and Mexico. *Parmelia hypotropa* (fig. 8) has a more northerly center of distribution in the United States than the nonsorediate counterpart *P. perforata* (fig. 7).

The existence of counterpart species may have some significance in interpreting speciation in *Amphigymnia*. The ancestral species were probably isidiate or nonsorediate. At the present time almost all nonsorediate species are confined to tropical regions and many of them are restricted to one continent. By contrast half of the pantropical species are sorediate. In some of the species, e.g., *P. latissima*, perfect sorediate counterparts (*P. cristifera*) have developed, and most of them are much more widely distributed in temperate areas than the nonsorediate counterpart. However, in some cases, such as *P. diacidula*, *P. direagens*, *P. grayana*, *P. rubifaciens*, *P. sancti-angelii*, and *P. subarnoldii*, no nonsorediate ancestral forms have survived, if indeed they ever existed. Finally, these

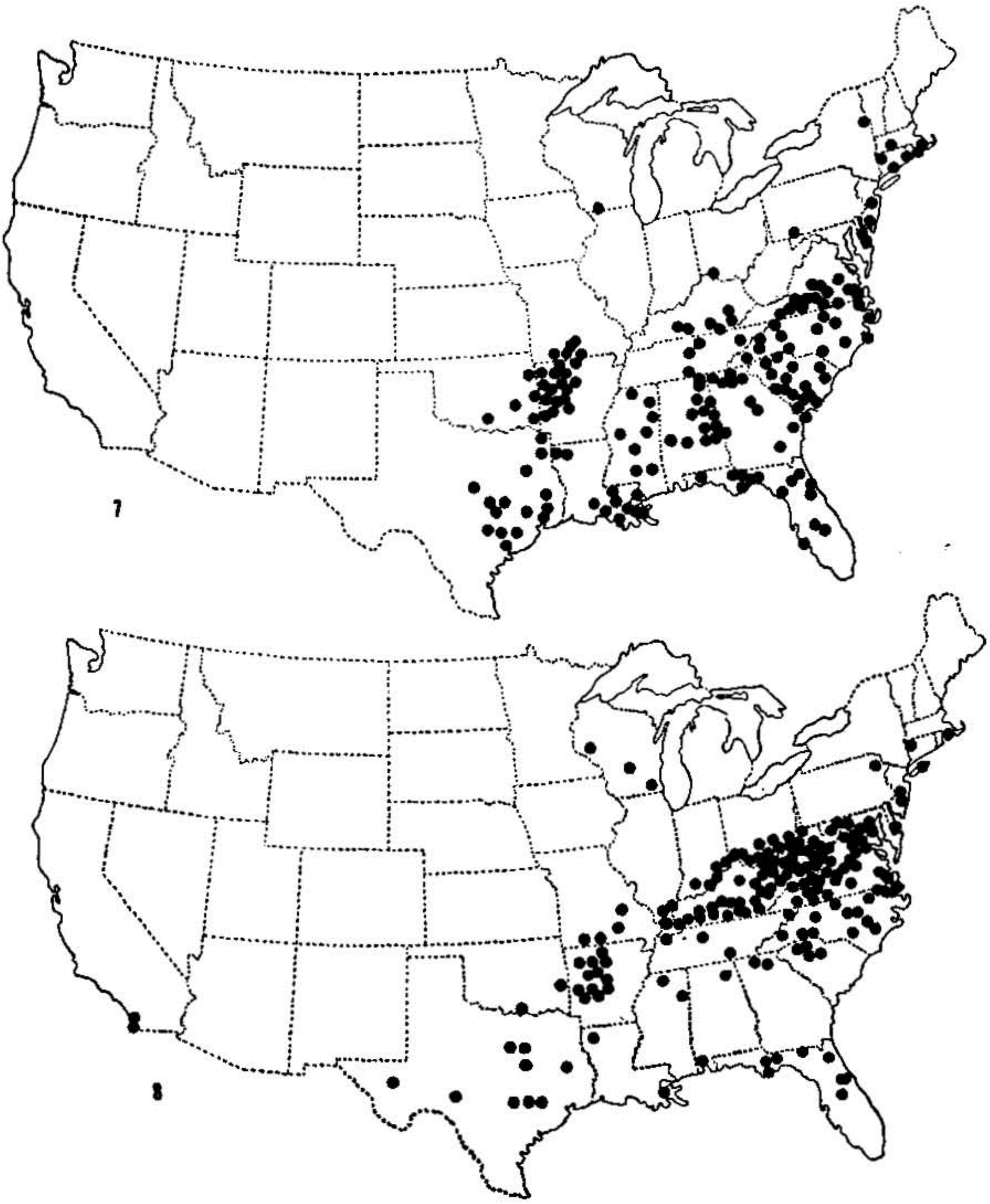


FIGURES 5–6.—Distribution: 5, *Parmelia andina* Müll. Arg.; 6, *P. austrosinensis* Zahlbr.

various counterpart species may be slowly evolving and diverging. For example, *P. tinctorum* would be a perfect isidiate counterpart to *P. andina* and *P. austrosinensis* if it were maculate and had perforate apothecia. *Parmelia eurysaca* would be a logical counterpart of sorediate *P. stuppea*, except that it has distinct laciniae. Many other examples could be cited.

CILIA

Cilia are very common in *Amphigymnia*, occurring in 77 of the 106 species, sporadically produced in the axils of the lobes in *P. zollingeri*, *P. dilatata*, and *P. conformata*, and entirely lacking in the remaining 26 species. The longest cilia, such as those of *P. cooperi*, *P. rampoddensis*, or *P. wainii*, are up to 6 mm. long and very conspicuous (pl. 2). At the other extreme, the cilia of *P. perlata* may be quite sparse and not more than 1 mm. long. The cilia of *P. argentina* and *P. mellissii* sometimes react K+ purple, but we do not believe that this reaction has any taxonomic value.



FIGURES 7–8.—Distribution in the United States: 7, *Parmelia perforata* (Jacq.) Ach.; 8, *P. hypotropa* Nyl.

The degree of association of cilia with other morphological and chemical characters is shown in table 2. This table shows, for example, that of the 77 ciliate species, 3% have lecanoric acid and of the 29 nonciliate species, 21% have lecanoric acid. Cilia have a positive or negative association with more than half of the characters listed. We believe that this high degree of correlation indicates that cilia are important taxonomic characters. This hypothesis is strengthened by the fact that there are almost no counterpart ciliate-

nonciliate species. The only clear-cut examples are *P. hololoba* and *P. andina*. It is impossible to find exact counterparts for the other 76 ciliate species among the 29 nonciliate species.

TABLE 2.—*Percentage of species with or without maculae, cilia, or perforate disc having various traits.*

Trait	Percentage of species having Maculae		Cilia		Perforate disc	
	Present	Absent	Present	Absent	Present	Absent
(Number of species)	(30)	(76)	(77)	(29)	(27)	(56)
gyrophoric acid	10	8	12	0	4	5
lecanoric acid	10	7	3	21	18	4
alectoronic acid	22	18	26	3	30	16
cryptochlorophaeic acid	10	0	4	0	7	3
protocetraric acid	3	21	10	31	0	23
salacinic acid	22	13	18	10	22	14
norstictic acid	10	3	4	14	11	2
stictic acid	0	5	5	0	0	7
usnic acid	0	12	12	7	0	14
maculae	—	—	35	10	59	20
cilia	90	66	—	—	82	68
white rim below	37	0	12	7	26	7
perforate disc	59	21	37	24	—	—
small spores	63	45	57	35	74	39
intermediate spores	26	27	18	43	22	28
large spores	11	29	25	22	4	33

MACULAE

Maculae in *Amphigymnia* are more or less regular, submacroscopic white spots in the upper cortex (pl. 2). They are related to but should not be confused with the irregular effigurate pseudocyphellae in *P. saxatilis* (L.) Ach. or *P. sulcata* Tayl. or with typical pseudocyphellae. Maculae are not always easy to distinguish in *Amphigymnia* and have usually been overlooked by lichenologists. Some 27 species have distinct maculae, 3 have variable or questionable maculae, and 76 have a normal opaque cortex without maculae. Maculae occur, however, on the amphithecium and pedicels of nearly all species. In some of these the maculae may be distinct at the base of the pedicels but do not clearly go beyond this point on the thallus, as in *P. eciliata*.

Maculae are strongly positively or negatively associated with seven other characters (table 2). Of these characters, cryptochlorophaeic acid, protocetraric acid, white rim below, and perforate apothecia share a similar degree of association with cilia. Maculae would then seem to be good species characters, especially since there are no recognizable maculate-nonmaculate counterpart species.

LOWER SIDE

The lower side in *Amphigymnia* is more variable than usually thought. Typically most species are jet black, with rather long, unbranched, moderate to sparse rhizines. The outer rim is naked, shiny, dark brown or less commonly mottled tan or brown and ivory (pl. 2). About 91 of the species in this monograph can be classified in this group.

A second group also has a black rhizinate center, but the marginal area is entirely pale, ivory to white, and conspicuously set off from the black center (pl. 2). There are at least 11 species with this so-called white rim:

P. abessinica
P. argentina
P. euneta
P. hababiana
P. hypotropa
P. melanothrix
P. paulensis
P. perforata
P. rigida
P. subrugata
P. uruguensis

It will be noted from table 2 that a white rim is highly associated with maculae, perforate apothecia, and cilia, and seems to be a sound character.

A third type of lower side found in three species is characterized by very short, rather dense rhizines produced to or nearly to the margin (pl. 2). The lower cortex is entirely pale brown or brown or blackened toward the center with age. These species (*P. subcaperata*, *P. subsumpta*, and *P. subtinctoria*) also have a strongly maculate cortex, cilia, and salacinic or cryptochlorophaeic acid. There are no counterpart species with a black lower side. The species could be placed in subgenus *Parmelia*, but because of their large broad lobes and lack of reticulation they are more properly treated here.

APOTHECIAL CHARACTERS

The typical apothecium is more or less distinctly pedicellate and has a rugose, maculate amphithecium. In *P. hanningtoniana* the amphithecium is very coarsely rugose to lobulate (pl. 2). The exciple is most frequently entire, but in *P. abessinica*, *P. abnuens*, *P. argentina*, *P. corniculans*, *P. euneta*, *P. hanningtoniana*, *P. melanothrix*, *P. merrillii*, *P. ornatula*, *P. perforata*, *P. rigida*, *P. subrugata*, *P. uruguensis*, and *P. wainii*, the exciple is more or less dentate and frequently but not always ciliate. Cilia are not constant in any one species and appear to have no consistent value as a species character. The exciple is conspicuously laciniate in *P. appendiculata*, *P. cornuta*, and *P. disparilis*. Apothecia are not known for some 23 species, of which 14 are sorediate, 8 are isidiate, and only 1 is without soredia or isidia.

Spores are uniformly simple and unicellular in *Amphigymnia* and the only significant variation is in size and in the thickness of the spore wall. There are three major size classes: (1) small thin-walled spores, 12–18 μ long, with the episporium 1.0–1.5 μ thick; (2) intermediate spores, 18–25 μ long, with the episporium 1.5–2.0 μ thick; and (3) large spores, 25–40 μ long, with the episporium 2.0–4.0 μ thick. These three size classes represent at best three clusters on a scale of continuous variation. However, it is not too difficult to assign any given species to one of these classes. The most significant area of intergradation is in species with intermediate or large spores, where *P. abessinica*, *P. austrosinensis*, *P. praesorediosa*, and some others could well be placed in either group.

Examination of tables 1 and 2 will show that spore size is not consistently correlated with other morphological characters. Spore size is, however, strongly correlated with some of the rare acids (table 3). We are inclined to feel that spore size alone is not a valid species character, but it is undeniably a valuable key character in identification work, especially for species with alectoronic acid. There are no species in this monograph based solely on spore size, although there are a few problematic species where there are rather significant differences in spore size (see *P. abnuens* and *P. crinita*). As a rule, wide divergence in spore size is an indication that we are dealing with two species and careful study will often reveal unnoticed differences in other morphological characters that confirm this.

TABLE 3.—*Percentage of species with large, intermediate, or small spores that contain each of 8 different lichen acids.*

(Number of species)	Large (19)	Intermediate (22)	Small (42)
gyrophoric acid	0	4	10
lecanoric acid	0	0	17
alectoronic acid	10	32	19
protocetraric acid	21	27	5
salacinic acid	10	0	26
norstictic acid	0	5	7
stictic acid	21	0	0
usnic acid	5	14	10

The most important apothecial character seems to be the perforate disc, found in at least 27 species. The discs of both small and large apothecia are clearly perforate, leaving a gaping hole which opens directly into the hollow stipe. Nonperforate species have a smooth continuous disc which may split radially with age but only rarely develops a true perforation. This character correlates rather strongly with a number of other characters (table 2), including protocetraric acid, maculae, and white rim. Perforation is apparently a valid

species character, especially in the absence of perforate-nonperforate counterpart species.

Other apothecial characters have been noted but appear to have little immediate value in the taxonomy of *Amphigymnia*. The height of the hymenium, for example, seems to vary in proportion to spore size. Small-spored species have a hymenium 35 to 65 μ high, large-spored species 90 to 130 μ high. In actual practice the height of the hymenium may vary 20 to 30 μ in different specimens of the same species. The size of the thecium is also directly proportional to spore size and has no particular value in descriptions. Pycnidia have not been consistently investigated because they seem to have no importance in the taxonomy of *Amphigymnia*; they are often absent or extremely difficult to find.

ANATOMICAL CHARACTERS

Anatomical characters play no role in the taxonomy of *Amphigymnia* at this time. Dodge (1959) gives a good summary of the internal structure of *Parmelia*. The thickness of the upper cortex and lower cortex depends partly on the age of the thallus so that a number of quite different measurements can be made on the same thallus. The importance of variation in the structure and arrangement of the medullary hyphae or the organization of the algal colonies is as yet unknown. Such variation has been useful in interpreting *Usnea* (Asahina, 1954a), but it has not been used in foliose genera.

Chemistry

The use of color tests in *Parmelia* taxonomy started with Nylander in 1866, and virtually every major lichenologist to date, excepting Müller-Argau and Fink, has used color tests as key characters in the genus. Refinements in identification of the chemicals were brought about by Asahina's microchemical tests (cf. Asahina & Shibata, 1954), which finally placed the nonspecific color reactions on a firm foundation. No one can study *Parmelia* microchemically without being profoundly impressed by the practical importance of lichen acids in species identification. In addition, the presence of certain acids is highly correlated with morphological characters, as previously shown, and geography, indicating that the acids have a more basic value than simply their use in identification work.

Although the chemical color tests are widely used, it is both surprising and disconcerting to find how inaccurate or incomplete are some of the tests reported in the literature by many recent lichenologists. If color tests are used at all, it is imperative that the results be trustworthy. Reports of colors with KOH and P are usually accurate, but

tests with C or KC are often erroneous. The Ca $(O\ Cl)_2$ reagent is all too often old or decomposed and fails to give any color reaction. This reagent should be prepared freshly each day and tested first on *Parmelia tinctorum* or *P. rudecta*, both of which contain lecanoric acid. In this connection it should be mentioned that microchemical tests pose even greater possibilities for error. It is hoped that a suitable manual for identifying lichen acids will appear in the near future and forestall this possibility.

Taxonomy of Chemical Strains

The use of chemistry in lichen taxonomy is a subject of active discussion by present-day lichenologists. The easy application of Asahina's microchemical methods has encouraged more and more workers to use chemical tests. The evidence in favor of using chemistry in identifying and characterizing lichens is now so overwhelming that few modern workers deny its use. The moot point, however, is whether chemical characters alone deserve taxonomic rank, and if so, what this rank should be.

There are now a number of well-documented examples of lichen species that are morphologically inseparable but chemically distinct. *Parmelia* is particularly rich in chemical strains. Many of these chemical variants show more or less clear phytogeographic differences (cf. Culberson & Culberson, 1956; Hale, 1956a), but none has yet been correlated with habitat, substratum, or microclimate. In fact, all evidence so far suggests that chemical strains result from genetic control.

The arguments in favor of species rank for chemical strains are in part pragmatic. Such species are given immediate recognition at the highest possible rank, where they will appear in keys and indexes without danger of being lost. As a corollary, of course, these taxa may be separated in taxonomic lists far from the parent species and the names alone give no inkling of otherwise very close affinities among the species. However, by using species rank, lichenologists are compelled to make more careful and complete identifications and at the same time add to the growing body of data on chemical variation. Even though we cannot yet fully evaluate these data, the fact that most present-day lichenologists ascribe little taxonomic value to chemistry does not preclude the possibility that chemical variation will be of very great importance in future lichen taxonomy. Certainly no one can deny that the taxonomy of *Cladonia* has not been immeasurably clarified and advanced by employing chemistry to the fullest degree.

Another choice is an infraspecific rank. Any infraspecific taxon shares the disadvantages (for bibliographers in particular) of a trinomial system, but at least all chemical variants would appear together in lists or indexes of species. Unfortunately few lichenologists have ever agreed on criteria for recognizing varieties or forms, and in the past these two taxa have been hopelessly abused. Moreover, most taxonomists do not routinely identify species to varietal or other subspecific rank. In other words, if chemical taxa were described as varieties, we would in effect discourage investigation of chemical variation. Literature records would usually refer only to group names, such as *Cladonia chlorophaea* (Flk.) Spreng., and interested taxonomists would have to reexamine the specimens to determine if the chemical variants *C. grayi* Merr., *C. cryptochlorophaea* Asah., etc., were included. The category of subspecies has appeared sporadically in lichen literature and was used to some extent by Runemark (1956) for describing chemical variation in the yellow Rhizocarpons. As far as I am concerned, this taxon has the same disadvantages as any other infraspecific rank.

A last means of recognizing chemical variation is the extra-nomenclatorial device of numbered "chemical strains" first proposed by Lamb (1951) and followed by several lichenologists (cf. Hale 1952). This category fails to provide a stable system of naming strains since it is not subject to rules of nomenclature. However, the use of chemical strain notations has a most acceptable temporary advantage if in a preliminary study we wish to indicate the existence of chemical variation without being forced to propose formal names.

Evidence in subgenus *Amphigymnia* either favoring or opposing taxonomic recognition of chemical variation is at best inconclusive. The species which by any reasonable definition can be considered as chemical strains are listed in table 4. These include 8 parent species (left column) and a total of 10 chemical variants. It is surprising that of the 10 strains, 7 have already been described in the literature, in each case without any cognizance of the older parent name.

Closer study of table 4 shows a preponderance of species with fatty acids or fatty acids and a color reacting acid, most often cryptochlorophaeic or salacinic acids. Of these species, *P. hababiana* (figs. 26, 27), *P. subsumpta*, *P. abessinica*, *P. subcaperata*, *P. xanthina* (but not including *P. aberrans*) (figs. 10–12), *P. subtinctoria*, and their respective chemical strains each have essentially identical distribution patterns and, as far as we can tell, similar habitat requirements. I do not believe that these variants can be considered as distinct species at this time. Both chemical and geographic data suggest variable populations of single species.

TABLE 4.—*Chemical strains in* Amphigymnia.

Strain 1	Strain 2	Strain 3
P. hababiana Gyel. (cryptochlorophacic +fatty)	unnamed species (fatty)	—
P. abessinica Kremplh. (cryptochlorophaeic +fatty)	*P. glaucocarpoides* Zahlbr. (fatty)	—
P. subcaperata Kremplh. (salacinic)	*P. recipienda* Nyl. (cryptochlorophaeic +fatty)	—
P. subsumpta Nyl. (salacinic)	unnamed species (cryptochlorophaeic +fatty)	—
P. subtinctoria Zahlbr. (salacinic)	*P. haitiensis* Hale (cryptochlorophaeic +fatty)	unnamed species (salacinic, cryptochlorophaeic, +fatty)
P. xanthina (Müll. Arg.) Vain. (fatty)	*P. madagascariacea* (Hue) des Abb. (KC+unknown+fatty)	*P. aberrans* (Vain.) des Abb. (gyrophoric)
P. perforata (Jacq.) Ach. (norstictic)	*P. rigida* Lynge (alectoronic)	—
P. margaritata Hue (salacinic)	*P. arnoldii* Du Rietz (alectoronic)	—

The three remaining examples show well-defined differences in distribution patterns. *Parmelia margaritata* (fig. 9) is confined to east-central United States, whereas *P. arnoldii* (figs. 9, 16) is common in the mountains of western and eastern North America, Mexico, West Indies, South America, and Europe. *Parmelia xanthina* (in-

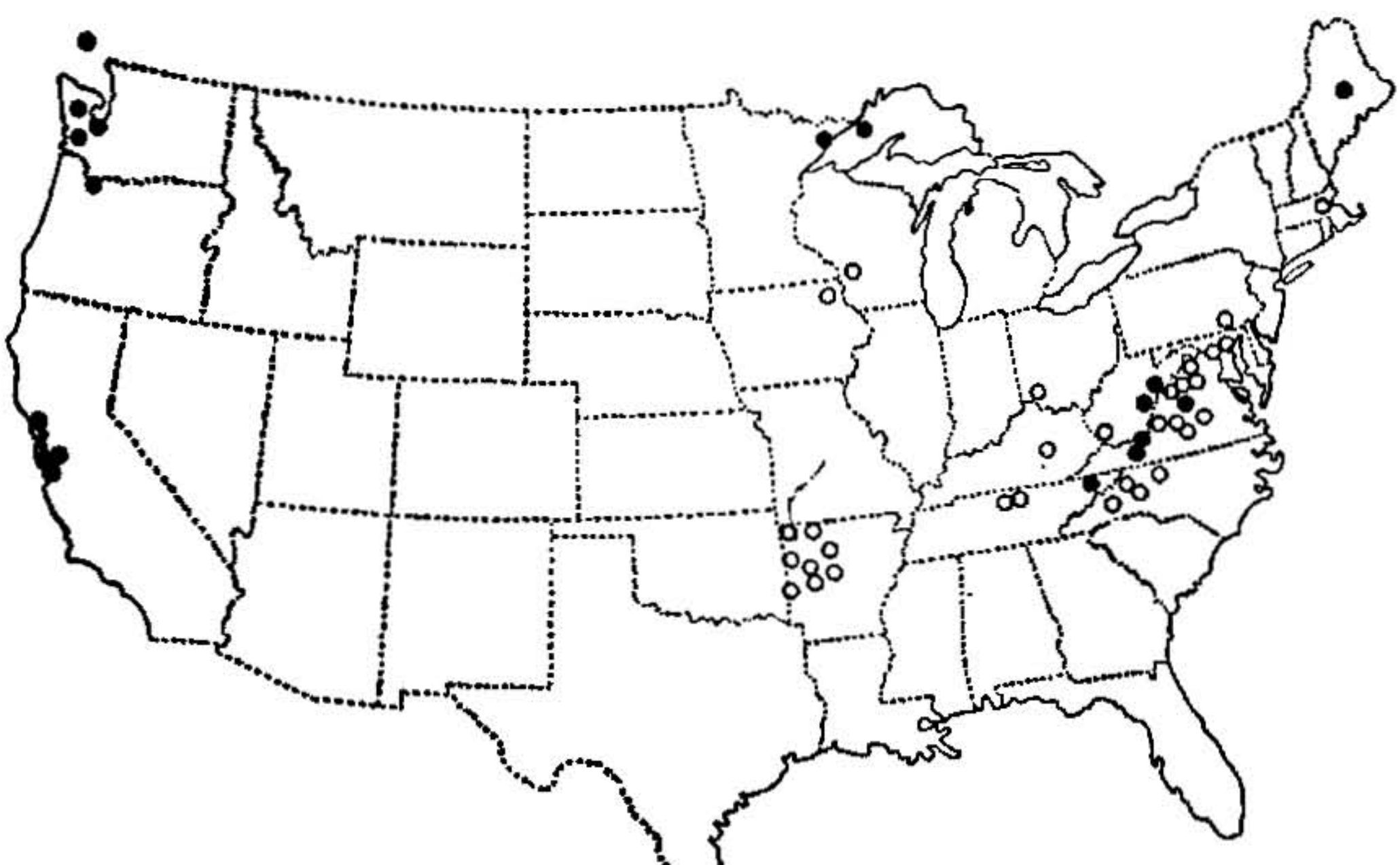
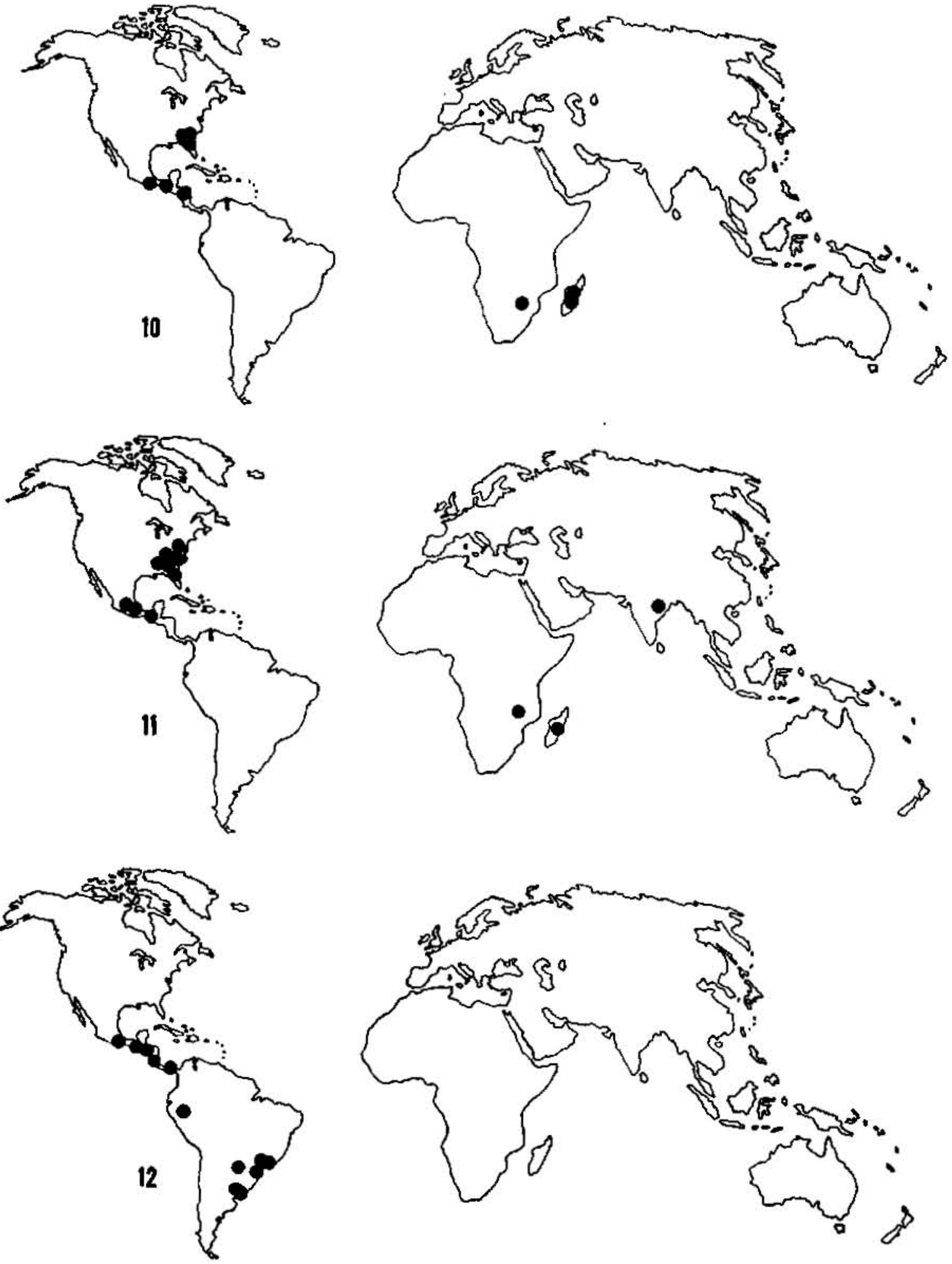


FIGURE 9.—Distribution in the United States of *Parmelia arnoldii* Du Rietz (●) and *P. margaritata* Hue (○).



FIGURES 10–12.—Distribution: 10, *Parmelia xanthina* (Müll. Arg.) Vain. (protolichesteric acid present); 11, *P. madagascariacea* (Hue) des Abb. (KC+ red unknown strain of *P. xanthina*); 12, *P. aberrans* (Vain.) des Abb. (gyrophoric acid present).

cluding *P. madagascariacea*) occurs widely in India, Africa, and North America (figs. 10, 11), but *P. aberrans* (fig. 12) is restricted to tropical America. *Parmelia rigida* occurs in southern South America and, with *P. perforata*, in the southern United States (fig. 29). *Parmelia perforata* extends much farther north in the United States (fig. 7). On the basis of the distribution patterns of these

species and the distinctiveness of the chemicals involved, I propose to recognize *P. arnoldii*, *P. aberrans*, and *P. rigida* as distinct species in addition to the earlier described chemical variants *P. margaritata*, *P. xanthina*, and *P. perforata*.

A definitive solution to the problem of recognizing chemical variation in lichens, if indeed such can ever be attained, must await two developments, a complete manual bringing up to date the identification of lichen acids and far more exhaustive field and herbarium studies of chemical strains. If chemical strains are not worthy of such complete investigation, then they are certainly not worthy of specific epithets and every effort should be made not to encumber the literature with hastily proposed chemical species.

Identification of Lichen Substances

A total of 23 different lichen substances, 15 of them definitely identified, has been demonstrated in the 106 species of *Amphigymnia* treated in this monograph. Almost every specimen examined was chemically tested. The substances were identified with routine microchemical procedures generally used by lichenologists, including color tests (concentrated aqueous solution of KOH, concentrated freshly prepared aqueous solution of Ca (O Cl)$_2$, and a 5% alcoholic solution of paraphenylenediamine ($C_6H_4(NH_2)_2$); Asahina's microchemical tests prepared according to Evans (1943); and chromatography with Whatman No. 1 paper. It must be emphasized that exhaustive analyses were not carried out because of limitations of equipment and space. Our attention was directed primarily at the substances of immediate use in taxonomy.

1. Alectoronic acid. This is the commonest substance, outside of atranorine, occurring in subgenus *Amphigymnia*. It was demonstrated in the following 21 species:

P. argentina
*P. arnoldii**
P. breviciliata
*P. chiapensis**
*P. corniculans**
P. direagens
P. erasmia
P. hypomiltoides
P. maclayana
*P. mellissii**
P. natalensis
*P. nilgherrensis**
P. ornatula
P. pancheri
P. procera
P. pseudonilgherrensis
*P. rampoddensis**
P. rigida
*P. rimulosa**
*P. subrugata**
P. wainii

Alectoronic acid is always deposited in the medulla. It usually occurs with small quantities of α-collatolic acid, but I have usually not attempted to make absolute identification of α-collatolic acid. Species in the above list marked with asterisks may also contain the red-orange pigment rhodophyscin, which is scattered in moribund

parts of the lower medulla. Alectoronic acid is identified by a bright fluorescence test, by the gummy residue from acetone, and by recrystallization in G.A.W. as small fan-shaped lamellae (Asahina, 1938, fig. 73).

2. Atranorine. This lichen substance occurs in varying concentration in all species of subgenus *Amphigymnia*. It is typically produced in the upper cortex where its presence is indicated by a distinct K+ pale-yellow reaction. It also probably occurs in the carbonized lower cortex as well, although here color tests are obscured. Only one species, *P. flavotincta*, contains atranorine in the medulla, a very rare occurrence in *Parmelia*. Atranorine is very easily identified in G.A.o–T. or in G.E. Because of its universal occurrence in *Amphigymnia* species, it has little diagnostic value, and it is merely observed as a constant component when tests are made for other lichen acids, especially with G.A.o–T.

3. Caperatic acid. This fatty acid has been positively identified in three species: *P. diacidula* (as an accessory component), *P. mesotropa*, and *P. praesorediosa*. Unfortunately the identification of lichen fatty acids has not been completely worked out. We have recognized caperatic acid by the formation of dendroid or warty globules in G.E. (cf. Asahina 1959, fig. 2). Caperatic acid is closely related to and probably occurs with protolichesteric acid in other species.

4. Cryptochlorophaeic acid. This acid was first discovered in *Cladonia* but later found in *Parmelia* (Hale, 1959a). Its chemical structure is unknown but it seems to be a depside. It has been found so far in six species of *Amphigymnia:*

P. abessinica
P. hababiana
P. schimperi
P. subcaperata
P. subsumpta
P. subtinctoria

In all of these species it is accompanied by protolichesteric acid, and in *P. subtinctoria* salacinic acid may be present as well. Each of these species, excepting *P. schimperi*, is represented by a chemical strain containing protolichesteric acid alone (*P. abessinica*, and *P. hababiana*) or salacinic acid (*P. subcaperata*, *P. subsumpta*, and *P. subtinctoria*). The medulla of species containing cryptochlorophaeic acid is KC+ deep red. A gummy residue from acetone recrystallizes as long curving needles in G.A.W. It should be noted that no crystals form in G.E.

5. Gyrophoric acid. This acid, widely distributed in lichen genera, occurs in nine species of subgenus *Amphigymnia*:

P. aberrans
P. diacidula
P. eunela
P. hanningtoniana
P. lobulascens
P. lophogena
P. permutata
*P. pseudocrinita**
*P. sancti-angelii**

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In the two species marked with asterisks rhodophyscin is an accessory component. *Parmelia permutata* contains in addition a K— orange-yellow pigment, *P. diacidula* contains caperatic acid, and *P. aberrans* contains usnic acid. The medulla of all of these species reacts C+ rose and the whitish residue from acetone recrystallizes as small warts or granules in G.E. or G.A.W. In problems where it must be absolutely differentiated from olivetoric or lecanoric acids, a chromatographic test is necessary; gyrophoric has a very low R_f value (Hale, 1956b).

6. Lecanoric acid. This acid, structurally related to gyrophoric acid, occurs in eight species, most of them common in Africa:

P. andina
P. austrosinensis
P. cooperi
P. defecta
P. hololoba
P. pseudotinctorum
P. soyauxii
P. tinctorum

The medulla is C+ deep blood red. The thick white acetone residue crystallizes as needle clusters in both G.E. and G.A.W. Chromatographic identification is very easy, lecanoric acid having an R_f range midway between gyrophoric acid and olivetoric acid.

7. Norstictic Acid. This is a rather rare acid in subgenus *Amphigymnia*, occurring in *P. aldabrensis*, *P. crassescens*, *P. hypotropa*, *P. perforata*, and *P. rubifaciens*. It may be intermingled with stictic acid in *P. aldabrensis* and *P. hypotropa*. The medullary color test is K+ yellow turning to red and P+ pale orange. Microchemical identification with G.A.o–T. is extremely simple, with the immediate formation of 4-angled yellow lamellae or small elliptical clusters.

8. Olivetoric acid. The only *Amphigymnia* species containing olivetoric acid are *P. abnuens* and *P. amboimensis*. The medulla is C+ deep red orange. The acetone residue is gummy and recrystallizes with some difficulty in G.A.W. A chromatographic test is usually needed for positive identification.

9. Protocetraric acid. This acid, with salacinic acid, is the second commonest acid in *Amphigymnia*, occurring in these 17 species:

P. blanchetii
*P. conformata**
*P. dilatata**
P. disparilis
*P. dominicana**
P. eborina
*P. fasciculata**
*P. fracta**
P. merrillii
P. pachyspora
P. peralbida
P. saccatiloba
P. setchellii
P. subarnoldii
P. subcorallina
*P. viridiflava**
P. zollingeri

Species with asterisks usually also contain usnic acid, and *P. subcorallina* contains protolichesteric acid. The medullary reaction is K— or faint brownish, C—, KC+ transient rose, and P+ brick red.

The acetone residue is usually small and recrystallizes as yellow balls from G.A.o-T. They can be mistaken for aggregates of salacinic acid (K+ red) but have a deeper color and less soluble residue.

10. Protolichesteric acid. As with caperatic acid, this fatty acid can only be identified with rather unsatisfactory microchemical tests with G.E. In this reagent thin angular or feathery plates are formed (cf. Asahina, 1959, fig. 4), sometimes aggregated and intergrading with caperatic acid. It occurs as the chief component in *P. abessinica* (ch. str.), *P. grayana*, *P. hababiana* (ch. str.), *P. melanothrix*, and in *P. ochroglauca* and *P. xanthina* accompanied with usnic acid. It also occurs as an accessory component in species containing cryptochlorophaeic acid. In *P. subcorallina* it occurs with protocetraric acid, in *P. paulensis* and *P. xanthina* (ch. str.) with unknown KC+ substances, and in *P. crocoides* and *P. cryptoxantha* with unidentified K− pigments. Because of the rather variable crystal shapes in G.E., we are not certain that the only fatty acid in these 14 species is protolichesteric acid or even that true protolichesteric acid is always present. It is hoped that future work in identification of these acids will help solve these problems.

11. Rhodophyscin. This red-orange hydroxyanthraquinone pigment was first discovered in *Physcia endococcinea*. It occurs in ten species of *Amphigymnia* as an accessory component with alectoronic or gyrophoric acids (see lists above under these acids). It reacts K+ deep purple. It is most easily identified with chromatography, forming a distinct spot at R_f .55–.65 (n-butanol-NH_4OH). Rhodophyscin occurs near the lower cortex in thalli that seem moribund or old. It must be carefully distinguished from the unknown K+ pigment No. 1 in *P. erasmia*, *P. hypomiltoides*, and *P. mesogenes* (see below).

12. Salacinic acid. This common K+ acid occurs in 17 species:

P. coralliformis
P. cristifera
*P. delicatula**
P. eurysaca
*P. flavescens**
P. latissima
P. leucosemotheta
P. margaritata
*P. miranda**
P. ramuscula
P. reparata
P. stuppea
P. subcaperata
P. subcrinita
*P. subsumpta**
P. subtinctoria
P. uruguensis

Species with asterisks also usually contain usnic acid; *P. subcaperata*, *P. subsumpta*, and *P. subtinctoria* have chemical strains with cryptochlorophaeic acid. Salacinic acid is first recognized by a deep red color test with K in the medulla. A usually abundant residue from acetone recrystallizes as deep yellow, boat-shaped plates in G.A.o–T. If aggregated, they may be confused at first with norstictic acid, which is also K+ red.

13. Stictic acid. Stictic acid occurs as the main component in only four species, *P. bangii*, *P. crinita*, *P. ciliata*, and *P. perlata*. It is an accessory component with norstictic acid in *P. aldabrensis* and *P. hypotropa*. The medulla reacts persistent K+ yellow and unmistakable colorless hexagons recrystallize in G.A.o–T.

14. Usnic acid. This yellow cortical pigment has been demonstrated in 12 species as an accessory component with gyrophoric acid (*P. aberrans*), protocetraric acid (*P. conformata*, *P. dominicana*, *P. fasciculata*, *P. fracta*, *P. viridiflava*), protolichesteric acid (*P. ochroglauca*, *P. xanthina*), salacinic acid (*P. delicatula*, *P. flavescens*, *P. miranda*), or a KC+ unknown (*P. xanthina*). It is found only rarely and in low concentration in *P. subsumpta*. Usnic acid can be tentatively identified by the yellow color of the thallus and is positively identified by a microchemical test with G.E. or with chromatography.

15. Vulpinic acid. This brilliant lemon-yellow pigment has been found in two species of subgenus *Amphigymnia*: *P. cornuta* and *P. sulphurata*. Microchemical identification can be made with G.E. (cf. Asahina, 1954b). Care should be taken not to confuse this pigment with other unidentified K— pigments (see below) which are pale yellow orange or yellow.

16. Unidentified hydroxyanthraquinone pigment No. 1. This conspicuous red-orange pigment occurs in the medulla of *P. erasmia* and *P. hypomiltoides*, both of which also contain alectoronic acid, and in *P. mesogenes*, which contains unknown substances. This pigment forms a streak with a lower R_f than rhodophyscin. It is more or less uniformly deposited, generally near the lower cortex, even at lobe tips, and is not associated with moribund parts of the medulla.

17. Unidentified K— pigment No. 1. The following six species contain the same pale yellow-orange pigment, heavily concentrated in the medulla of apothecia and in the lower half or all of the medulla: *P. appendiculata*, *P. araucariarum*, *P. endosulphurea*, *P. myelochroa*, *P. permutata*, and *P. subcolorata*. This pigment is accompanied by gyrophoric acid in *P. permutata*. In the remaining species the accompanying components have not been identified. Barbatic acid is suspected but not yet positively identified. The K, C, and P reactions are vague and microchemical tests have been fruitless.

18. Unidentified K— pigment No. 2. Two species, *P. cryptoxantha* and *P. ebulliens*, contain traces of a very faint unidentified yellow pigment.

19. P+ Unknown. *Parmelia direagens*, in addition to alectoronic acid, contains an unidentified P+ substance in the soredia, which forms deep-yellow warts in G.A.o-T.

20. K+ Unknown. *Parmelia inexspectata* contains an unknown

K+, P— substance which has not been identified with any crystal tests.

21. Unknown KC+ substance No. 1. One chemical strain of *P. xanthina* (*P. madagascariacea* strain) reacts KC+ red. Abundant colorless needles and aggregate clusters form in G.E., but they have not been identified.

22. Unknown KC+ substance No. 2. This unidentified compound is found in *P. paulensis*. It reacts KC+ faint red; no identification has been made.

23. Unknown substances. *Parmelia mesogenes* Nyl. contains a colorless substance that is unreactive with color tests. It forms large needle clusters in G.E.

Geographical Distribution

Phytogeography of lichens is actually no more than a presentation of known distribution patterns interpreted with reference to patterns already established for phanerogams and ferns. Higher plants have a fossil record, and there is a more or less coherent link between modern and fossil forms. Lichens have no fossil records and we know nothing of their evolution in geological ages. We will therefore confine our discussions here to a summary of the distribution patterns. These discussions must be tempered with the fact that more thorough collecting will undoubtedly extend the distributions of many of the species now considered to be endemic.

The following 26 species are pantropical. By our definition this means that they have been found on at least three of the major continental areas, North or South America, Europe, Africa, Asia, and Australia, although they may be very rare in some parts of their ranges.

P. andina (fig. 5)
P. austrosinensis (fig. 6)
P. breviciliata (fig. 23)
P. crinita (fig. 17)
P. cristifera (fig. 4)
P. dilatata
P. endosulphurea (fig. 14)
P. euneta
P. hababiana (figs. 26, 27)
P. hypotropa
P. mellissii
P. perlata (fig. 20)
P. permutata
P. praesorediosa (fig. 15)
P. rampoddensis
P. sancti-angelii
P. stuppea (fig. 21)
P. subarnoldii
P. subcrinita
P. subrugata
P. subsumpta
P. subtinctoria (fig. 24)
P. sulphurata (fig. 22)
P. tinctorum
P. xanthina (figs. 10, 11)
P. zollingeri

The most interesting observation that can be made on the cosmopolitan species is that half of them (13) are sorediate. Only five species (*P. andina*, *P. breviciliata*, *P. euneta*, *P. subrugata*, and *P. zollingeri*) lack soredia and isidia.

The following 30 species are endemic to the Americas. Many of these are restricted to Mexico, the West Indies, or South America, as may be seen in the lists of localities below. In contrast to the pantropical species, half (15) of the species here lack soredia and isidia. Only eight are sorediate.

P. aberrans (fig. 12)
P. abnuens
P. araucariarum
P. argentina
P. bangii
P. blanchetii
P. chiapensis
P. coralliformis
P. cornuta
P. crassescens
P. crocoides
P. delicatula
P. eborina
P. ebulliens
P. erasmia
P. eurysaca
P. flavescens
P. flavotincta
P. fracta
P. hypomiltoides
P. margaritata
P. mesogenes
P. mesotropa
P. miranda
P. myelochroa
P. peralbida
P. rigida
P. rubifaciens
P. uruguensis
P. viridiflava

Twenty-two species have been found only in Africa, mostly central and southern Africa. As in the Americas, about half of them lack soredia and isidia.

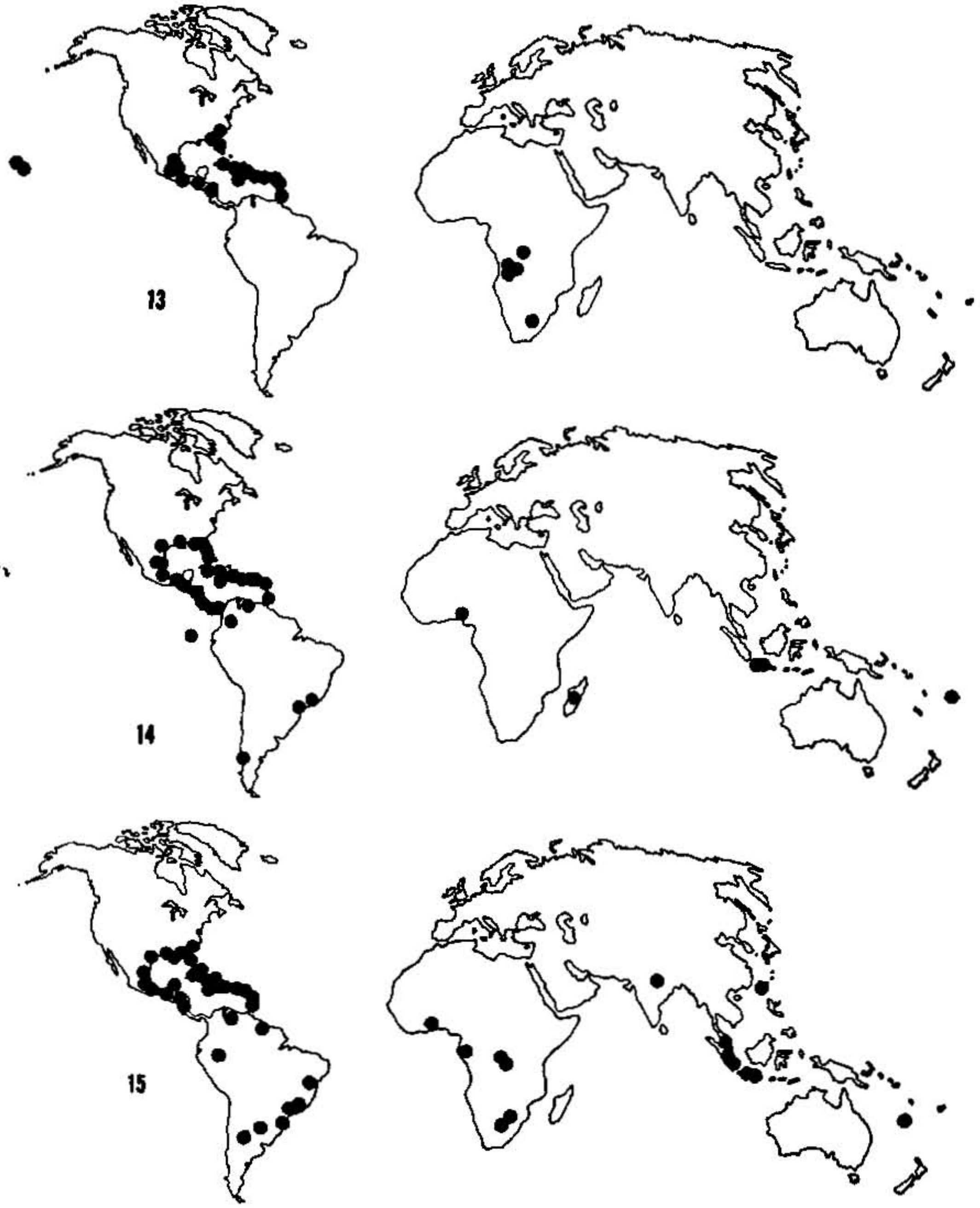
P. amboimensis
P. cooperi (fig. 25)
P. cryptoxantha
P. defecta
P. diacidula
P. direagens
P. hanningtoniana
P. hololoba
P. inexpectata
P. lobulascens
P. lophogena
P. maclayana
P. natalensis
P. ochroglauca
P. ornatula
P. pachyspora
P. pseudocrinita
P. pseudotinctorum
P. rimulosa
P. schimperi
P. soyauxii
P. subcolorata

Seven species occur only in tropical America and Africa:

P. abessinica
P. conformata
P. disparilis
P. eciliata (fig. 18)
P. fasciculata
P. leucosemotheta
P. wainii

Three additional species, *P. appendiculata*, *P. melanothrix*, and *P. paulensis*, are typically American but have disjunct distributions in Madagascar or nearby islands.

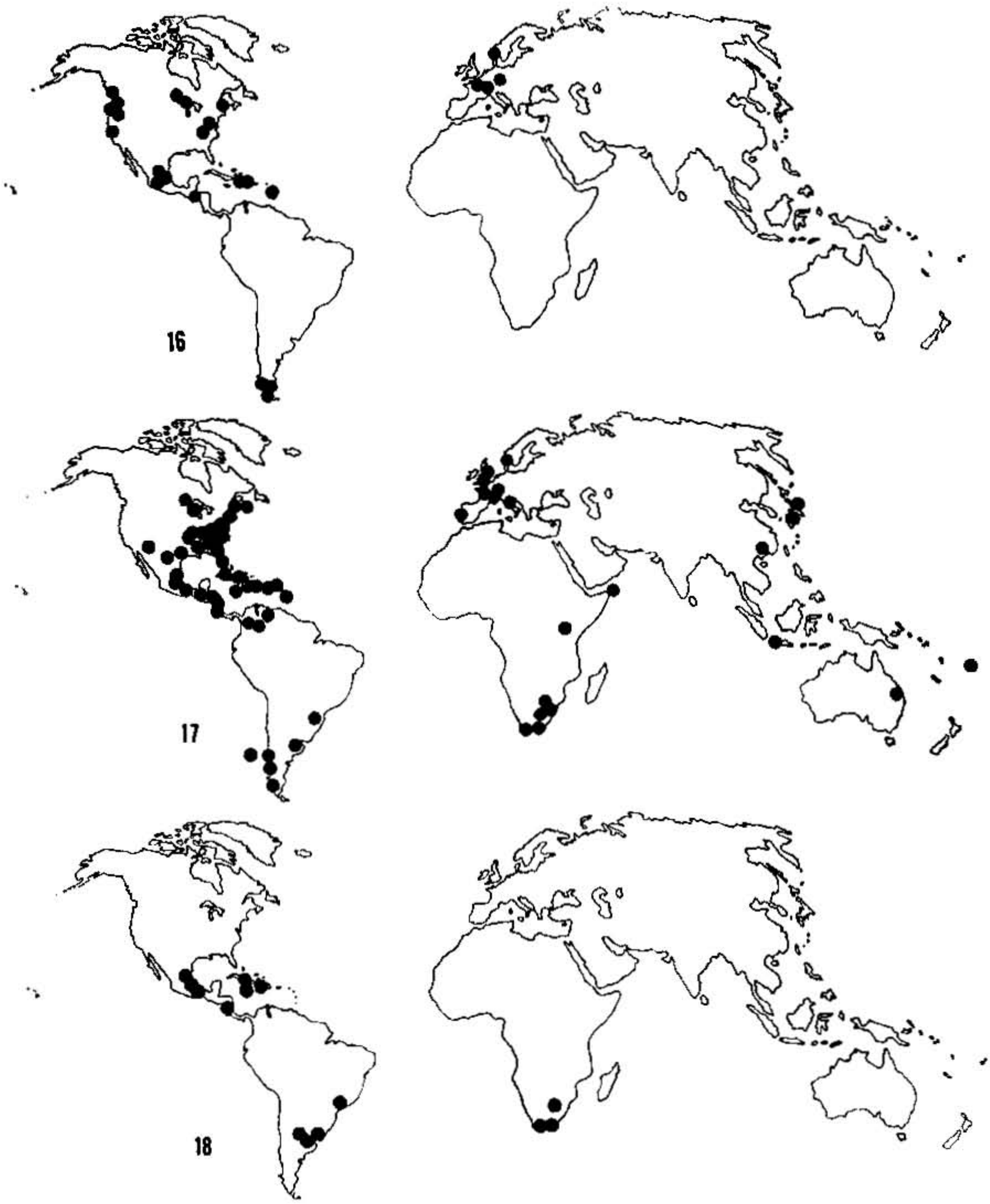
Only four species, *P. corniculans*, *P. merrillii*, *P. nilgherrensis* (fig. 28), and *P. subcorallina*, are restricted to Asia. Two species, *P. grayana* (fig. 19) and *P. pseudonilgherrensis*, occur in Asia and in Africa.



FIGURES 13–15.—Distribution: 13, *Parmelia dominicana* Vain.; 14, *Parmelia endosulphurea* (Hillm.) Hale; 15, *Parmelia praesorediosa* Nyl.

Three species, *P. ramuscula*, *P. saccatiloba*, and *P. setchellii*, are endemic to the Pacific region. On the whole, this region has a very poor *Amphigymnia* flora.

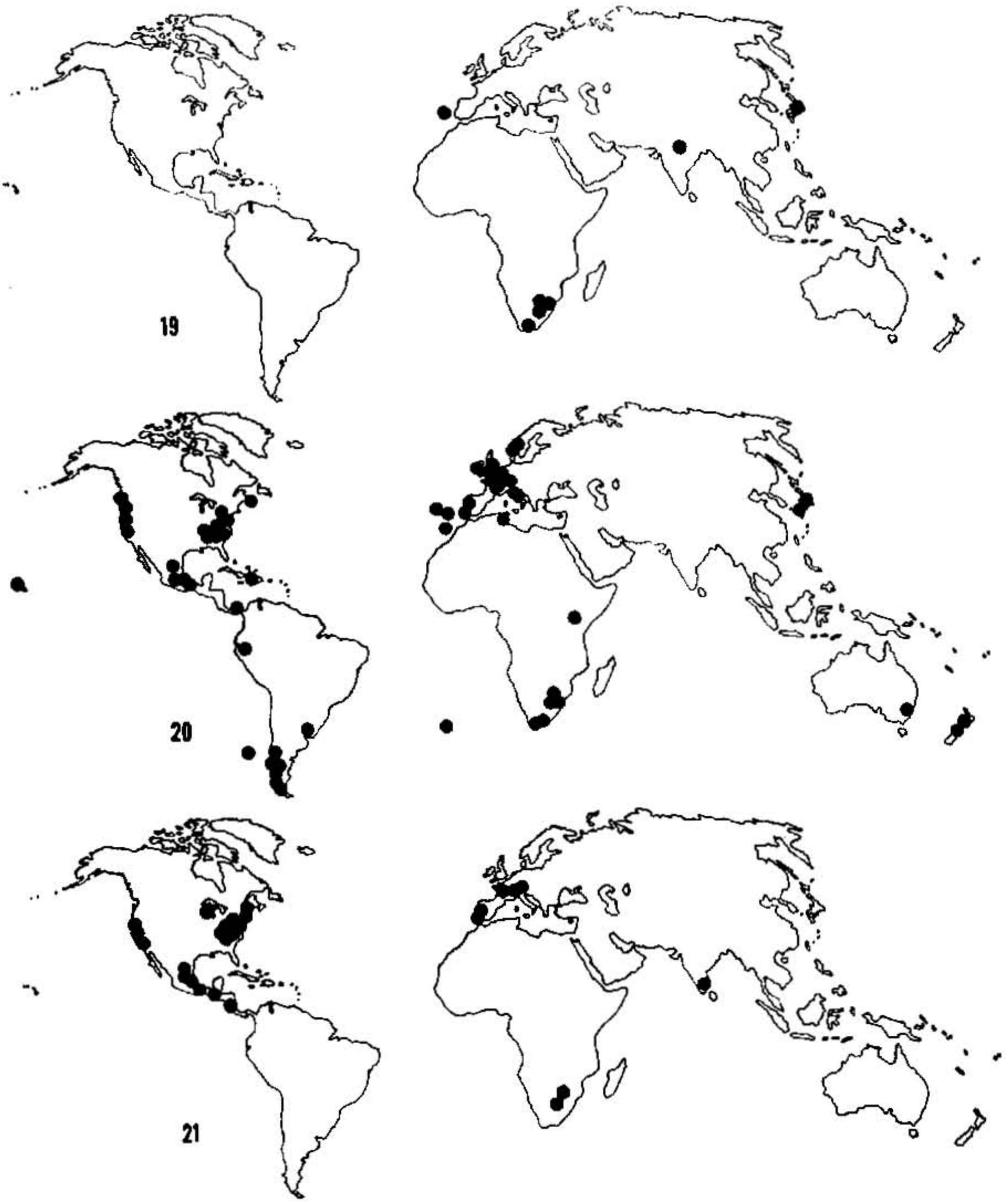
Two species, *P. reparata* and *P. subcaperata*, have an unusual distribution in America and Australia–New Zealand. These may eventually prove to be pantropical, although their absence in Africa seems reasonably well established. It should be noted in passing that there are no *Amphigymnia* species endemic to Australia or New Zealand.



FIGURES 16–18.—Distribution: 16, *Parmelia arnoldii* Du Rietz; 17, *Parmelia crinita* Ach.; 18, *Parmelia eciliata* (Nyl.) Nyl.

The remaining species are not easily classified. These include *P. aldabrensis* (Africa, India Ocean), *P. arnoldii* (temperate North and South America, Europe), *P. dominicana* (Hawaii, Tropical America, Africa), *P. latissima* (Tropical America, India), *P. pancheri* (New Caledonia, Asia), *P. perforata* (North America, Europe, Madagascar), and *P. procera* (Africa, Asia, New Caledonia).

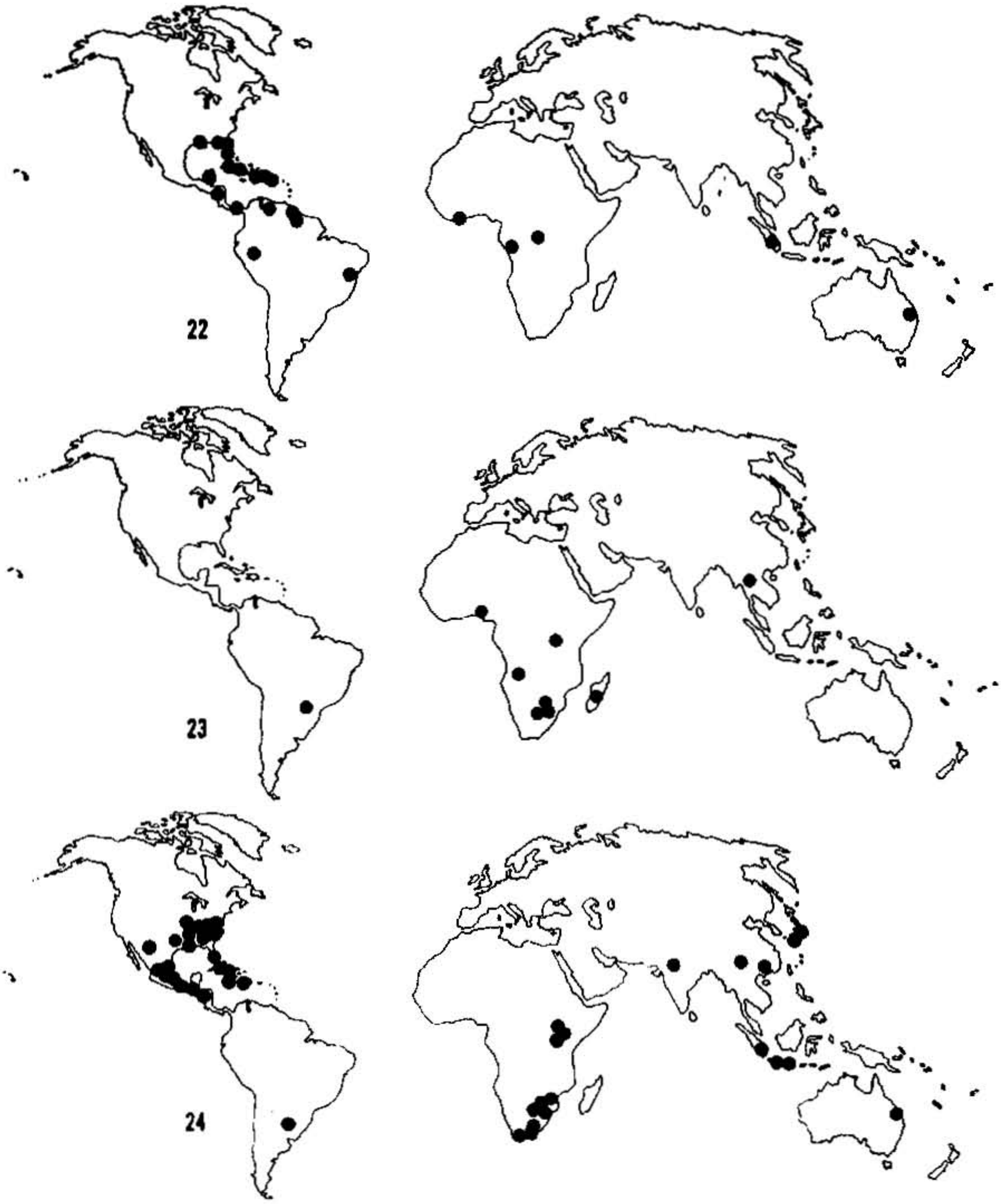
A further breakdown of the species according to the total number in various geographic areas is instructive and shows parallelism with



FIGURES 19–21.—Distribution: 19, *Parmelia grayana* Hue; 20, *Parmelia perlata* (Huds.) Ach.; 21, *Parmelia stuppea* Tayl.

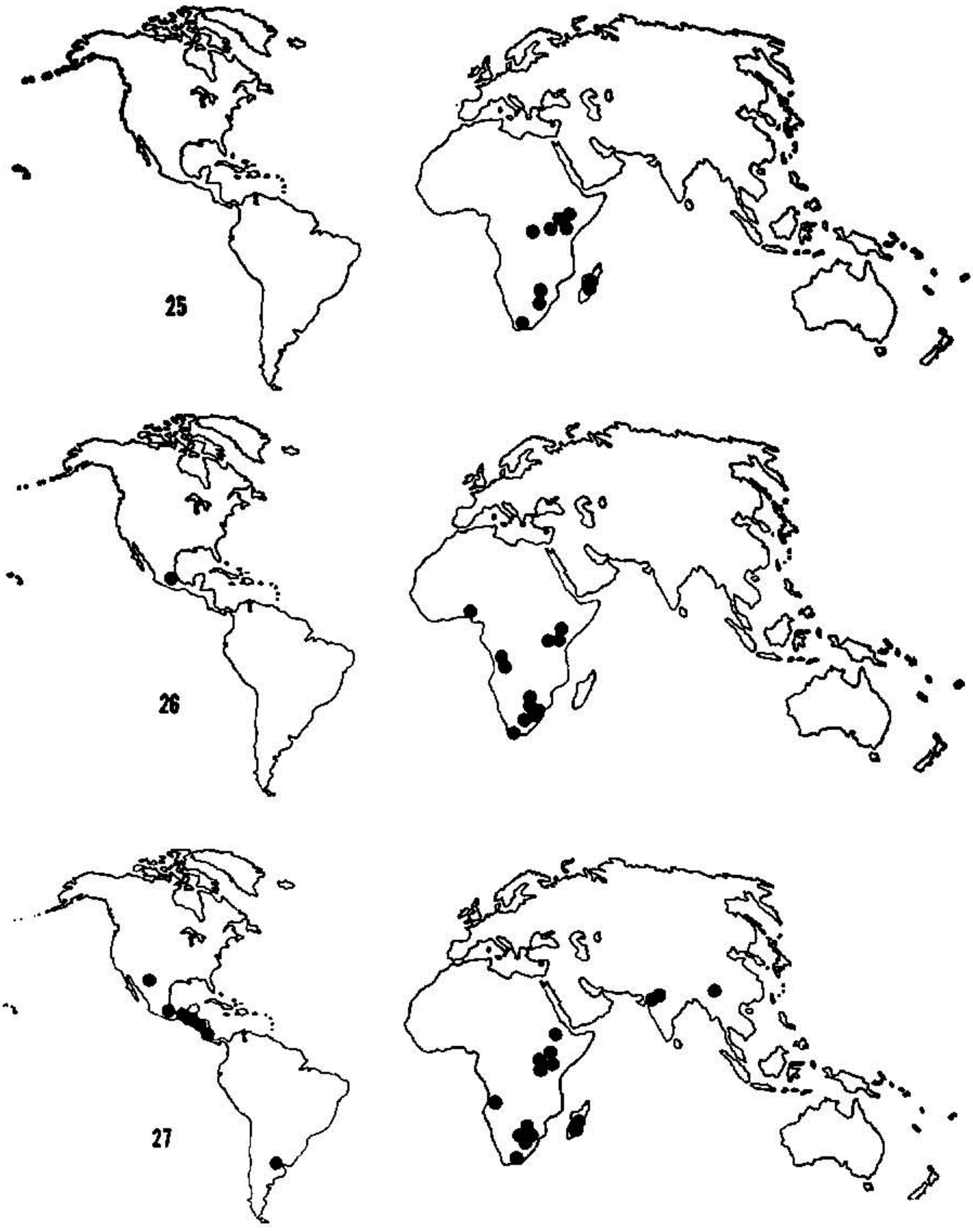
the degree of endemicity. North America north of Mexico has an *Amphigymnia* flora of 25 species, Mexico and Central America 47, the West Indies 27, and South America 51. Europe has only 8 species (*P. arnoldii*, *P. austrosinensis*, *P. crinita*, *P. dilatata*, *P. hypotropa*, *P. perforata*, *P. perlata*, and *P. stuppea*). Africa has a grand total of 64 species, making it the richest area. Asia has 36 species, the Pacific region 10, and Australia and New Zealand 17.

The ecology of the *Amphigymnia* species seems to be comparatively



FIGURES 22–24.—Distribution: 22, *Parmelia sulphurata* Nees & Flot.; 23, *Parmelia breviciliata* Hale.; 24, *Parmelia subtinctoria* Zahlbr. (specimens with salacinic acid).

simple. Almost all of them flourish best in open rather dry deciduous forests or savannas at low to medium elevation. In dense deciduous forests the typical habitat is the canopy branches. In open savannas or pastures or on shade trees in coffee or banana plantations the lower trunks are thickly covered with Amphigymnias. At sea level the most commonly collected species are the pantropical weeds such as *P. praesorediosa* and *P. tinctorum*. The richest development of species, at least in the tropics, appears to be at elevations between 500 and 2000 m. Few species are found above 3000 m.



FIGURES 25–27.—Distribution: 25, *Parmelia cooperi* Stein. & Zahlbr.; 26–27, *Parmelia hababiana* Gyel.: 26, protolichesteric acid strain (=*P. glaucocarpoides* Zahlbr.); 27, cryptochlorophaeic acid strain).

Subgeneric Classification

The number of previously described subgeneric taxa in *Amphigymnia* is small and most of them, in fact, have been proposed by only two lichenologists, Vainio and Gyelnik. The typification of these few names, however, has been extremely difficult, mainly because Vainio's classification, used by almost all lichenologists, is based on

color of the thallus (presence or absence of usnic acid), a character which we have found to be of secondary importance. Because of this, it might be well to review first the important morphological characters that we have determined in subgenus *Amphigymnia*, especially with respect to their possible use in setting up a subgeneric classification. These data may be summarized as follows:

1. Isidia, soredia, and the lack of isidia and soredia in general show very weak association with other morphological and chemical characters. There was rather significant correlation between sorediate–NIS species but not enough to justify splitting them from the isidiate species.

2. Maculae, cilia, and perforate apothecia all show a high degree of association with each other and with white rim below.

3. Spore size is not consistently correlated with any characters outside of some of the rarer acids.

4. The presence of usnic acid is a rather rare trait negatively associated with maculae and perforate apothecia.

After considering these data, we must conclude that there is no one dominating character that will immediately divide *Amphigymnia* into natural sections. The primary characters are cilia, maculae, perforate apothecia, and white rim below, all of which are mutually associated and show strong association with some of the lichen acids. Of these four characters, perforate apothecia are least usable because nearly 25% of the species are sterile. Maculae are useful but are difficult to recognize without considerable experience. White rim below can also be troublesome to distinguish and is a relatively rare character. This leaves cilia as the most likely and certainly the most easily recognized character for a major sectional division.

If we proceed now to a study of subgeneric taxa proposed by past workers, we find only one basic system, which was first proposed by Vainio (1890) as the result of his experience with the lichen flora of Rio de Janeiro. He divided *Parmelia* into three sections: *Amphigymnia*, *Hypotrachyna* (=*Parmelia*), and *Xanthoparmelia*. These sections, now recognized as subgenera, were carefully delimited for the most part and have been correctly interpreted by most lichenologists. In this monograph our attention will be directed only at subgenus *Amphigymnia*.

Within section *Amphigymnia*, Vainio erected two groups without formal rank, based entirely on color of the thallus: *Subglaucescentes*, gray species (lacking usnic acid) and *Subflavescentes*, the yellow-green species (usnic acid present). As far as we know, no one has ever attempted to typify Vainio's subgeneric taxa. It seems reasonable to assume that he considered *Subglaucescentes* to be the typical group in *Amphigymnia* since it is the largest and is presented first. The

Subflavescentes by contrast is a smaller group of only three species. The selection of a lectotype for *Subflavescentes* is not difficult since the species listed here by Vainio all contain usnic acid and are ciliate. *Parmelia delicatula* seems to be the most suitable type species and has also been mentioned as such by Gyelnik (1932, p. 225).

The eight species assigned by Vainio to *Subglaucescentes* form a motley group, some ciliate, some nonciliate. Selection of a type must unfortunately be arbitrary. Since the lectotype of *Subflavescentes* is ciliate, it would seem desirable to select a nonciliate species for *Subglaucescentes*, especially in view of our reliance on cilia as a primary character. The best known nonciliate species listed is *P. tinctorum* Nyl. (identified by Vainio as *P. coralloidea* (Mey. & Flot.) Vain.), a common pantropical species. As will be seen, Gyelnik also defined *Subglaucescentes* as including typically nonciliate species as well as ciliate ones.

The second major subgeneric classification for the Amphigymnias was proposed by Gyelnik in 1932. It is essentially a modification of Vainio's. Gyelnik did not recognize section *Amphigymnia* but adopted in its place two sections, *Subflavescentes* (Vain.) Gyel. and *Subglaucescentes* (Vain.) Gyel., and created within each section parallel nonciliate–ciliate subsections as follows:

Section *Subflavescentes* (Vain.) Gyel.
  Subsection *Eciliatae* Gyel. (lectotype *P. caperata*)
  Subsection *Ciliatae* Gyel. (type *P. delicatula*)
Section *Subglaucescentes* (Vain.) Gyel.
  Subsection *Eciliolae* Gyel. (lectotype *P. perlata*)
  Subsection *Ornaticolae* Gyel. (lectotype *P. perforata*)

Gyelnik made several errors which make typification rather arbitrary. Of three species listed for subsection *Eciliatae*, one (*P. kernstockii* Lynge & Zahlbr.=*P. flaventior* Stirt.) is pseudocyphellate and two (*P. soredians* Nyl. and *P. caperata* (L.) Ach.) belong in subgenus *Parmelia*. *Parmelia perlata*, the type of subsection *Eciliolae*, is actually ciliate and it is possible that Gyelnik did not interpret this species correctly.

Our studies correlating morphology and chemistry in *Amphigymnia* have convinced us that thallus color is useless as a sectional character. If our assessment of the importance of cilia is correct, Gyelnik has come closest to a natural subdivision of subgenus *Amphigymnia*, although it is complicated by his acceptance of Vainio's two color based groups. By recombining taxa described by Vainio and Gyelnik, we are proposing the following classification. Typification and discussions of each taxon will be presented below in the list of species.

Subgenus *Amphigymnia* (Vain.) Dodge
  1. Section *Amphigymnia* (Section *Subglaucescentes* (Vain.) Gyel.)

2. Section *Subflavescentes* (Vain.) Gyel.
   Subsection *Subflavescentes*
      Series *Subflavescentes*
      Series *Emaculatae* Hale
   Subsection *Ornaticolae* Gyel.
      Series *Subpallidae* Hale
      Series *Ornaticolae*

Key to the Subgeneric Taxa

1. Margins and apices of lobes without cilia or axils of lobes rarely sparsely ciliate . . . . . 1. Section **Amphigymnia**
1. Margins and apices of lobes distinctly ciliate . . 2. Section **Subflavescentes**
   2. Upper cortex without distinct maculae . . . . Subsection **Subflavescentes**
      3. Thallus yellow (usnic acid) . . . . . Series **Subflavescentes**
      3. Thallus mineral gray (usnic acid lacking) . . . . . Series **Emaculatae**
   2. Upper cortex distinctly maculate . . . . . Subsection **Ornaticolae**
      4. Lower side uniformly pale brown, short rhizinate to the margins. Series **Subpallidae**
      4. Lower side black and rhizinate in the center, brown to white or mottled and naked along the margins . . . . . Series **Ornaticolae**

Artificial Key to Species

1. Thallus isidiate, sorediate-isidiate, or pustulate . . . . . I.
1. Thallus lacking isidia.
   2. Thallus sorediate or pustulate . . . . . II (p. 230).
   2. Thallus lacking soredia or pustules . . . . . III (p. 232).

I. THALLUS ISIDIATE, SOREDIATE-ISIDIATE, OR PUSTULATE

1. Margins of lobes smooth, without cilia.
   2. Medulla pale yellow orange . . . . . **13. P. endosulphurea**
   2. Medulla white.
      3. Thallus yellowish green, usnic acid present.
         4. Isidia normal, to 1 mm. high, laminal . . . . . **31. P. conformata**
         4. Isidia coralloid, to 5 mm. high, mostly marginal . . **14. P. fasciculata**
      3. Thallus mineral gray to buff, usnic acid lacking.
         5. Isidia coralloid, to 5 mm. high, mostly marginal.
            6. Medulla K+ red (salacinic acid) . . . . . **23. P. ramuscula**
            6. Medulla K−, P+ red (protocetraric acid) . . . **14. P. fasciculata**
         5. Isidia laminal, to 1 mm. high, not conspicuously coralloid.
            7. Isidia very thick, 0.2–0.3 mm. in diameter.
               8. Medulla C+ red (lecanoric acid); Africa . **22. P. pseudotinctorum**
               8. Medulla C−, P+ red (protocetraric acid); Pacific region. **26. P. setchellii**
            7. Isidia thin, usually less than 0.1 mm. thick.
               9. Medulla C+ red (lecanoric acid) . . . . . **28. P. tinctorum**
               9. Medulla C−, P+ red (protocetraric acid).
                  10. Thallus coriaceous; spores large; Pacific region. **25. P. saccatiloba**
                  10. Thallus membranous; spores small; tropical America. **20. P. peralbida**
1. Margins of lobes distinctly ciliate.
   11. Medulla deep lemon yellow, K− . . . . . **78. P. sulphurata**

11. Medulla white or pigmented, pigment K+ purple.
12. Thallus yellowish green, usnic acid present.
13. Lower side pale below, short rhizinate or papillate to the margin.
82. P. subtinctoria
13. Lower side jet black, the margins naked.
14. Medulla K+ red or brown.
15. Plants saxicolous; salacinic acid present . . . **33. P. flavescens**
15. Plants corticolous; protocetraric and fumarprotocetraric acid present . . . . . **31. P. conformata**
14. Medulla K−.
16. Medulla P+ red (protocetraric and fumarprotocetraric acid).
31. P. conformata
16. Medulla P−.
17. Medulla C+ rose (gyrophoric acid) . . . . . **30. P. aberrans**
17. Medulla C−, KC− or KC+ rose . . . . . **37. P. xanthina**
12. Thallus mineral or ashy gray to buff, usnic acid lacking.
18. Isidia coralloid, marginal, 1–5 mm. high.
19. Cortex heavily white maculate . . . . . **88. P. coralliformis**
19. Cortex emaculate.
20. Medulla K+ yellow (atranorine) . . . . . **54. P. flavotincta**
20. Medulla K− (alectoronic acid) . . . . . **63. P. mellissii**
18. Isidia simple to moderately branched, to 1 mm. high.
21. Isidia thick, pustular; medulla C+ rose (gyrophoric acid).
60. P. lophogena
21. Isidia thin, not pustulate (but sometimes sorediate); medulla C−.
22. Isidia in part granular or sorediate.
23. Medulla P+ red (protocetraric acid) . . **76. P. subcorallina**
23. Medulla P−.
24. Alectoronic acid present . . . . . **63. P. mellissii**
24. Protolichesteric acid present . . . . . **98. P. paulensis**
22. Isidia normal, cylindrical.
25. Medulla in part orange red, pigment K+ purple.
26. Medulla C+ rose (gyrophoric acid); Africa.
70. P. pseudocrinita
26. Medulla C− (alectoronic acid); Central America and Mexico.
52. P. erasmia
25. Medulla entirely white.
27. Lower side uniformly brown, short rhizinate to the margin.
82. P. subtinctoria
27. Lower side jet black, the margins more or less naked.
28. Medulla C+ rose (gyrophoric acid); Africa.
70. P. pseudocrinita
28. Medulla C−; cosmopolitan species.
29. Medulla K+ persistent yellow (stictic acid).
47. P. crinita
29. Medulla K+ red (salacinic acid).
30. Cortex strongly maculate; lower side rhizinate or papillate to margin, pale brown in a broad zone.
82. P. subtinctoria
30. Cortex emaculate or faintly maculate; lower side naked and shiny dark brown along the margins.
77. P. subcrinita

II. THALLUS SOREDIATE OR PUSTULATE

1. Margins of lobes smooth, without cilia.
   2. Medulla pale yellow orange . . . . . **2. P. araucariarum**
   2. Medulla white.
      3. Medulla K+ red.
         4. Soredia farinose, soralia elongate; thallus loosely attached; salacinic acid present . . . . . **5. P. cristifera**
         4. Soredia more or less conglutinated, soralia irregular; thallus adnate; norstictic acid present . . . . . **24. P. rubifaciens**
      3. Medulla K− or K+ brownish.
         5. Medulla P+ red (protocetraric acid).
            6. Soredia farinose, yellowish, usnic acid abundant . **10. P. dominicana**
            6. Soredia granular, white, usnic acid usually absent . . **8. P. dilatata**
         5. Medulla P−.
            7. Medulla C−, KC− (caperatic acid) . . . . . **21. P. praesorediosa**
            7. Medulla C+, KC+ red (lecanoric acid).
               8. Plants saxicolous, dark below at the margin . . . . **7. P. defecta**
               8. Plants corticolous, often pale or white rimmed below. **3. P. austrosinensis**

1. Margins of lobes ciliate.
   9. Thallus yellowish green, usnic acid present.
      10. Lower side pale, short rhizinate to the margin . . . **81. P. subsumpta**
      10. Lower side black, naked at the margin.
         11. Soredia laminal in extensive pustules . . . . . **55. P. fracta**
         11. Soredia marginal or submarginal in linear soralia.
            12. Medulla K+ red (salacinic acid); Mexico . . . . **34. P. miranda**
            12. Medulla K− or K+ brown.
               13. Medulla P− (protolichesteric acid); Africa . **35. P. ochroglauca**
               13. Medulla P+ red (protocetraric acid); tropical America. **36. P. viridiflava**
   9. Thallus mineral or whitish gray to buff, usnic acid absent.
      14. Soredia chiefly laminal, often originating from extensive pustular eruptions.
         15. Soralia orbicular; thallus coriaceous, upper cortex maculate; Africa. **96. P. natalensis**
         15. Soralia originating from irregular cracks and pustules; thallus membranous, cortex emaculate.
            16. Medulla K−, P− (alectoronic acid); South Africa . **72. P. rimulosa**
            16. Medulla K+ yellow or red, P+ yellowish.
               17. Stictic acid present; South America . . . . . **42. P. bangii**
               17. Stictic acid absent; Africa . . . . . **48. P. cryptoxantha**
      14. Soredia chiefly marginal, pustules lacking.
         18. Medulla in part with red or yellow-orange pigments.
            19. Pigments K−; medulla C+ rose (gyrophoric acid). **68. P. permutata**
            19. Pigments K+ purple.
               20. Medulla C+ rose (gyrophoric acid) . . . **73. P. sancti-angelii**
               20. Medulla C−, KC+ red (alectoronic acid).
                  21. Pigment conspicuous throughout the medulla; soredia submarginal and subisidiate . . . . . **58. P. hypomiltoides**
                  21. Pigment scattered near the lower cortex; soredia farinose.

22. Soredia originating submarginally; sorediate lobes revolute.
41. P. arnoldii

22. Soredia terminal; sorediate lobes involute.
71. P. rampoddensis

18. Medulla white, pigments absent.
23. Medulla K+ yellow or yellow turning red.
24. Cortex distinctly maculate.
25. Lower side usually pale, rhizinate or papillate to the margin.
81. P. subsumpta

25. Lower side black, brown or white and naked along the margins.
26. Lower side with a white marginal rim; norstictic or stictic acid present . . . . . **92. P. hypotropa**

26. Lower side brown along the margins; salacinic acid present.
93. P. leucosemotheta

24. Cortex dull, emaculate.
27. Soralia linear, terminal. . . . . **74. P. stuppea**

27. Soralia orbicular to sublinear, submarginal, the sorediate lobes revolute.
28. Soralia chiefly on lobe margins, mostly linear; stictic acid present . . . . . **67. P. perlata**

28. Soralia chiefly on marginal lobules or laciniae, mostly orbicular; salacinic acid present . . . . . **62. P. margaritata**

23. Medulla K−.
29. Medulla P+ red.
30. Only soredia reacting P+ orange red; South Africa.
50. P. direagens

30. Soredia and medulla both reacting P+ orange red; pantropical.
31. Cilia produced densely around lobe tips; soralia linear.
75. P. subarnoldii

31. Cilia sparse or absent at lobe tips; soralia irregular.
8. P. dilatata

29. Medulla P−.
32. Medulla C+ rose or red.
33. Cortex distinctly maculate.
34. Medulla C+ rose (gyrophoric acid) . . **94. P. lobulascens**
34. Medulla C+ red (lecanoric acid) . . . . **87. P. cooperi**

33. Cortex emaculate or in part faintly maculate.
35. Medulla C+ red (lecanoric acid) . . . . **87. P. cooperi**
35. Medulla C+ rose (gyrophoric acid).
36. Soralia farinose, linear; pantropical.
73. P. sancti-angelii

36. Soralia coarse, irregular; caperatic acid present; South Africa . . . . . **49. P. diacidula**

32. Medulla C−.
37. Lower side rhizinate or papillate to the margin, pale in a broad zone . . . . . **81. P. subsumpta**

37. Lower side with a broad naked zone, jet black at the center, pale or dark brown at the margin.
38. Cortex maculate.
39. Lower side with a broad ivory zone. . **90. P. hababiana**
39. Lower side dark brown at the margins.
100. P. pseudonilgherrensis

38. Cortex emaculate; lower side dark at the margin.
40. Medulla KC— (protolichesteric acid); Africa and Asia. **56. P. grayana**
40. Medulla KC+ red (alectoronic acid); pantropical.
41. Soralia in part submarginal; sorediate lobes revolute. **41. P. arnoldii**
41. Soralia terminal; sorediate lobes involute. **71. P. rampoddensis**

III. THALLUS LACKING SOREDIA OR PUSTULES

1. Margins of lobes lacking cilia.
2. Medulla pigmented orange red or yellow.
3. Pigment K+ purple . . . . . **16. P. mesogenes**
3. Pigment K—.
4. Pigment pale yellow; acetone residue bubbling in G.E. **12. P. ebulliens**
4. Pigment yellow orange; acetone residue not bubbling.
5. Protolichesteric acid present . . . . . **6. P. crocoides**
5. Fatty acids lacking . . . . . **18. P. myelochroa**
2. Medulla white.
6. Medulla K+ red.
7. Spores 28–32 μ; salacinic acid present . . . . . **15. P. latissima**
7. Spores 20–25 μ; norstictic acid present . . . . . **4. P. crassescens**
6. Medulla K— or K+ brownish.
8. Medulla P+ orange red.
9. Plants saxicolous; spores 11–16 μ long . . . . . **11. P. eborina**
9. Plants corticolous; spores 16–22 μ long.
10. Cortex maculate; margins laciniate . . . . . **9. P. disparilis**
10. Cortex emaculate; margins smooth, rarely laciniate. **29. P. zollingeri**
8. Medulla P—.
11. Medulla C+ red (lecanoric acid).
12. Plants saxicolous; Africa . . . . . **27. P. soyauxii**
12. Plants corticolous; pantropical . . . . . **1. P. andina**
11. Medulla C—.
13. Medulla KC+ red (alectoronic acid) . . . . . **19. P. pancheri**
13. Medulla KC—.
14. Spores 26–28 μ; unknown substance effervescent in G.E. **12. P. ebulliens**
14. Spores 16–21 μ; caperatic acid present . . . **17. P. mesotropa**
1. Margins of lobes ciliate.
15. Thallus yellowish green, usnic acid present; South America. **32. P. delicatula**
15. Thallus whitish or mineral gray to buff, usnic acid lacking.
16. Medulla, at least in part, pigmented yellow or orange yellow.
17. Pigment K—, present in most of the medulla.
18. Exciple of apothecia entire, disc perforate; Africa. **104. P. subcolorata**
18. Exciple dentate or laciniate disc imperforate.
19. Vulpinic acid present . . . . . **46. P. cornuta**
19. Unknown orange-yellow pigments present . **40. P. appendiculata**

17. Pigment K+ purple, scattered near the lower cortex.
20. Spores 18–24 μ; cortex more or less distinctly maculate.
21. Thallus coriaceous, strongly maculate; lobes adnate; Asia.
97. P. nilgherrensis
21. Thallus membranous, weakly maculate; lobes suberect; tropical America . . . . . **86. P. chiapensis**
20. Spores 28–34 μ; cortex not distinctly maculate.
22. Apothecia imperforate; pantropical . . . . . **105. P. subrugata**
22. Apothecia perforate; Asia . . . . . **45. P. corniculans**
16. Medulla white, pigments lacking.
23. Apothecia present.
24. Apothecial disc imperforate.
25. Medulla K+ yellow or red, P+ yellow.
26. Stictic acid present; tropical America and South Africa.
51. P. eciliata
26. Unknown acid present; Africa . . . . . **59. P. inexspectata**
25. Medulla K−.
27. Medulla P+ red (protocetraric acid).
28. Spores large, 26–34 μ, the episporium 2–4 μ thick.
29. Lobe margins and frequently apothecia laciniate; Asia.
64. P. merrillii
29. Lobes and apothecia entire; Africa . . **66. P. pachyspora**
28. Spores small or intermediate, to 22 μ long, the episporium less than 2 μ thick.
30. Spores small, 10–15 μ long; thallus saxicolous.
43. P. blanchetii
30. Spores intermediate, 18–22 μ long; thallus corticolous.
29. P. zollingeri
27. Medulla P−.
31. Medulla C+ rose or red.
32. Spores large, 22–34 μ long; South America. **38. P. abnuens**
32. Spores small, 10–14 μ long; Africa . **39. P. amboimensis**
31. Medulla C−.
33. Spores large, 24–34 μ long.
34. Medulla KC− (protolichesteric acid).
95. P. melanothrix
34. Medulla KC+ (alectoronic acid).
35. Lower side pale at the margin; exciple dentate; pantropical . . . . . **105. P. subrugata**
35. Lower side dark brown, exciple entire; Asia.
97. P. nilgherrensis
33. Spores small or intermediate, to 22 μ long.
36. Cortex maculate.
37. Exciple ciliate; white rim below; alectoronic acid present; tropical America . . . . **85. P. argentina**
37. Exciple entire; margin dark brown below; cryptochlorophaeic acid present; Africa. **103. P. schimperi**
36. Cortex emaculate.
38. Plants saxicolous . . . . . **44. P. breviciliata**
38. Plants corticolous.

39. Cilia dense; spores 18–22 μ long . . **79. P. wainii**
39. Cilia sparse; spores 12–16 μ long . . **69. P. procera**
24. Apothecia perforate.
40. Spores large, 28–34 μ long . . . . . **45. P. corniculans**
40. Spores small or intermediate, to 22 μ long.
41. Medulla K+ red.
42. Cortex dull, emaculate . . . . . **53. P. eurysaca**
42. Cortex shiny, maculate.
43. Lower side with black center and white rim around the margin . . . . . **99. P. perforata**
43. Lower side with black or pale brown center and brown margin.
44. Lower side uniformly brown or pale brown.
45. Lower side rhizinate to the margin.
80. P. subcaperata
45. Lower side naked at the margin . **84. P. aldabrensis**
44. Lower side black at the center.
46. Lower side rugose, short rhizinate to the margin; southern South America . . . **106. P. uruguensis**
46. Lower side smooth, naked at the margin; tropical America and Australia . . . . . **101. P. reparata**
41. Medulla K−.
47. Medulla C+ rose or red.
48. Cortex maculate; medulla C+ rose (gyrophoric acid).
89. P. euneta
48. Cortex dull, emaculate; medulla C+ red (lecanoric acid).
57. P. hololoba
47. Medulla C−.
49. Lower side uniformly pale brown, rhizinate to the margin.
80. P. subcaperata
49. Lower side black at the center, paler at the margins.
50. Cortex dull, emaculate; lower side brown at the margins.
51. Plants saxicolous; exciple ciliate . . **65. P. ornatula**
51. Plants corticolous; exciple eciliate.
61. P. maclayana
50. Cortex shiny, maculate; lower side usually pale ivory to white, brown, or mottled below at the margins.
52. Amphithecium coarsely rugose-lobulate.
91. P. hanningtoniana
52. Amphithecium smooth or rugose.
53. Medulla KC− . . . . . **83. P. abessinica**
53. Medulla KC+ red.
54. Cryptochlorophaeic acid present.
83. P. abessinica
54. Alectoronic acid present.
55. Lower side with a broad white margin.
102. P. rigida
55. Lower side mottled or brown at the margin.
56. Thallus coriaceous; cilia coarse; Asia.
97. P. nilgherrensis
56. Thallus membranous; cilia fine; tropical America . . . . . **86. P. chiapensis**

23. Apothecia not present.
  57. Medulla K−. P−.
    58. Medulla C+ red or rose.
      59. Lobes sublinear, laciniate, emaculate . . **39. P. amboimensis**
      59. Lobes rotund, maculate . . . . . **89. P. euneta**
    58. Medulla C−.
      60. Cortex strongly white-maculate . . . . . **80. P. subcaperata**
      60. Cortex dull, lacking white maculae.
        61. Thallus corticolous, laciniate . . . . . **45. P. corniculans**
        61. Thallus saxicolous, without laciniae . . **44. P. breviciliata**
  57. Medulla P+ and/or K+ yellow to red.
    62. Cortex strongly white-maculate.
      63. White rim below or brown and naked . . . **99. P. perforata**
      63. Brown below with fine rhizines to the margin. **80. P. subcaperata**
    62. Cortex dull, emaculate.
      64. Medulla K+ distinct yellow or red.
        65. Lobes with distinct marginal laciniae; salacinic acid present. **53. P. eurysaca**
        65. Lobes with few laciniae; salacinic acid lacking.
          66. Stictic acid present; tropical America and South Africa. **51. P. eciliata**
          66. Unknown substance present; Africa . **59. P. inexspectata**
      64. Medulla K− or K+ faint brownish yellow (protocetraric acid present).
        67. Thallus saxicolous; lobes distinctly ciliate . **43. P. blanchetii**
        67. Thallus corticolous; cilia rare . . . . . **29. P. zollingeri**

Subgenus *Amphigymnia*

Section *Amphigymnia* Vain. (1890, p. 28).
Parmotrema Mass. Atti I. R. Ist. Veneto, III, 5: 248. 1860. Lectotype: *P. perforata* (Jacq.) Ach.

Type species: *Parmelia tinctorum* Nyl.

Thallus adnate to loosely attached, 5–30 cm. in diameter; lobes broad, rotund, 5–20 mm. wide; lower side black or brown, rhizinate in the center, the rhizines simple, often coarse, the margins usually with a broad naked zone; apothecia more or less pedicellate, the disc often perforate.

1. Section *Amphigymnia*

Section *Amphigymnia* * *Subglaucescentes* Vain. (1890, p. 28, as "Subglaucescens").
Section *Subglaucescentes* (Vain.) Gyel. (1932, p. 225).
Section *Subglaucescentes* subsection *Eciliolae* Gyel. (1932, p. 225).
Section *Amphigymnia* subsection *Subglaucescentes* (Vain.) Hillm. (1934, p. 243). Superfluous combination.

Thallus adnate to loosely attached; lobes broad, rotund, 5–20 mm. wide, the margins eciliate or rarely with sparse cilia in the axils; lower side black and rhizinate, the marginal zone brown, ivory to white, or mottled and naked.

The 29 species in section *Amphigymnia* seem to form a natural grouping. Most have a brown rather than white marginal rim below and all except *P. andina*, *P. austrosinensis*, and *P. disparilis* lack maculae. Five of the eight species in the subgenus with lecanoric acid are found in this section; only one species (*P. pancheri*) contains alectoronic acid. Eleven of the species are endemic to the Americas, five to Asia, and only three to Africa. These facts seem to indicate that section *Amphigymnia* is the most primitive group in the subgenus.

1. Parmelia andina Müll. Arg. Rev. Mycol. 1: 169. 1879.

Parmelia abessinica var. *nuda* Müll. Arg. Flora 62:289. 1879. Type collection: Seriba Ghattas, Djur, Africa, *Schweinfurth* (G, lectotype; M, US, W, isotypes).

P. africana Müll. Arg. Flora 63:265. 1880. Based on *P. abessinica* var. *nuda* Müll. Arg.

P. hildebrandtii Kremplh. f. *nuda* Müll. Arg. Flora 74:376. 1891. Type collection: South Africa, *Hannington* (G, lectotype).

P. zambesica Müll. Arg. Verhl. Zool. Bot. Gesell. Wien 53:296. 1893. Type collection: Boroma, Africa, *Menyhart* s.n. (G, lectotype).

P. pedicellata Stein. Sitzungsber. Akad. Wiss. Wien 106:214. 1897. Type collection: Matchakos, Kenya, *Liechtenstein*, 1896 (WU, holotype).

P. olivetorum var. *esorediata* Vain. *in* Welw. Cat. Afr. Pl. 2:399. 1901. Type collection: Serra de Mongollo, *Welwitsch* 110 (TUR, lectotype; BM, isotype).

P. olivetorum var. *hyporysalea* Vain. *in* Welw. Cat. Afr. Pl. 2:399. 1901. Type collection: Morro de Lopolla, Angola, *Welwitsch* 27 (TUR, lectotype; BM, isotype).

P. menyhartii Stein. Verh. Zool. Bot. Gesell. Wien 53:235. 1903. Type collection: Zambesi, Africa, *Menyhart*(?) 475 pr. p. (WU, holotype).

P. paraguariensis Lynge, Ark. Bot. 13, no. 13:71, *pl. 1, fig. 7*. 1914. Type collection: Cierro Negro, Paraguari, Paraguay, *Malme* 1539 (S, holotype).

P. rissoensis Lynge, Ark. Bot. 13, no. 13:69. 1914. Type collection: Near Río Apa, Colonia Risso, Paraguay, *Malme* 1895B (S, holotype).

P. hyporysalea (Vain.) Vain., Bot. Mag. Tokyo 35:47. 1921.

P. hyporysalea (Vainio) Stein. & Zahlbr. Bot. Jahrb. Engler 60:533. 1926. Superfluous combination.

P. hyporysalea var. *menyhartii* (Stein.) Stein. & Zahlbr. Bot. Jahrb. Engler 60:535. 1926.

P. pedicellata var. *subbullata* Stein. & Zahlbr. Bot. Jahrb. Engler 60:536. 1926. Type collection: Bukoba, Lake Victoria, Africa, *Schröder* 323 (W, holotype).

P. dalei Dodge, Ann. Mo. Bot. Gard. 46:131. 1959. Type collection: Toro, Fort Portal, Uganda, *Dale* L44 (K, holotype).

P. subbullata (Stein. & Zahlbr.) Dodge, Ann. Mo. Bot. Gard. 46:162. 1959.

P. thomasii Dodge, Ann. Mo. Bot. Gard. 46:168. 1959. Type collection: Mt. Otse, West Nile, Uganda, *Thomas* 1962 (K, holotype).

Type collection: Cisne, Ecuador, *André* 4324 bis (G, holotype; K, isotype).

Thallus often very large, to 30 cm. broad, loosely attached to bark, light mineral gray; lobes large and rotund, 10–20 mm. wide, margins

smooth to broadly crenate, cilia lacking; upper surface plane to broadly undulous, continuous or reticulately cracked with age, faintly to distinctly white-maculate, isidia and soredia lacking; lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia numerous, large, to 20 mm. in diameter, stalked, amphithecium rugose, white-maculate, disc perforate; hymenium 50–70 μ high; spores 7–10×13–18 μ, the episporium 1.0–1.5 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ blood red, P−, atranorine and lecanoric acid present.

The large synonymy of *P. andina* seems unaccountable. It is a conspicuous, extremely uniform lichen with a combination of morphological and chemical characters quite unique in the subgenus *Amphigymnia*. Large perforate apothecia are almost always present in great abundance. The maculae are usually distinct but may be rather faint on older lobes. It is most common in savannas of central and south-central Africa as far south as the Tropic of Capricorn but completely absent from the Cape area. It is much rarer in other tropical areas in South America and Asia (fig. 5). The sorediate counterpart is *P. austrosinensis* Zahlbr.

Additional specimens examined:

COLOMBIA: No locality, *Blaghorne*, s.d. (K). BOLIVIA: Chaco: Fataranda, *Fries* L156 (S). PARAGUAY: Paraguari, *Malme* 1529 (MO). ARGENTINA: Salta: General Ballivián, Orán, *Digilio-Grassi* 676 (MO).

SUDAN: Mongalla, *Dandy* 523 (BM). IVORY COAST: Cercle Dombokro: Mt. Orombo-Boka, *Santesson* 10724a (UPS). LIBERIA: Central Province: Piatah, Gbarnga, *Baldwin* 12383 (US). GUINEA: Cercle of N'Zérékoré: Nimba Mtns., *Santesson* 10516b (UPS). SIERRA LEONE: Njala, *Deighton* M5976 (K). CAMEROONS: Between Jaunde and Dengdeng, *Mildbraed* 8403 (K). ANGOLA: Benzuela: Between Benzuela and Coporolo, *Degelius*, Feb. 2, 1960 (DEGEL); Bié: Chinguar, *Degelius*, Feb. 9, 1960 (DEGEL); between Vila General Machado and Coemba, *Degelius*, Feb. 10, 1960 (DEGEL); Cuanza Sul: Near Santa Comba Dao, *Degelius*, Mar. 3, 1960 (DEGEL); Capir, Amboim, *Gossweiler* 9907 (BM); Huila: Bimba, Humpala Plateau, *Degelius*, Feb. 6, 1960 (DEGEL); Malange: Northeast of Lunda, Dundo, *Gossweiler* 13928 (US); Moxico: Luso, *Degelius*, Feb. 11, 1960 (DEGEL). REPUBLIC OF CONGO: Brazzaville, *Degelius*, Mar. 12, 1960 (DEGEL). CONGO: N. Kivu: Nyarusambo, Goma, *Degelius*, Mar. 16, 1960 (DEGEL). RUANDA-URUNDI: Usumbara, *Degelius*, Mar. 17, 1960 (DEGEL); west of Albertville, *Höeg*, Feb. 25, 1930 (TRH, US); Patambalu, *Tailfer* 43 (BR); Kiyaka-Kwango, *Devred* 2607 (BR); near Lukafu, *Schmitz* 1839 (BR); Eala, *Louis* 2123 (BR). NORTHERN RHODESIA: Abercorn Distr., *Bullock* 2103 pars (K). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Mar. 4, 1930 (TRH); Makoni, *Eyles* 215 (PRE); Salisbury, *Montagu* 1809 (PRE); Dora River, Umtali, *Schweickerdt* 2219 (PRE). KENYA: Central Prov.: Nairobi, *Maas Geesteranus* 10273 (L, LD); 4 mi. W. of Nairobi, *Maas Geesteranus* 4393 (L, LD). TANGANYIKA: Dodoma, *Höeg*, Mar. 16, 1930 (TRH); Kigonsero, at Peramiho, *Detrich*, 1958 (KLEM). UGANDA: Budonga Forest, Bungoro, *Taylor* 3319 (BM); Kilpayo, *Dümmer* 848 (BM);

West Nile, below Metu Rest Camp, *Chancellor*, Sept. 14, 1953 (BM). MOÇAMBIQUE: Catembe, Lorenço Marques, *Borle* 35 (PRE). UNION OF SOUTH AFRICA: NATAL: Weenin, *Höeg*, Oct. 20, 1929 (TRH); Pinetown, *Doidge* 1546 (PRE).

MADAGASCAR: Côte de Mahafaly, *Perrier de la Bathie*, June 1910 (LD). INDIA: Madras, *Shuter*, s.d. (K); MADURAI DISTR.: Shembaganur, *Foreau* 4176 (AWAS). THAILAND: Doi Sutep, *Tsuyama* 10, 11 (TNS). TAHITI: *Wragge*, December 1905 (BM).

2. Parmelia araucariarum Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:179. 1909.

Type collection: Near São Amaro, São Paulo, Brazil, *Schiffner* (W, holotype; BPI, MICH, isotypes).

Thallus often large, 10–15 cm. in diameter, loosely attached to bark, mineral gray with a yellowish tinge at times; lobes rotund, 7–14 mm. wide, becoming crowded and suberect toward the center, margins entire, sorediate, soralia linear to irregular, sorediate lobes sinuate and dissected, soredia granular; upper surface shiny, continuous to reticulately cracked with age; medulla pale yellow orange; lower side black and sparsely rhizinate, dark brown and naked in a broad zone along the margins. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K+, C+, KC+ more intensely yellow, P−, atranorine, an unidentified pigment, and unknown substances present.

Externally *P. araucariarum* closely resembles *P. dilatata* Vain., but the medulla is pigmented orange yellow and the lobe margins are not as dissected. It is apparently the sorediate phase of *P. myelochroa* Hale, although the chemicals accompanying the unknown pigment have not yet been fully determined for either species. *Parmelia araucariarum* is endemic and widespread in South America.

Additional specimens examined:

BRITISH GUIANA: Essequibo River, Moraballi Creek, *Richards* 239 (K). PERU: SAN MARTÍN: Tingo María, elev. 625–1100 m., *Allard* 20700, 21893, 22524 (US); HUÁNUCO: Hacienda Exito, Churubamba, *Mexia* 8249a (F, US); AYACUCHO: Aina, between Huanta and Río Apurimac, *Killip & Smith* 23142 (US). BRAZIL: No locality, *Gardner* (M). PARAGUAY: Villa Morro, Asuncion, *Malme* 1585 (S). ARGENTINA: SALTA: Río Pescado, *Digilio-Grassi* 384, 469 (MO).

3. Parmelia austrosinensis Zahlbr. Symb. Sin. 3:192. 1930.

Parmelia olivetorum var. *hypomelaena* Krempih. Verh. Zool. Bot. Ver. Wien 26:443. 1876. Type collection: Lima, Peru, *Barranca* (M, holotype; UPS, isotype).

P. olivetorum var. *sorediosa* Vainio *in* Welw. Cat. Afr. Pl. 2:399. 1901. Type collection: Serra de Muxaûla, Cazengo, Angola, *Welwitsch* 112 (TUR, holotype; BM, isotype).

P. hyporysalea (Vainio) Vainio var. *cinerascens* Vainio, Bot. Mag. Tokyo 35:47. 1921. Type collection: Prov. Awaji, Japan, *Mikuma* 140 pr. p. (TUR, Vain. herb. no. 2564, holotype).

P. mesotropa var. *compactior* Zahlbr. Symb. Sin. 3:192. 1930. Type collection: Sanyingpan, north of Yunnanfu, Yunnan, China, *Handel-Mazzetti* 581 (WU, holotype; W, isotype).

P. meridionalis Tavares, Port. Acta Biol., ser. B, 1:159, *pl. 10, fig. 2*. 1945. Type collection: Arredores de Setúbal, Estremadura, Portugal, *Tavares* (LISU, holotype; not seen); Portela de Sacavém, Estremadura, Portugal, *Tavares* (M, paratype).

P. cazengensis Dodge, Ann. Mo. Bot. Gard. 46:152. 1959. Based on *P. olivetorum* var. *sorediosa* Vainio.

P. olivetoroides Dodge, Ann. Mo. Bot. Gard. 46:154. 1959. Type collection: Cape of Good Hope, s.c. (FH–Tuck, holotype).

Type collection: Gwanyinschan, near Kweiyang, Kweitschou, China, *Handel-Mazzetti* 10580 (WU, lectotype; BPI, W, isotypes; cf. Hale (1959a) for details of typification).

Thallus 6–10 cm. in diameter, loosely attached to bark, very light mineral gray; lobes broad, 10–15 mm. wide, often ascending, rotund, margins sorediate, sinuate, soralia linear; upper surface plane, dull to shiny and more or less clearly maculate; lower side black and rhizinate at the center, naked and light brown, mottled to ivory, or white in a broad zone along the margins. Apothecia very rare, substipitate, to 10 mm. in diameter, amphithecium maculate, sparsely sorediate, disc widely perforate; hymenium 75 μ high; spores 6–10×10–16 μ, episporium 1.5 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ blood red, P−, atranorine and lecanoric acid present.

Parmelia austrosinensis is the sorediate counterpart of *P. andina* Müll. Arg. It is a pantropical species most common in savannas of Africa and southern South America (fig. 6). When typically developed, the thallus is medium sized, suberect, with strictly marginal soralia and a distinct white zone below. Maculae range from quite distinct to virtually absent. Apothecia are extremely rare.

Additional specimens examined:

U.S.: MISSOURI: Kirbyville, Taney Co., *Hale* 4400 (US); LOUISIANA: New Orleans, Orleans Co., *Tainturier* s.n. (US); TEXAS: East of Fort Worth, Tarrant Co., *Stretilzer* s.n. (WISC); 18 m. east of San Antonio, Bexar Co., *Hubricht* B1926 (MO); Pearsall, Frio Co., *Darrow* 4864 (DUKE); Duffau, Erath Co., *Hale* 5494 (US); 10 mi. west of Leakey, Real Co., *Darrow* 4901 (US). MEXICO: SAN LUIS POTOSÍ: Del Maiz, *Cain* 27608 (TRTC, US); GUANAJUATO: South of San Luis de la Paz, *Cain* 27562a (TRTC, US); PUEBLA: 69 km. east of Puebla, *Hale* 19336 (US); Pasco Viejo, *Arsène* 4197 (US); VERACRUZ: 9 km. east of Jalapa, *Hale* 19412 (US); OAXACA: 53 km. northwest of Oaxaca, *Hale* 20801 (US); CHIAPAS: South of Teopisca, *Hale* 20508 (US).

HAITI: Below Furcy, Dept. de l'Ouest, *Wetmore* 2678 (MSC, US). DOMINICAN REPUBLIC: Gauma, Santiago, *Wetmore* 3911 (MSC, US); Los Amaceyes, Cordillera Setentrional, *Wetmore* 3392 (MSC).

VENEZUELA: LARA: Barquisimeta, *Saer* 2, 135 (US). COLOMBIA: Chipaque, *André* 1226 (K). URUGUAY: Parque Rivera, Montevideo, *Herter* 99689

(MO, US). ARGENTINA: Pampa del Infierno, *Meyer* 2106 (MO); no locality, *Lorentz & Hieronymus* (M).

ETHIOPIA: Addis Ababa, *Negri* s.n. (F). CONGO: Yangambi, Lueveo Plateau, *Louis* 8155 (BR); Kiyaka-Kwango, *Devred* 2607 (BR). KENYA: NAIVASHA PROV.: Kinangop, Aberdare Mountains, *Taylor* 1616 (BM); CENTRAL PROV.: 5 km. west of Nairobi, *Maas Geesteranus* 10271 (L, LD); RIFT VALLEY PROV.: Menengai, Nakuru Distr., *Maas Geesteranus* 4610, 10281 (L, LD, US), 4556, 4621, 4622 (L). MOÇAMBIQUE: LOURENÇO MARQUES: 2 km. east of Namaacha, *Almborn* 7106 (LD); 3 km. north of Vilahuiza, *Almborn* 6884 (LD); Lourenço Marques, *Junoa* 474 (PRE). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Feb. 2, 1930 (TRH); Gwelo, *Höeg*, Jan. 2, 1930 (TRH). UNION OF SOUTH AFRICA: ORANGE FREE STATE: Clarens, *Plank* s.n. (PRE); TRANSVAAL: Pretoria, *Smith* 6274 (PRE), *Almborn* 5878 (LD); Sibasa, *Reusburg* 1573 (PRE); Bushbuckridge, *Wager* 1386 (PRE); BASUTOLAND: Near Masite Mountains, *Hewitt* s.n. (TRH); NATAL; Boschfontein Forest, Lions River Distr., *Almborn* 8724 (LD); 4 mi. south of Pietermaritzburg, *Almborn* 8541 (LD); Weinen, *Höeg*, Oct. 20, 1929 (TRH); northeast of Eschowe, Eschowe Distr., *Höeg*, Sept. 8, 1929 (TRH); Upper Umkomaas, Impendhle, *Höeg*, Oct. 3, 1929 (TRH); Innersdale, Estcourt, *Höeg*, Nov. 3, 1929 (TRH); north of Hluklurve, Nongoma, Zululand, *Höeg*, Aug. 17, 1929 (TRH); CAPE PROVINCE: Koningskroon Farm, Elliot, *Höeg*, Dec. 1, 1929 (TRH); Port Alfred, *Höeg*, Dec. 16, 1926 (TRH); Woodbury, Alexandria, *Höeg*, Aug. 20, 1929 (TRH); Dordrecht, *Höeg*, Nov. 21, 1929 (TRH); Port Elizabeth, *Höeg*, August 1929 (TRH); Round House, Lions Head Distr., *Arnell* 1146c (LD); Oudtohoorn, Congo Caves, *Arnell* 1450a (LD); Wilderness, George, *Arnell* 1344b (LD); Kentani, *Pegler* 1231 (PRE); Kingwilliamstown, *Victoria* 33 (PRE); Erste River, Stellenbosch, *Garside* 100, 148 (BM); 13 mi. east of East London, *Almborn* 10666 (LD); east of Kirstenbosch, Wynberg Distr., *Almborn* 23 (LD); Grahamstown, Albany Distr., *Britton* s.n. (TRH), *Almborn* 10861 (LD); near Coega, Uitenhage, *Almborn* 4065, 4107 (LD).

INDIA: Above village Naret, Askote, Almora, Northwest Himalayas, *Awasthi* 3297 (AWAS). JAPAN: PROV. TOTOMI: Kawasaki, *Kurokawa* 51074 (LD, TNS, US). SUMATRA: Sitarang, Toba, *Ouwehand* 175 (BO); Karshoogvlakte, *Lörzing* 7052 (BO). JAVA: Tjiumbuleuit, near Bandung, *Groenhart* 8855, 8867 (BO); Pasir Larongé, *Lugard* 10 (BO); Tjibodas, *Neervoort* 65 p.p. (BO); Tjipanas, *Lugard* 18 (BO). AUSTRALIA: QUEENSLAND: Brisbane, *Bailey* s.n. (BM).

4. Parmelia crassescens Stirton, Royal Phil. Soc. Glasgow Proc. 10:161. 1877.

Type collection: Amazonas, South America, *Trail* 17 (BM, holotype; GLAM, isotype).

Thallus loosely adnate, 10–15 cm. wide, light mineral gray, turning buff in the herbarium; lobes rotund, 7–12 mm. wide, more or less convoluted in age, margins crenate to irregularly lobulate, soredia, isidia, and cilia lacking; upper surface dull, continuous but becoming rugose and reticulately cracked with age; lower side black and sparsely rhizinate at the center, brown and naked in a broad zone at the margins. Apothecia more or less adnate, 3–5 mm. in diameter, disc imperforate; hymenium 80–90 μ high; spores 10–12×20–25 μ, episporium 1.5–2.0 μ thick; pycnidia rare, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ yellow orange, atranorine and norstictic acid present.

The type of *P. crassescens* is a fragment which at first seemed to be identical with *P. latissima* Fée. It is chemically distinct from *P. latissima*, however, in producing norstictic acid, a rare acid in subgenus *Amphigymnia*. Two fertile collections from South America have consistently smaller spores than *P. latissima*.

Additional specimens examined:

BRITISH GUIANA: Basin of Rupununi River, Yupukari, *Smith* 2256 (K, MO, US). BRAZIL: Serra do Itatiaia, *Hemmendorff* 12 (S).

5. Parmelia cristifera Tayl. London Journ. Bot. 6:165. 1847. PLATES 1, 4

Parmelia perforata var. *ulophylla* Mey. & Flot. Nov. Act. Acad. Caes.-Leop.-Carol. Naturf. 19, suppl. 1: 218. 1843. Type collection: Oahu, Hawaiian Islands (G, lectotype).

P. hildebrandtii Kremplh. Linnaea 41:139. 1877. Type collection: Johanna Island, Comoro Islands, *Hildebrandt* 1866c (BM, K, isotypes).

P. hildebrandtii f. *sorediosa* Müll. Arg. Flora 74:376. 1891. Type collection: Comoro Island, *Schweinfurth* s.n. (G, lectotype; K, isotype).

P. mesotropa Müll. Arg. f. *sorediosa* Müll. Arg. Flora 74:377. 1891. Type collection: Cachar, India, *Keenan* (K, holotype; G, isotype).

P. latissima Fée f. *cristifera* (Tayl.) Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:205. 1899.

P. claudelii var. *clemensiae* Vain., Phil. Journ. Sci. 4:659. 1909. Type collection: Lake Lanao, Mindanao, Philippines, *Clemens* 1319 (TUR, Vain. herb. no. 2542, lectotype).

P. submesotropa Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. Based on *P. mesotropa* f. *sorediosa* Müll. Arg.

P. cristifera f. *cinerata* Zahlbr. Repert. Sp. Nov. Fedde 33:58. 1934. Type collection: Kuwarus, Formosa, *Asahina* 51 (W, holotype; BPI, isotype).

P. gardneri Dodge, Ann. Mo. Bot. Gard. 46:179. 1959. Type collection: Brazil, *G. Gardner* (FH-Tayl, holotype).

P. gossweileri Dodge, Ann. Mo. Bot. Gard. 46:153. 1959. Type collection: Chiloango, Angola, *Gossweiler* 8091 (K, holotype).

P. imerinensis Dodge, Ann. Mo. Bot. Gard. 46:143. 1959. Type collection: East Imerina, Madagascar, *Hildebrandt* (FH, holotype).

Type collection: Calcutta, India, *Wallich* (FH-Tayl, lectotype).

Thallus expanded, 10–25 cm. in diameter, loosely attached to bark, light mineral gray; lobes broad and rotund, 12–20 mm. wide, margins sorediate, soralia linear, sorediate lobes sinuous, more or less involute, cilia lacking; upper surface dull, continuous, cracked with age; lower side black and sparsely rhizinate, naked and brown in a broad zone along the margins. Apothecia rare, usually poorly developed, adnate, 1–5 mm. in diameter, disc imperforate; hymenium 100–120 μ high; spores 13–18×26–35 μ; episporium 3–4 μ thick; pycnidia rare, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ orange red, atranorine and salacinic acid present.

Parmelia cristifera is one of the commonest pantropical Parmelias, collected frequently by all botanists. It is characterized by abundant

marginal soralia and salacinic acid. Apothecia are very rare; spores are large, indicating a close affinity with *P. latissima* Fée, which is strictly tropical and primarily American. *Parmelia cristifera* is especially common in tropical America and the Pacific region (cf. fig. 4), but it is surprisingly rare in Africa and unknown from all of eastern Africa. The only species with which *P. cristifera* might be easily confused is *P. dilatata* Vain., which differs in containing protocetraric acid (medulla K—), in having sparse development of cilia, and in more laciniate margins with coarse irregular soralia.

Müller based *P. hildebrandtii* f. *sorediosa* on five syntypes from Africa, but only the one listed above was found at Geneva. The type collections of *P. perforata* var. *ulophylla* Mey. & Flot. were destroyed at Berlin, but fortunately Hillmann (1940) had examined the material. It consisted of a mixture of *P. cetrata* Ach. and *P. cristifera* Tayl. The isotype at Geneva is a mixture of the same two species, of which *P. cristifera* is selected as the lectotype.

Additional specimens examined:

U.S.: FLORIDA: Suwanee River State Park, Suwanee Co., *Hale* 17573 (US); 5 mi. north of Okeechobee, Okeechobee Co., *Hale* 17723 (US); 5 mi. north of Silver Glen Springs, Marion Co., *Hale* 17591 (US); Sanford, Seminole Co., *Rapp, Merrill, Lich. Exs.* 54 (FH, US); Highlands Hammock State Park, Highlands Co., *Hale* 16923 (US); 12 mi. west of Daytona Beach, Volusia Co., *Hale* 17083 (US); Lakeland, Polk Co., *McFarlin* 230 (FLAS); Hillsborough State Park, Hillsborough Co., *Schallert* s.n. (FLAS). MEXICO: JALISCO: Santa Cruz de Vallarta, *Mexia* 1299 (US); HIDALGO: Cuyamaloya, *Pringle* 10753 (US); VERA CRUZ: 15 mi. south of Catemaco, *Hale* 19846, (US); 46 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19463 (REN, US), 19456 (MSC, US); PUEBLA: Cholula, *Arsène* 4297 (US); CHIAPAS: El. Suspiro, 10 km. north of Berriozábal, *Hale* 20220 (US); El Sumidero, near Tuxtla Gutiérrez, *Hale* 20073 (S, TNS, US); Hacienda, *Matuda* s.n. (MICH). BRITISH HONDURAS: Bermuda Bank, *Lundell* 1981 (MICH). NICARAGUA: Mosquito Coast, *Schramm* s.n. (US); Sangsangta Distr., *Schramm* 50 (US). COSTA RICA: Hamburg Finca, below Cairo, Prov. Limón, *Standley* 48670 (US); San Isidro Coronado, *Alfaro* 32398 (US). PANAMA: CANAL ZONE: Juan Mina, Chagres River, *Bartlett* 16822 (MICH); Las Cascadas Plantation, near Summit, *Standley* 29500 (US).

BAHAMAS: Great Bahama, *Brace* 3608 (NY); New Providence, *Britton* 3311 (NY); Maidenhead Coppice, *Britton* 3233, 3238 (NY). CUBA: No locality, *Wright, Lich. Cubae* 68 (K, UPS, US); Pinar del Rio, *Cuesta* 395 (NY); Baracoa, *Johnston* s.n. (FH); near Santa Barbara, Isle of Pines, *Ross* s.n. (F); La Prenda, *Manuel* 36a, *Hioram* 5226 (BPI); Loma del Gato, Sierra Maestra, *León* 10614 (BPI, NY); Puerto Boniato Ridge, Santiago de Cuba, Oriente, *Imshaug* 24652 (MSC, US). HAITI: St. Michel de l'Atalaye, *Leonard* 7857 (NY); near Kalacroix, Dept. Artibonite, *Leonard* 7837 (US); northwest of Jacmel, *Thomas* 75 (MO), 77 (NY, US); below Citadelle, south of Milot, *Wetmore* 2838 (MSC). DOMINICAN REPUBLIC: Sabana de la Rosa, near Km. 28, on Durante highway, *Allard* 15982b, 15994 (US); Piedra Blanca, La Vega, *Allard* 18025 (US); Hato Major, Siboey, *Thomas* 53, (FH, MO, NY); Consuelo, Macoris, *Taylor* 126 (FH,

NY); without locality, *Raunkiaer* 497 (C). JAMAICA: Without locality, *Hansen* (C); Mandeville, *Cushman* 11, 147 (FH); Westmoreland Hills, New Market, *Britton* 524 (FH, NY); Farm Hill, St. Thomas, *Orcutt* 3551 (US); near Castleton, *Maxon* 737 (US); Strawberry Hill, Cinchona, *Plitt* 46 (BPI); Fern Gully, St. Ann, *Imshaug* 15796 (MSC, US); Lime Hall to Green Park, St. Ann, *Imshaug* 15849 (MSC, US); Mt. Diablo, St. Catherine, *Imshaug* 13766, 13767 (MSC); Wareika House, summit of Long Mountain, *Imshaug* 13499 (MSC). PUERTO RICO: Barranquitas, *Hioram* 220, 221 (NY, FH), *Sintenis* 43 (G); near Cayey, *Sintenis* 27, 29 (G); near Adjuntas, *Sintenis* 77, 79, 110a (G), 96 (G, K); Mayaguez, *Fink* 1282 (FH, M, MICH); Naranjito, *Fink* 273 (FH, MICH); Aibonito, *Fink* 1837 (FH, MICH); 7 miles south of Caguas, *Heller* 295, 309 (FH, NY); Monte Llano, Cayey, *Goll* 460 (US); Caguitas, *Goll* 361 (US); Arecibo to Utuado, *Howe* 385 (NY); Mt. Morales, near Utuado, *Howe* 440 (FH, NY); Rio de Maricao, *Britton* 4057 (FH, NY); Vega Baja, *Britton* 1435 (FH, NY); San Narciso, *Britton* 7332 (NY); Monte Montoso, *Britton* 4152, 4173 (FH, NY); Luquillo Mountains, *Wilson* 55 (FH, NY), 295 (NY); Campo Alegre, *Stevenson* 2477 (FH, US). VIRGIN ISLANDS: Virgin Gorda, Virgin Peak, *Smith* 10575 (US); St. Croix: Mt. Eagle, *Boergesen* s.n. (C), *Thompson* 462 (NY); St. Thomas: Crown, *Britton* 1441 (FH, NY); without locality, *Eggers* s.n. (C). GUADELOUPE: Without locality, *Questel* 3810 (MO), *L'Herminier* s.n. (UPS); Prise d'Eau, *LeGallo* 2724 (MSC); near Lamentin, *LeGallo* 583 (MO); Vernon, Basse-Terre, *Degelius*, June 23, 1958 (DEGEL). DOMINICA: Roseau, *Evans* 64 (FH, NY, YU). MARTINIQUE: Le Morne Rouge, *Degelius*, May 20, 1958 (DEGEL); Ajoupa-Bouillon, *Degelius*, May 25, 1958 (DEGEL). GRENADA: Epping Forest, St. David, *Imshaug* 16146 (MSC, US).

SURINAM: Without locality, s.c. (K). BRITISH GUIANA: Pl. Vryheid, *Linder* 949 (MICH); near Kaieteur Falls, *Cowan & Soderstrom* 2041 (US); along Mure-mure Creek, Kaieteur Plateau, *Cowan & Soderstrom* 2203 (US). VENEZUELA: Between Cotiza and Las Venados, near Caracas, *Allert* 78 (US); Bolívar: Guaiquinima, Río Paragua, *Killip* 37845 (US). COLOMBIA: Dept. Santander: Northern slope of Mesa de los Santos, *Killip & Smith* 14996 (US). PERU: Dept. San Martín: Tingo María, *Allard* 20562 (US); Dept. Ayacucho: Aina, between Huanta and Río Apurimac, *Killip & Smith* 22572: (US). BRAZIL: Near Santos, São Paulo, *Schiffner* s.n. (M).

GUINEA: Issia, cercle of Dalva, *Santesson* 10400a (UPS). IVORY COAST: 20 km. west of Séguéla, *Santesson* 10673b (UPS). LIBERIA: 10 miles east of Zwedru, Tchien Distr., *Baldwin* 12412 (US). NIGERIA: Nkami Road, Oban, *Talbot* s.n. (BM). CONGO: Eala, *Guesquière* 2081 (BR, US); Yangambi, Luweo Plateau, *Louis* 7150 (BR). ANGOLA: Buco Zau, Cabinda, *Gossweiler* 7240 (BM); Sera Subluali, Maiambe, *Gossweiler* 8033 (BM). MAURITIUS: *Robillard* s.n. (M, US). BOURBON: *Rodriguez* 8, 21 (P).

BURMA: Without locality, *McMillan* 279 (US). THAILAND: Udaun, *Kerr* 215 (K); Chieng Dao, *Tsuyama* 4 (TNS, US); Neeckey, *Kostermans* 532 (BO). FORMOSA: Taroko, *Ogata* s.n. (TNS, US). PHILIPPINES: Bohol, *Ramos* 11585 (F); Tayabas: Lucban, Luzon, *Elmer* 7227 (US); Rizal: Luzon, *Ramos* 22477 (US). SUMATRA: Near Lubuk Sikaping, Tandjung Alai, *Groenhart* 8991 (BO); Boekit Koelampi, *Theunissen* s.n. (BO); Fort de Kock, *Jacobson* 10 (BO). SARAWAK: Kuching, *Brooke* 462 (BM). BORNEO: Peak of B. Papan, Kutai, *Meijer* B2045 (BO). CELEBES: Rante Lemo, *Kjellberg* 33 (BO). AMBON ISLAND: Laha, *Ruinen* s.n. (BO). NEW GUINEA: Nondugl, Western Highlands Distr., *Hoogland* 3194 (BM).

FIJI: VITI LEVU: Mba, vicinity of Nandarivatu, *Smith* 5968 (US). MARQUESAS ISLANDS: Nukuhiva, near Hakaui, *Brown* 472 (BISH). RAROTONGA: *Parks* 22396 (F). PITCAIRN ISLAND: Parlver Valley Ridge, *St. John* 14963 (BISH). HAWAIIAN ISLANDS: MAUI: Honokahau Drainage Basin, *Forbes* 587 (BISH); KAUAI: *Faurie* 74, 75, 76, 77, 84 (BM); HAWAII: Milo, *Faurie* 853, 854 (BM); OAHU: Honolulu, *Faurie* 448 (BM); Pohakea Pass, Waianae Mountains, *Fosberg* 9510 (US); Kalimoa Valley, *Rock* 86 (US); Tantalus, *Heller* 2160 (US); without locality, *Heller, Merrill Lich. Exs.* 200 (M, US). NEW ZEALAND: Without locality, *Banks & Solander*, August 1769 (BM).

6. Parmelia crocoides Hale, sp. nov.

Thallus laxe adnatus, 6–12 cm. diametro, cinereo-glaucescens, lobis rotundatis, 8–14 mm. latis, margine integris vel aetate incisis, superne planus, nitidus, levissime albomaculatus, aetate rugosus, rimosus, sorediis, isidiis, ciliis destitutis, strato corticeo superiore 10–13 μ crasso, strato gonidiali 16–20 μ crasso, medulla croceo-lutea, 110–130 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger, sparse rhizinosus, ambitu fusco-castaneus, late nudus. Apothecia ignota; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K+, C+, KC+ intensius croceo-lutea, P−, atranorinum, acidum protolichestericum, et pigmentum K− ignotum continens.

Type in the U.S. National Herbarium, collected between San Pedro de Montes de Oca and Curridabat, San José, Costa Rica, Feb. 2, 1924, by P. C. Standley (no. 32772).

This peculiar species appeared at first to be a relative of *P. latissima* Fée but the upper surface is shiny and more or less maculate and the medulla is pigmented pale orange red. Protolichesteric acid is present in low concentration. This species is known only from the type locality.

7. Parmelia defecta Hale, sp. nov.

Thallus adnatus vel laxe adnatus, rigidulus, plerumque saxicola, 6–12 cm. diametro, albicans, parum lobatus, lobis rotundatis, sinuatis, plus minusve congestis ad centrum, superficie et partim margine sorediatis vel pustulato-sorediatis, sorediis diffusis, granulosis, soraliis marginalibus irregulariter linearibus, superne opacus, laevigatus, strato corticeo superiore 14–18 μ crasso, strato gonidiali 16–20 μ crasso, medulla alba, 70–90 μ crassa, strato corticeo inferiore 12–15 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus vel albo-variegatus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K−, C+ rubescens, KC+ rubescens, P−, atranorinum et acidum lecanoricum continens.

Type in Lund University, collected in Indumeni Forest, Cathedral Park area, Bergville, Natal, Africa, Nov. 3, 1953, by Ove Almborn (no. 8934).

This species appears to be the sorediate counterpart of *P. soyauxii* Müll. Arg. Both species are saxicolous and endemic to Africa.

Parmelia austrosinensis Zahlbr., normally a corticolous lichen, differs in broader, more or less suberect lobes with a pale zone below. These two sorediate species may intergrade to some extent but careful field studies would be needed to clarify their relationship.

Additional specimens examined:

UGANDA: Entebbe, *Proctor*, Mar. 9, 1959 (K, US). SWAZILAND: 15 mi. southwest of Piggs Peak, Mbabane, *Almborn* 7927 (LD). UNION OF SOUTH AFRICA: ORANGE FREE STATE: 5 mi. west of Ladybrand, *Maas Geesteranus* 6521 (L); NATAL: Indumeni Forest, Bergville, *Almborn* 9319 (LD); CAPE PROV.: Dordrecht, *Hõeg*, Nov. 21, 1929 (TRH); near the Punch Bowl, Louis Trichardt, Zoutpansberg, *Almborn* 6095 (LD). MADAGASCAR: Montasoa, *Räsänen* (H).

8. **Parmelia dilatata** Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:33. 1890.
   Parmelia cetrarioides f. *integra* Harm. Ann. Crypt. Exot. 1:327. 1928. Type collection: Botanical Garden, Singapore, *Demange* s.n. (P, holotype).
   P. robusta Degel. Göteb. Kungl. Vet. Vitterh. Samh. Handl., ser. B, 1, no. 7:33. 1941. Type collection: Forêt de Crannou, Finistère, France, *Picquenard* in 1898 (P, holotype).
   P. kauaiensis Zahlbr. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:99. 1944. Type collection: Halemanu to Kaholuamano, Kauai, Hawaii, *Kusche* 5506 (BPI, holotype; W, isotype).
   P. lobulascens var. *isidiosissima* Dodge, Ann. Mo. Bot. Gard. 40:375. 1953. Type collection: Gbense, Sefadu, Sierra Leone, *Adames* (K, holotype).
   P. sieberi Dodge, Ann. Mo. Bot. Gard. 46:148. 1959. Type collection: Mauritius, *Sieber* 44 (FH, holotype).

Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 397 (TUR, holotype, Vain. herb. no. 2548; BM, FH, M, UPS, isotypes).

Thallus loosely attached to bark, 10–20 cm. broad, mineral gray or faintly yellowish gray; lobes rotund, 10–15 mm. wide, margins entire at the tips, laterally becoming lacerate, sorediate, soredia coarse, mostly in linear soralia or developing on short irregular laciniae, cilia lacking or abnormally developed in the axils, 0.5–1.5 mm. long; upper surface smooth, rather shiny, faintly white-maculate or dull, reticulately cracked with age; lower side black and sparsely rhizinate, brown to mottled ivory and naked in a broad zone at the margins. Apothecia rare, 3–5 mm. in diameter, adnate, disc imperforate; hymenium 70–80 μ high; spores 8–10×18–22 μ, episporium about 2 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine, protocetraric acid, and rarely traces of usnic acid present.

Parmelia dilatata is one of the commonest pantropical lichens. It is unfortunate that the oldest epithet, *P. dilatata*, is represented only by a single apparently abnormal collection from Rio de Janeiro, which contains a trace of usnic acid and is eciliate. The population lacking usnic acid and having at least some sparse cilia is represented

perfectly by the holotype of *P. robusta* and is by far the commoner phase of this species. Development of cilia is especially variable. Specimens from the West Indies in particular may have conspicuous cilia in the lobe axils and very rarely at lobe tips. Cilia may be so abundant that confusion with *P. subarnoldii* des Abb. is not unlikely. However, *P. subarnoldii* has distinct cilia around the lobe tips as well as finer soredia and more regular, linear soralia. The soralia of *P. dilatata* are typically irregular and produced on small marginal laciniae. Possible points of confusion with *P. cristifera* Tayl. and *P. fasciculata* Vain. are discussed under these species.

Additional specimens examined:

U.S.: TENNESSEE: Cross Roads, Overton Co., *Phillips* 334 (US); SOUTH CAROLINA: Santee State Park, Orangeburg Co., *Hale* 16485 (US); 10 mi. southwest of Walterboro, Colleton Co., *Hale* 16574 (US); GEORGIA: 5 mi. south of Quitman, Brooks Co., *Hale* 16765 (US); 10 mi. northeast of Midway, Bryan Co., *Hale* 16806 (US); FLORIDA: 1 mi. south of Pittman, Lake Co., *Hale* 17750 (US); 26 mi. west of Tallahassee, Leon Co., *Pursell* 100LF30 (MSC); Sebring, Highlands Co., *McFarlin* 566 (FLAS); Bartow, Polk Co., *McFarlin* 96 (FLAS); Tomoka State Park, Volusia Co., *Hale* 17054 (US); Myakka River State Park, Sarasota Co., *Hale* 16911 (US); Fort Myers, Lee Co., *Standley* 326 (US); Sanford, Seminole Co., *Rapp* s.n. (FLAS); 3 mi. west of Bunnell, Flagler Co., *Hale* 17039 (US); Oleno State Park, Alachua Co., *Hale* 16431 (US). MEXICO: VERACRUZ: 11 km. east of Las Vigas, *Hale* 20951 (DUKE, MSC, REN, S, TNS, US); CHIAPAS: Just south of Teopisca, *Hale* 20522 (COLO, DUKE, LISU, MSC, REN, S, TNS, US); Km. 1145 on highway 190, west of San Cristóbal, *Hale* 20202 (COLO, US); 18 km. southeast of San Cristóbal, *Hale* 20274 (US), 20250 (LISU, US); Lagos de Monte Bello, *Hale* 20413 (COLO, US); Mt. Ovando, *Matuda* 28 (TNS). GUATEMALA: ALTA VERAPAZ: Cobán, *Standley* 92061 (MO); Finca Mocca, *Johnson* 170i (US). HONDURAS: COMAYAGUA: Vicinity of Siguatepeque, *Standley & Chacón* P6315 (F); MORAZÁN: La Montañita, *Standley* 12366 (F); EL PARAÍSO: Region of Quebrada de Dantos, *Standley et al.* 1273 (F). BRITISH HONDURAS: El Cayo Distr., *Mains* 4098 (FH, MICH). NICARAGUA: JINOTEGA: Vicinity of Jinotega, *Standley* 9704 (F). COSTA RICA: SAN JOSÉ: Vicinity of Santa Maria de Dota, *Standley* 42481 (US); CARTAGO: Cerro de La Carpintera, *Standley* 34209 (US). PANAMA: CHIRIQUÍ: Chiriquí Volcano, *Scholander* s.n. (US).

BERMUDA: Payutes, s.c. (K). CUBA: PINAR DEL RÍO: Between Viñales and Pinar del Río, *Imshaug* 25320 (MSC, US); Sierra de las Yequas, *León* 5264 (FH); ISLE OF PINES: Rocky Point, *Britton* 15415 (FH, NY); ORIENTE: Summit of Pico Turquino, Sierra Maestra, *Imshaug* 25128 (MSC, US); slopes of El Gato, Loma del Gato, *Imshaug* 24773 (MSC). HAITI: East end of Montagne Noire, near Kenscoff, *Imshaug* 22533 (MSC, US); ridge leading to Pic Macaya, Morne Macaya, *Wetmore* 3238 (MSC); summit of Tête Etang, *Imshaug* 22608 (MSC). DOMINICAN REPUBLIC: Casabito, La Vega, *Wetmore* 3430 (MSC); between Pico del Yaque and Chinguela, *Wetmore* 3723 (MSC, US); Constanza, near Valle Nuevo, *Allard* 17692, 17696 (US); Sabana de la Rosa near Km. 28, *Allard* 15971 (US). JAMAICA: John Crow Peak, *Imshaug* 15365 (MSC); slope of Catherine's Peak, Blue Mountains, *Imshaug* 13399 (MSC, US); without locality, *Hart* 122 p.p. (NY); Albion, St. Ann., *Imshaug* 15914 (MSC); near Guys Hill, St. Ann., *Imshaug* 13647 (MSC). PUERTO RICO: Lares to

San Sebastian, *Britton* 2789 (FH). DOMINICA: Roseau, *Evans* 57 (NY, YU).

VENEZUELA: Cerro Yapacana, Río Orinoco, *Maguire* 30818 (MO); Avila, *Vogl* s.n. (M); Caracas, *Linden* 380 (K); BOLÍVAR: Ptari Tepui, *Steyermark* 59952 (MO); Salto de Auraima, Río Paragua, *Killip* 37371a (US). COLOMBIA: NORTE DE SANTANDER: Región del Sarara, *Cuatrecasas* 12525 (US); MEDELLÍN: Vicinity of Medellín, *Charetier* 192 (US); CUNDINAMARCA: Bogotá, *Lesdain* s.n. (MO), *Apollinaire* s.n. (MO, US). ECUADOR: Recreo, *Eggers* (F); without locality, *André* 826 (K). PERU: SAN MARTÍN: Tingo Maria, *Allard* 21644, 22424 (US), *Morrow* 9605 (US). BOLIVIA: Mapiri, *Bang* 1750 (US); Trinidad, Beni, *Werdermann* 2305b (S). BRAZIL: MINAS GERAIS: Sitio, *Vainio Lich. Bras. Exs.* 397 (BM, M), 538b (K); GOIAS: cast of Rio Verde on Goiania Road, *Cutler* 8029 (F); MATO GROSSO: Santa Anna da Chapada, *Robert* 650 (BM); Buriti, Serra da Chapada, *Malme* s.n. (S); Coxipó, near Cuyabá, *Malme* 2198 (S).

FRANCE: Coatloch, Finistère, *des Abbayes, Lich. Armor. Exs. Sel.* 31 (LD); Forêt du Cranou, just northwest of St. Conval, Bretagne, *Santesson* 10278a (UPS, US). PORTUGAL: Serra de Cintra, Monserrate, Estremadura, *Tavares, Lich. Lus. Sel. Exs.* 45 (H, US, WIS).

LIBERIA: Belleyella, Boporo Distr., *Baldwin* 12311 (US). GUINEA: Nimba Mountains, cercle of Zérékoré, *Santesson* 10562a (UPS). CONGO: Isalowe Reserve, *Louis* 8648 (BR); Kabalo, Katanga, *Höeg*, s.n. (TRH). ANGOLA: MOXICO: Lucusse, *Degelius*, Feb. 13, 1960 (DEGEL); between Luso and Cachipoque, *Degelius*, Feb. 16, 1960 (DEGEL); HUILA: Caconda, *Degelius*, Feb. 8, 1960 (DEGEL); CUANZA-SUL: Faz. Ceres, Mt. Chitandalua, *Degelius*, Feb. 21, 1960 (DEGEL); BIÉ: Munhango, *Degelius*, Feb. 10, 1960 (DEGEL); Caio, Hambe Region, *Gossweiler* 8013 (BM). MOÇAMBIQUE: Tinga-Tinga, Inhambane, *Schelpe* 4469, 4469a (LD); near Maxixe, Inhambane Mongue, *Schelpe* 4463a, b (LD); Inhaca Island, *Leighton* 3324, 3325 (LD). SOUTHERN RHODESIA: South of Felixburg Station, *Höeg* s.n. (TRH); M'Ulnaluska River, *Richard* s.n. (K). UNION OF SOUTH AFRICA: TRANSVAAL: Near the Punch Bowl, Louis Trichardt, Zoutpansberg, *Almborn* 6244 (LD).

SINGAPORE: *Johnson* A–109 (US). PHILIPPINES: Camp Keithley, Mindanao, *Clemens* 1300 (US). BORNEO: Sarawak, *Brooke* 10204 (BM). AUSTRALIA: NEW SOUTH WALES: Tilba-Tilba, *Render* s.n. (BM); QUEENSLAND: Cairns, *Fitzalan* s.n. (BM).

9. Parmelia disparilis Nyl. Syn. Lich. 1:381. 1860.

Parmelia odontata Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:185. 1899. Type collection: Bourbon, *Rodriguez* in 1889 (P, holotype).

P. tephrina Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:183. 1899. Type collection: Nilgherries Mountains, Coonoor, India, *Gray* in 1893 (P, holotype).

P. appendiculata Fée f. *disparilis* (Nyl.) des Abb. Mem. Inst. Sci. Madagascar, ser. B, 7:11. 1956.

Type collection: Nossi-Bé, Madagascar, *Pervillé* 1847–52 (P, lectotype).

Thallus loosely adnate to bark, up to 15 cm. in diameter or more, mineral gray; lobes rotund, 10–14 mm. wide, often suberect, margins conspicuously laciniate, laciniae to 10 mm. long, becoming caniculate, cilia absent or very sparsely developed in axils, 0.5 mm. long; upper surface smooth, shiny, more or less distinctly white-maculate, reticulately cracked with age; lower side black and sparsely rhizinate at the center, brown to ivory or mottled and naked in a broad zone along

the margins. Apothecia numerous, to 15 mm. in diameter, pedicellate, amphithecium rugose, white-maculate, exciple variable, from entire to dentate or even laciniate, disc imperforate; hymenium 90–100 μ high; spores 8–10×16–21 μ, episporium 1.5–2.0 μ thick; pycnidia common on laciniae, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

Parmelia disparilis is very near *P. zollingeri* Hepp except for the distinct maculae and laciniae. The spores of *P. disparilis* tend to be somewhat smaller, although perhaps not significantly so. It is a rare species occurring in Asia, Africa, and Mexico. Its relation to *P. appendiculata* is discussed under that species.

Additional specimens examined:

MEXICO: Chiapas: El Sumidero, near Tuxtla Gutiérrez, *Hale* 20078 (DUKE, MSC, REN, S, TNS, US); road to El Suspiro, north of Berriozábal, *Hale* 20081, 20115 (US).

CONGO: Isalowe Flower Reserve, Yangambi, *Louis* 6596 (BR, US).

10. Parmelia dominicana Vain. Journ. Bot. Brit. & For. 34:32. 1896. Plate 3

Parmelia perlata var. *flavogranulosa* Vain. Ann. Acad. Sci. Fenn. 6, no. 7:13. 1915. Type collection: Mt. Stewart, St. Croix, *Raunkiaer* 433 (TUR, Vain. herb. no. 2362, holotype; C, isotype).

P. capitulifera Zahlbr. *in* Magn. Ark. Bot. 30B, no. 3:9. 1941. Type collection: Punaluu, Oahu, *Rock* 176 (W, lectotype; BPI, isotype).

Type collection: Crater, Souffrière, Dominica, *Elliott* 114 (TUR, holotype).

Thallus adnate to loosely adnate, saxicolous or corticolous, up to 15 cm. in diameter, mineral gray with a pale yellowish tinge to distinctly yellowish green; lobes rotund, 8–12 mm. wide, margins sorediate laterally, soralia irregular to subcapitate, confluent, in part sublaminal, tinged distinctly yellowish, cilia lacking; upper surface opaque, reticulately cracked with age; lower side black and sparsely rhizinate, brown and naked in a rather broad zone along the margins. Apothecia very rare, 3–5 mm. in diameter, adnate, amphithecium sorediate, disc imperforate; hymenium 65–70 μ high; spores 5–7× 16–18 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, fading, P+ orange red, atranorine, usnic acid, and protocetraric acid present.

Parmelia dominicana is distinguished by the yellowish farinose soralia caused by the large concentration of usnic acid in the soredia. Most yellow Parmelias produce usnic acid only in the cortex and the soredia remain white. The concentration of usnic acid in the cortex of *P. dominicana* varies considerably, specimens from tropical America being more or less mineral gray with traces of usnic acid and specimens from Hawaii and Africa being distinctly yellowish green.

It is a typical weedy species in disturbed areas of tropical America, occurring more rarely in Hawaii and Africa (fig. 13).

Additional specimens examined:

U.S.: NORTH CAROLINA: Smith Island, Brunswick Co., *Culberson* 7996 (DUKE, US); FLORIDA: Gold Head Branch St. Park, Clay Co., *Hale* 17695 (US); Sanford, Seminole Co., *Rapp*, Apr. 4, 1924 (FLAS, US); Snake Key, Dade Co., *Baker*, s.n. (FLAS). MEXICO: VERACRUZ: 24 km. northwest of San Andrés Tuxtla, *Hale* 19775 (US); OAXACA: Cerro San Felipe, *Hale* 20747 (US); Km. 686 on highway 190, northwest of Tehuantepec, *Hale* 20645 (TNS, US); CHIAPAS: 2 km. east of Oaxaca-Chiapas State line, on highway 190, *Hale* 19888 (S, US); Km. 956 on highway 190, west of Ocozocoautla, *Hale* 20596 (US). NICARAGUA: JINOTEGA: Vicinity of Jinotega, *Standley* 9573 (F).

CUBA: PINAR DEL RIO: Alturas de Pizarras, *Imshaug* 25220, 25231 (MSC); above Matahambre, *Imshaug* 25314 (MSC); ORIENTE: Slope of El Gato, Loma del Gato, Sierra Maestra, *Imshaug* 24755 (MSC). HAITI: Northwest of Jacmel, *Thomas* 75 (NY). DOMINICAN REPUBLIC: Sabana de la Rosa, near Km. 28, Duarte Highway, *Allard* 15958 (US). JAMAICA: Bloxburgh Ridge, St. Andrew, *Imshaug* 15100 (MSC, US). PUERTO RICO: San Juan, *Britton* 292 (FH, NY); hills between Cabo Rojo and San German, *Britton* 4318 (NY). LESSER ANTILLES: VIRGIN ISLANDS: Virgin Gorda, *Fishlock* 346 (FH, NY); ST. CROIX: No locality, *Raunkiaer* 433 (C); DOMINICA: Roseau, *Evans* 59 (FH), *Evans* 62 (US, Y), Crater, Souffriere, *Elliott s.n.* (TUR); no locality, *Campbell*, November 1958 (K); ST. BARTHELEMY: Vité, *Le Gallo* 426a (MO).

COLOMBIA: Isla de Providencia, *Proctor*, Apr. 29, 1948 (MO, PH).

ANGOLA: BIÉ: Between Coemba and Munhango, *Degelius*, Feb. 10, 1960 (DEGEL); HUILA: Sá da Bandeira, 10 km. north of Sá da Bandeira, *Degelius*, Feb. 3, 1960 (DEGEL); MOXICO: Lucusse, River Lungué Bungo, *Degelius*, Feb. 13, 1960 (DEGEL, US); between Luso and Cachipoque, *Degelius*, Feb. 16, 1960 (DEGEL). CONGO: Southwest of Albertville, *Hôeg*, Mar. 5, 1930 (TRH). SOUTHERN RHODESIA: South of Felixburg, *Höeg*, Feb. 4, 1930 (TRH).

HAWAII: KAUAI: Kilauea, *Faurie* 79 (BM); Manamaulu, *Faurie* 81 (BM, LD); OAHU: Pumaluu Mtns., *Rock* 176 (BPI, FH, W).

11. Parmelia eborina Hale, sp. nov. PLATE 3

Thallus late expansus, rigidulus, laxe umbrosa ad saxa adnatus, cinereo-albicans vel eborinus, 10–15 cm. latus, lobis rotundatis, pro parte imbricatis, 8–15 mm. latis, ciliis, sorediis, isidiis destitutis, superne opacus, continuus, strato corticeo superiore 18–20 μ crasso, strato gonidiali 20–22 μ crasso, medulla alba, 80–100 μ crassa, strato corticeo inferiore 20–22 μ crasso, subtus ater, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia rara, 3–5 mm. diametro, nonnihil pedicellata, disco imperforato; hymenium 70–80 μ altum; sporae 5–7×11–14 μ, episporio 1 μ; pycnidia numerosa; conidia 1×5–7 μ. Thallus K+ flavescens; medulla K−, C−, KC+ fugiter rosea, P+ aurantiaca, atranorinum et acidum protocetraricum continens.

Type in the Chicago National History Museum, collected in the vicinity of El Zamorano, Morazán, Honduras, Nov. 26, 1946-Jan. 9, 1947, by P. C. Standley (no. 236).

Parmelia eborina is probably rather common on shaded rocks in Central America and more rarely in the West Indies. The distinguishing features are the lack of soredia and isidia, the presence of protocetraric acid, and the ashy white, often monophyllous thallus which may break apart easily in the herbarium. One other species with protocetraric acid and without isidia, *P. zollingeri* Hepp, has larger spores, a rigid thallus, and corticolous habit.

Additional specimens examined:

HONDURAS: COMAYAGUA: Comayagua, *Standley* 5762 (F); MORAZÁN: Las Mesas, elev. 900 m., *Standley & Williams* 46, 49 (F); vicinity of El Zamorano, *Standley* 137 (F, US), 220 (F), 308 (F), 1692 (F, MO), 2267 (F), 11661 (F, US); EL PARAISO: Las Casitas, *Standley et al.* 596 (F).

DOMINICAN REPUBLIC: Monción, Monte Cristo, *Valeur* 203 (US).

COLOMBIA: Isla de Providencia, *Proctor*, Apr. 29, 1948 (MO).

12. Parmelia ebulliens Hale, sp. nov.

Thallus laxe adnatus, 8–12 cm. diametro, rigidus, cinereo-albicans vel eborinus, lobis 6–10 mm. latis, contiguis et partim imbricatis, marginibus integris vel crenatis, plus minusve convolutis irregulariter laciniato-lobatis, isidiis, sorediis, ciliis destitutis, superne planus, opacus, minute rimosus in aetate, strato corticeo superiore 20–25 μ crasso, strato gonidiali 22–26 μ crasso, medulla inconspicue flavida, 100–130 μ crassa, strato corticeo inferiore 14–16 μ, inferne niger, sparse rhizinosus, ambitu castaneus, anguste nudus. Apothecia numerosa, breve pedicellata, 5–8 mm. diametro, amphithecio rugoso, albomaculato, excipulo rimoso, radiato-fissurino, disco imperforato; hymenium 100 μ altum; sporae 10–15$\times$25–28 μ, episporio 2 μ crasso; pycnidia numerosa, conidiis 1$\times$4–5 μ. Thallus K+ flavescens; medulla K−, C−, KC−, P−, atranorinum, acidum incoloratum ignotum et pigmentum flavidum ignotum continens.

Type in the University of Michigan, collected at Mt. Ovando, Chiapas, Mexico, April 1936, by E. Matuda.

Parmelia ebulliens externally resembles a small fertile specimen of *P. zollingeri* Hepp, or if sterile, *P. eborina* Hale. The pale-yellow medulla and peculiar chemistry set it apart from both of these species. The residue from acetone is abundant and resembles the residue of evernic acid. However, no crystals are formed in either G.A.W. or G.E., and addition of these reagents or KOH causes bubbling and dissolution of the residue. Lamellar plates are formed in G.A.Q. but these have not been identified further. *Parmelia ebulliens* is apparently corticolous in Mexico, but the Jamaican specimens are saxicolous.

Additional specimens examined:

MEXICO: CHIAPAS: Mt. Ovando, *Matuda*, December 1937 (MICH, US).

JAMAICA: Trail from Content Gap to Flora River, elev. 2850 ft., St. Andrew, *Imshaug* 14365 (MSC).

13. Parmelia endosulphurea (Hillm.) Hale, comb. nov.

Parmelia tinctorum var. *endosulphurea* Hillm. Repert. Sp. Nov. Fedde 48:8. 1940.

P. praetervisa Müll. Arg. var *flavicans* Müll. Arg. Flora 71:494. 1888. Type collection: Cayey, Puerto Rico, *Sintenis* 21 (G, holotype).

P. tinctorum var. *chrysophora* Zahlbr. ex Hillm. Repert. Sp. Nov. Fedde 48:10. 1940. Type collection: Near Batavia, Java, *Schiffner* 3196 (W, lectotype; WU, isotype).

Type collection: Mexico, *Orcutt* 4728 (MO, holotype).

Thallus loosely adnate, 10–15 cm. broad, light mineral gray; lobes rotund, 10–15 mm. wide, margins entire, cilia lacking; upper surface plane, opaque, densely isidiate, isidia 0.06–0.08 mm. in diameter, to 3 mm. high, simple to sparingly branched; medulla pale orange yellow, especially near the upper cortex; lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia rare, short-stalked, 5–10 mm. in diameter, disc imperforate; hymenium 65–80 μ high; spores 6–9 $\times$ 19–23 μ, episporium 1.5–2 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+, C+, KC+, more intensely yellow, P—, atranorine, an unidentified pigment, and unknown substances present.

I published a note identifying a large number of tropical specimens previously identified as *P. sulphurata* Nees & Flot. with *P. lindmanii* Lynge (Hale, 1959a). More critical study has shown that *P. lindmanii* is actually a *Hypotrachyna* species, although quite broad lobed and chemically identical with the *Amphigymnia* species. *Parmelia lindmanii* has axial cilia and small spores (5–8 $\times$ 10–13 μ); it is a rather rare species known only from southern Brazil, Uruguay, Paraguay, and Argentina. All of the remaining isidiate specimens with a pale sulphurous medulla are true Amphigymnias, lacking any trace of axial cilia, having broader lobes with a distinct bare zone below, and, when fertile, intermediate-sized spores (6–10 $\times$ 18–23 μ). The correct name for this species is *P. endosulphurea*. It is extremely common in the Caribbean region but much rarer elsewhere (fig. 14). The chemistry is not clear except that the pigment is the same one found in *P. appendiculata* Fée, *P. araucariarum* Zahlbr., and others.

Additional specimens examined:

U.S.: ALABAMA: Pocosin, 4 mi. southeast of Troy, Pike Co., *McCullough* 453 (US); FLORIDA: Gainesville, Alachua Co., *Nelson* s.n. (FLAS); Suwanee River State Park, Suwanee Co., *Hale* 17636 (US); Orange Park, Clay Co., *Hale* 17743 (US); Everglades National Park, Dade Co., *Degelius*, Nov. 22, 1939 (DEGEL), *Imshaug* 23955 (MSC); TEXAS: 3 mi. east of Edna, Victoria Co., *Darrow* (TAES). MEXICO: VERACRUZ: 24 km. northwest of San Andrés Tuxtla, *Hale* 19763 (US); 15 km. south of Catemaco, *Hale* 19797 (US); CHIAPAS: 50 km. west of Tuxtla Gutiérrez, *Hale* 19941 (DUKE, MSC, REN, S, TNS, US). COSTA RICA: GUANACASTE: Upper slopes of Cerro San José de Libano, *Dodge* 7962 (MICH);

LIMÓN: Portete, *Quiros* 1478 (MO); vicinity of Guápiles, *Standley* 37398 (US). PANAMA: Juan Mina, Chagres River, Canal Zone, *Bartlett* 16822 (MICH); Barro Colorado Island, *Aviles* 945 (F).

BAHAMAS: New Providence, *Britton* 6583 p.p. (FH, NY). CUBA: PINAR DEL RÍO: Sumidero, *Shafer* 13926 (FH); LAS VILLAS: Trinidad Mountains, *Imshaug* 24598 (MSC). HAITI: Below Citadelle, south of Milot, *Wetmore* 2826 (MSC, US), 2859 (MSC); near Port Margot, *Nash* 99 (FH); Between Petionville and Ft. Jacques, *Thomas* 36a (NY). DOMINICAN REPUBLIC: Los Amaceyes, Cordillera Setentrional, *Wetmore* 3400, 3406 (MSC); Cerrazo, on ridge from La Cumbre to Santiago, *Wetmore* 3844 (MSC, US), 3871 (MSC); Guama, Santiago, *Wetmore* 3906 (MSC, US); west of Ciudad Trujillo, *Allard* 16794a, 16778 (US); Repressa Dam, near Maná, *Allard* 17285, 17287 (US); Hato Major, along Río Magua, *Thomas* 32 (NY). JAMAICA: 1 mi. northwest of Stewart's Town, *Pierce* 510 (PH); Farm Hill, St. Thomas, *Orcutt* 3551a (US); Birch's Hill, Hanover, *Imshaug* 15724 (MSC); Mt. Diablo, St. Catherine, *Imshaug* 13782, 14241 (MSC); Mandeville, *Cushman* 8 (FH); Santa Cruz Mountains, *Britton* 483 (FH); below August Town, St. Andrew, *Imshaug* 13637 (MSC); Hopewell, St. Ann, *Imshaug* 15805 (MSC, US). PUERTO RICO: Sardinera, Mona Island, *Britton* 1801 (FH, NY); near Maricao, *Sintenis* 2 (G); near Aibonito, *Sintenis* 55 p.p. (G); Adjuntas, *Sintenis* 79 (G); Monte Montoso, *Britton* 4180 (FH, NY); Mayaguez, *Fink* 1326 (FH, G); Naranjito, *Fink* 279 (FH). U.S. VIRGIN ISLANDS: ST. THOMAS: Bonne Resolution, *Britton* 444 (FH, NY); ST. JOHN: Makumli, *Raunkiaer* 442 (C); Sussanaberg, *Boergesen* s.n. (C). BRITISH VIRGIN ISLANDS: TORTOLA: *Eggers* 3192 (C), *Fishlock* 502 (FH, NY); VIRGIN GORDA: *Fishlock* 345 (FH, NY). GUADELOUPE: Trois Rivières, *Le Gallo* 421, 558 (MO). MARTINIQUE: Without locality, *Husnot* 442 (G); Fonds-St.-Denis, *Degelius*, May 26, 1958 (DEGEL); La Pagerie, *Degelius*, May 17, 1958 (DEGEL). ST. LUCIA: *Murray* (G). BARBADOS: Welchman's Hall Gully, *Evans* s.n. (YU). TRINIDAD: San Fernando Palmiste, *Broadway* 8987 (K).

VENEZUELA: MÉRIDA: Río Chama Valley, Mérida, *Dennis* 1673 (K). COLOMBIA: BOLÍVAR: Torrecilla, near Turbaco, *Killip & Smith* 14675 (US). CHILE: Without locality, *Barclay*, 1836 (BM). BRAZIL: RIO DE JANEIRO: Rio de Janeiro, *Glaziou* 1842 (M), *Milne*, s.n. (K), *Vainio, Lich. Bras. Exs.* 480 (BM); BAHIA: São Beulo, *Leutzelburg* 296a (M); RIO GRANDE DO SUL: Encrusilhada do Sul, *Cuezzo* 13371 (F); SÃO PAULO: Near Conceicão de Itanhaen, *Schiffner* (BM).

IVORY COAST: Forêt d'Akadiedon, *des Abbayes* s.n. (S). MADAGASCAR: Fort Carnot, *Decary* s.n. (LD).

JAVA: Buitenzorg Garden, Batavia, *Schiffner* 3196 (FH). FIJI: Suva, *Edmondson* s.n. (BISH, US).

Localities already published by Hale (1959a) for Florida, Louisiana, Grenada, El Salvador, British Honduras, Nicaragua, and Uruguay (excluding the type of *P. lindmanii* Lynge) are not repeated in this list.

14. Parmelia fasciculata Vain. Hedwigia 38:122. 1899.

Parmelia fatiscens Lynge, Ark. Bot. 15, no. 1:1. 1917. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* (S, holotype).

Type collection: Bogotá, Colombia, *Weir* 66 (K, holotype; TUR, isotype).

Thallus loosely adnate on bark, 5–15 cm. in diameter, mineral gray, often with a yellowish tinge; lobes rotund, 6–12 mm. wide, margins of lobe tips entire, lateral margins laciniate and dissected, laciniae

developing into large coralloid clusters to 4 mm. high, sometimes becoming pustular or sorediate-pustulate, cilia very rarely developed; upper surface plane, dull, reticulately cracked with age; lower side black and sparsely rhizinate in the center, brown and naked in a broad zone along the margins. Apothecia rare, 3–6 mm. in diameter, substipitate, amphithecium irregularly pustulate, disc imperforate; hymenium 50–65 μ high; spores 8–10×18–20 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish orange, fading, P+ brick red, atranorine, protocetraric acid and traces of usnic acid present.

The most unusual feature of *P. fasciculata* is the large coralloid outgrowths which superficially resemble tiny thalli of *Stereocaulon*. They originate from marginal laciniae or directly from the upper cortex. The tips of the branches are warty and sometimes become pustulate but never develop true soredia. The species is quite rare. It seems to be related to *P. dilatata* Vain., which may develop similar, although far less conspicuous, coralloid outgrowths along with coarse soredia. Both species are faintly maculate. *Parmelia ramuscula* Hale and *P. flavotincta* Hale have similar coralloid structures but differ in chemistry.

Additional specimens examined:

JAMAICA: East Peak, Blue Mountains, *Imshaug* 14833 (MSC).
LIBERIA: Firestone Plantations, Harbel, *R. Hale*, Oct. 1958 (US).

15. Parmelia latissima Fée, Ess. Crypt., suppl. 119, *pl. 38, fig. 4.* 1837.

Type collection: Jamaica, *s.c.* (G, lectotype).

Thallus large, expanded, loosely attached to bark, 10–25 cm. in diameter; lobes rotund, 8–20 mm. wide, margins entire; upper surface plane, dull, continuous or becoming reticulately cracked with age, soredia and isidia lacking; lower side black and rhizinate, brown and naked in a broad zone at the margin. Apothecia common, adnate to substipitate, disc imperforate; hymenium 100–120 μ high; spores 14–16×28–32 μ, episporium 3–4 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Fée described *P. latissima* from two collections in tropical America. Fortunately Müller-Argau kept fragments of both of these specimens. The lectotype follows the accepted concept of *P. latissima*, a plant with the medulla reacting K+ red; the other specimen is *P. zollingeri* Hepp (medulla K−, protocetraric acid present). *Parmelia latissima* represents the simplest kind of *Amphigymnia*, having more or less adnate imperforate apothecia and lacking isidia, soredia, cilia, and maculae. *Parmelia zollingeri* is very close, as is *P. crassescens* Stirt., but both of these species may be separated by different chemistry and

smaller spores. The sorediate counterpart is *P. cristifera* Tayl. *Parmelia latissima* is virtually restricted to tropical America except for one locality in India (cf. fig. 3). The name has been used incorrectly in the literature many times and has often been cited as the parent species for numerous varietal taxa.

Additional specimens examined:

MEXICO: VERACRUZ: 15 km. south of Catemaco, *Hale* 19843a (US); CHIAPAS: El Sumidero, near Tuxtla Gutiérrez, *Hale* 20187 (MSC, US); 50 km. west of Tuxtla Gutiérrez, *Hale* 21050 (DUKE, US); El Suspiro, 9 km. north of Berriozábal, *Hale* 21232 (US); CAMPECHE: Tuxpeña, *Lundell* 1303 (F). HONDURAS: ATLÁNTIDA: Lancetilla, near Tela, *Standley* 54210, 54606, 55415 (F). NICARAGUA: Vicinity of Casa Colorado, near El Crucero, *Standley* 8603 (F). COSTA RICA: GUANACASTE: Vicinity of Tilarán, *Standley* 44428 (US); ALAJUELA: San Ramón, *Brenes* 14462a (MO); CARTAGO: Potrero at Santiago, *Dodge* 4557 (MICH); Turrialba, *Maxon* 206 (MO); El Muñeco, south of Navarro, *Standley* 33676 (US).

BAHAMAS: New Providence, *Britton* 3239 (FH, NY); Marsh Harbor, Abaco, *Brace* 1658 (FH, NY). CUBA: Without locality, *Wright, Lich. Cubae* 67 (BM, FH, K, M, UPS, US); PINAR DEL RÍO: Source of Río Taco-Taco, Sierra de los Organos, *Morton* 4280 (MO, US); San Diego de los Baños, *Earle & Murrill* 258 (FH), *Palmer & Riley* 607 (US); HABANA: Cayo Largo, *Proctor* s.n. (PH); ORIENTE: Gran Piedra, *Shafer* 9118 (FH); La Prenda, *Hioram* 2590 (NY), 6102 (BPI); Loma del Gato, *León* 9849, 9886, 9998 (BPI, NY), *Imshaug* 24784, 24805, 24949 (MSC, US), *Hioram* 6694 (US). GRAND CAYMAN: East End Island, *Lewis* 11 (PH). HAITI: Northwest of Jacmel, *Thomas* 77 (FH, MO, US); Port Margot to Corrut, *Nash* 224 (FH); summit of ridge north of Forêt des Pins, Dept. l'Ouest, *Wetmore* 3155 (MSC), *Imshaug* 22697 (MSC, US). DOMINICAN REPUBLIC: Vicinity of Constanza, La Vega, *Allard* 17694b (US). JAMAICA: Moseley Hall Cave, *Imshaug* 13669 (MSC, US), 13676 (MSC); Coopers Hill, Red Hills, St. Andrew, *Imshaug* 14145 (MSC, US), 13732, 13712, 13715, 13716 (MSC); Birches Hill, Hanover, *Imshaug* 15675 (MSC); Mandeville, *Cushman* 1 (FH, NY); Claremont, *Orcutt* 3979 (US); Castleton, *Underwood* 1938 (FH), *Plitt* s.n. (BPI); Hollymount, Mt. Diablo, St. Catherine, *Imshaug* 14218 (MSC, US); Silver Hill Gap, Blue Mountains, *Imshaug* 14083 (MSC); Beaufort, *Wullschlaegel* 1256 (M); Coldspring Gap, *Purdie* s.n. (K); near Lydford P.O., *Proctor* 8654 (PH); without locality, *Eggers* 3721, *Hansen* s.n. (C). PUERTO RICO: Mayaguez, *Fink* 1022 (NY). GUADELOUPE: Pointe à Pitre, *Questal* 9 (MO). CURAÇAO: La Vela, *Curran & Haman* 513 (US).

VENEZUELA: BOLÍVAR: Río Paragua, Salto de Auraima, *Killip* 37371 (MO, US). COLOMBIA: CHOCO: Port Utria, *Taylor* 879 (H, K). PERU: AYACUCHO: Estrella, *Killip & Smith* 23068 (US); Mito, *Bryan* 222 (F); Lamas, *Spruce* 112/2 (K). BRAZIL: MATO GROSSO: Santa Anna da Chapada, *Robert* 649 (BM, K), 650 (BM, K, US), 651 (K).

INDIA: Calcutta, *Wallich* (BM). MARQUESAS: Nukuhiva, near Hakaui, *Brown* 472 (BISH, US).

16. Parmelia mesogenes Nyl. Flora 68:609. 1885.

Type collection: Orizaba Peak, Mexico, *Galeotti* 6958 (P, holotype).

Thallus saxicolous or corticolous, expanded, rather adnate, to 15 cm. broad, mineral gray; lobes rotund, 8–12 mm. wide, margins entire; upper surface plane, opaque, isidia, soredia, and cilia lacking; medulla

white or turning orange red near the lower cortex; lower side black and moderately rhizinate, brown, shiny, and naked in a broad zone at the margins. Apothecia common, stalked to substipitate, 6–8 mm. in diameter, disc imperforate; hymenium 115–130 μ high; spores 12–14×21–30 μ, episporium 2.0–2.5 μ; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, pigmented medulla K+ purple, atranorine, an unknown anthraquinone, and unknown colorless substances crystallizing in G.E.

Parmelia mesogenes has few distinguishing features since it lacks soredia, isidia, and maculae and is negative with color tests. The unknown acid crystallizes in G.E. as very large needle clusters. The pigment, which is found even in the lobe tips, is identical with the one in *P. erasmia* Hale and *P. hypomiltoides* Vain. *Parmelia mesogenes* is both saxicolous and corticolous in wet cloud forests where banana plantations are found. It is endemic to Mexico but will probably eventually be found in other parts of Central America.

Additional specimens examined:

MEXICO: VERACRUZ: Mirador, *Liebmann* 7562b (C); Teocello Canyon, just south of Xico, *Hale* 21150 (S, TNS, US), 21156 (DUKE, REN, US), 21175 (US); northeast of Huatusco, *Hale* 19521 (US); 7 km. north of Fortín de las Flores, *Hale* 19694 (US); 46 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19407a (US); CHIAPAS: El Sumidero, Tuxtla Gutiérrez, *Hale* 20026 (US).

17. Parmelia mesotropa Müll Arg. Rev. Mycol. 10:55. 1888.

Parmelia saccatiloba Tayl. *f. membranacea* Lynge, Ark. Bot. 13, no. 13:67. 1914. Type collection: Pilcomayo, Gran Chaco, Paraguay, *Malme*, 1893 (S, holotype).

P. subregressa Lynge, Ark. Bot. 13, no. 13:58. 1914. Type collection: Paraguari, Paraguay, *Malme* 1525B (S, holotype).

Type collection: Asunción, Paraguay, *Balansa s.n.*, 1878 (G, lectotype).

Thallus adnate to bark, 5–10 cm. in diameter, light mineral gray; lobes rotund, 5–8 mm. wide, margins entire to broadly crenate; upper surface plane, opaque, reticulately cracked with age, isidia, soredia, and cilia lacking; lower side black and sparsely rhizinate, brown and naked in a rather narrow zone along the margins. Apothecia numerous, 5–8 mm. in diameter, amphithecium maculate, disc imperforate; hymenium 60–90 μ high; spores 7–11×15–21 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and caperatic (mixed with protolichesteric acid?) present.

Parmelia mesotropa resembles *P. latissima* Fée and *P. zollingeri* Hepp in external appearance and the lack of soredia, isidia, and cilia, but it is too small to be confused with either of these species. It

differs furthermore in the P— reaction. The sorediate counterpart of *P. mesotropa* appears to be *P. praesorediosa* Nyl., a much more widely distributed species.

Additional specimens examined:

MEXICO: Oaxaca: 77 km. northwest of Tehuantepec, *Hale* 20631 (US). GUATEMALA: Jutiapa: Jutiapa, *Standley* 75250, 75949 (MO); El Barrial, east of Jutiapa, *Standley* 75816 (F, US); between Jutiapa and La Calera, *Standley* 76106 (F).

BOLIVIA: El Beni, Trinidad, *Werdermann* 2389 (S). BRAZIL: Mato Grosso: Santo Antonio, near Cuyabá, *Malme* 215CB (S); Santa Anna da Chapada, *Malme* 2392** (S). URUGUAY: Río Verde, Chaco, *Herter* 84954 (MO) PARAGUAY: Pilcomayo, Gran Chaco, *Malme*, Sept. 7, 1893 (S); Asunción, *Malme* 1678** (S).

18. Parmelia myelochroa Hale, sp. nov. Plate 3

Thallus laxe adnatus, usque ad 15 cm. latus, rigidus, viridi- vel albido-glaucescens, lobis primo rotundatis, demum late revolutis, paulo congestis, 8–12 mm. latis, margine parce dentato-laciniatulis vel integris, superne laevigatus, nitidulus, centrum versus rugosus, cortice continuo, sorediis isidiisque destitutis, strato corticeo superiore 11–15 μ crasso, strato gonidiali 11–15 μ crasso, medulla luteo-flavens, 100–125 μ crassa, strato corticeo inferiore 11–15 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia numerosa, pedicellata, 7–15 mm. lata, disco imperforato, amphithecio rugoso, albo-maculato; hymenium 75–90 μ altum; sporae 9–13×21–26 μ, episporio 1.5–2.0 μ; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K+ intensius flavescens, C+ flavescens, KC+ flavescens, P—, atranorinum, acidum barbaticum (?) et pigmenta ignota continens.

Type in the U.S. National Herbarium, collected in deciduous mist forest, elev. 1040 m., 50 km. west of Tuxtla Gutiérrez, Chiapas, Mexico, Mar. 18, 1960, by M. E. Hale (no. 21049; isotype in TNS).

Parmelia myelochroa is a tropical American species rarely seen among older herbarium collections. It was recognized by Zahlbruckner from Schiffner's Brazilian collections as *P. sulphurata* f. *nuda*, an herbarium name only. Externally it resembles *P. latissima* Fée, with which it is often found. However, *P. myelochroa* has a conspicuous yellow-orange medulla and intermediate spores. The chemical components are still not fully known. *P. araucariarum* Zahlbr. and *P. endosulphurea* (Hillm.) Hale are respectively the sorediate and isidiate counterparts of *P. myelochroa*.

Additional specimens examined:

MEXICO: Chiapas: 50 km. west of Tuxtla Gutiérrez, *Hale* 20214 (US), 19909 (S, US). HONDURAS: Comayagua: Near Siguatepeque, *Yuncker et al.* 6499 (F).

PERU: Selva Real, Tingo María, *Morrow* 9654 (US, WJC). BRAZIL: MINAS GERAIS: Road to São Miguel, *Mexia* 5239 (MO, S, US); São Paulo: Mt. Jaraguá, near Taipas, *Schiffner*, June 1901 (BM, M, WU).

19. Parmelia pancheri Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:202. 1899.

Type collection: New Caledonia, *Pancher* (P, holotype).

Thallus large, 10–20 cm. in diameter, loosely attached to bark, mineral gray; lobes rotund, to 10 mm. wide, more or less imbricate and crowded toward the center, margins smooth, sometimes narrowly black rimmed, cilia lacking, upper surface smooth to rugose with age, soredia and isidia lacking, opaque; lower side black and sparsely rhizinate, brown to tan and naked in a broad zone along the margins. Apothecia large, to 30 mm. in diameter, stalked, amphithecium rugose-maculate, disc perforate; hymenium 50–60 μ high; spores 5–9×12–18 μ, episporium 1.0–1.5 μ thick; pycnidia abundant.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

When I first examined the holotype of *P. pancheri*, I considered the lack of cilia to be an abnormal condition since all other species with alectoronic acid have cilia. After examining several other collections, I realized that the lack of cilia is normal for this species. Maculae are not noticeably developed. Except for the collection from Thailand, *P. pancheri* is known only from New Caledonia.

Additional specimens examined:

THAILAND: Doi Sutep, *Tsuyama* 7 (TNS,US). NEW CALEDONIA: No locality, *Pionniero*, 1907 (DUKE).

20. Parmelia peralbida Hale, sp. nov. PLATE 5

Thallus laxe adnatus vel adnatus, membranaceus vel rigidulus, cinereo-candidus vel albicans, 5–10 cm. diametro, lobis rotundatis, vulgo monophyllosis, usque ad 15 mm. latis, ciliis destitutis, modice isidiatis, isidiis tenuibus, simplicibus, 0.03–0.08×0.3–1.0 mm., superne planus, nitidus, aetate leviter rimosus, strato corticeo superiore 30–40 μ crasso, strato gonidiali 20 μ crasso, medulla alba, 140–150 μ crassa, strato corticeo inferiore 20 μ crasso, inferne nigricans, sparse rhizinosus, versus ambitum castaneus, nitidus, late glaber. Apothecia rara, adnata, ad 4 mm. diametro, disco imperforato, amphithecio isidiato; hymenium 35–40 μ altum; sporae 5–7×8–10 μ (maturae?), episporio 1 μ; pycnidia dispersa; conidia 1×6–7 μ. Thallus K+ flavescens; medulla K−, C−, KC+ fugiter rosea, P+ aurantiaca, atranorinum et acidum protocetraricum continens.

Type in the Farlow Herbarium (Tuck), collected in Jamaica, 1884, by J. Hart (no. 124; isotype in K).

This species is characterized by the large whitish thallus, the very thin unbranched isidia, and the presence of protocetraric acid. It is

usually collected sterile so that the range of variation in spore size is uncertain. The low hymenium and the unusually small spores are noteworthy, if they prove to be consistent. *Parmelia peralbida* is known only from the Caribbean area. Two other species resemble it in having isidia and protocetraric acid. *Parmelia saccatiloba* Tayl. has large saccate lobes, coarser and shorter isidia, and large spores (24–26 μ long). It is known from four localities in the South Pacific. If it occurs among the sterile specimens from the Caribbean area, it would be difficult to tell it from *P. peralbida*. *Parmelia koyaensis* Asahina, an Asian species in subgenus *Parmelia* with slightly branched rhizines, is smaller but otherwise very similar in external appearance.

Additional specimens examined:

MEXICO: CHIAPAS: Lagos de Monte Bello, *Hale* 20397 (US). HONDURAS: MORAZÁN: Vicinity of El Zamorano, *Standley* 239 (F, US); La Montañita, *Standley* 12373 (F). PANAMA: CHIRIQUÍ: Monte Lirio, *Seibert* 1011 (MO).

HAITI: Ridge between Forêt des Pins and Petit Source, *Wetmore* 3076 (MSC). JAMAICA: No locality, *Hart* 102 pr.p. (NY); Main Ridge Gap, Blue Mountains, *Imshaug* 14757 (MSC); east of East Peak, Blue Mountains, *Imshaug* 14889 (MSC); New Haven Gap, Blue Mountains, *Imshaug* 15153 (MSC).

21. Parmelia praesorediosa Nyl. Sert. Lich. Trop. Labuan Singapore 18. 1891.

PLATE 5

Parmelia capitata Lynge, Ark. Bot. 13, no. 13:59, *pl. 1, figs. 4, 5*. 1914. Type collection: Rio Vermelho, near Bahia, Bahia, Brazil, *Malme* (S, holotype).

P. sanctae-crucis Vain. Ann. Acad. Sci. Fenn. 6, no. 7:14. 1915. Type collection: Near Fair Plain, St. Croix, *Boergesen* (C, holotype; TUR, isotype).

P. neglecta Asahina, Journ. Jap. Bot. 17:71, *fig. 77*. 1941. Type collection: Raisha, Formosa, *Asahina* F. 51 (TNS, holotype).

P. luzonensis Räs. Ann. Bot. Soc. Zool. Bot. Vanamo 3:78. 1948. Type collection: Panai-Kabayan, Benguet, Luzon, Philippines, *McGregor* 8806 (H, holotype).

P. subcetrarioides des Abbayes, Bull. Inst. Fr. Afr. Noire 13:974. 1951. Type collection: Kankan, Guinea, Africa, *des Abbayes* (REN, lectotype; US, isotype).

Type collection: Singapore, *Almquist* (H, Nyl. herb. no. 35547, holotype; S, isotype).

Thallus adnate, 5–10 cm. in diameter, mineral gray to buff; lobes 5–8 mm. wide, rotund, margins suberect and sorediate, soralia often crescent-shaped and in part submarginal, cilia lacking; upper surface smooth, dull; lower side black and rhizinate in the center, brown or mottled ivory at the margins. Apothecia rare, 4–10 mm. in diameter, short-stalked, amphithecium rugose, sorediate, disc imperforate; hymenium 70–80 μ high; spores 7–10×15–21 μ, episporium 1.2–2.0 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and caperatic acid present.

Parmelia praesorediosa is a pantropical species (fig. 15). It is both corticolous and saxicolous and occurs at low elevations, often on cultivated trees, apparently as a weedy species in areas disturbed by man. Margins of sorediate lobes are often sinuous and the soralia crescent-shaped. Externally it might be mistaken for small specimens of *P. cristifera* Tayl. or *P. dilatata* Vain., but the medulla is K—, P—. The nonsorediate counterpart is *P. mesotropa* Müll. Arg., a rarer tropical American species.

Additional specimens examined:

U.S.: South Carolina: Bulls Island, Charleston Co., *Culberson* 10031 (DUKE); near Creston, Calhoun Co., *Culberson* 7734, 7742 (DUKE); 3 mi. west of Sumter, Sumter Co., *Culberson* 7773 (DUKE); Alabama: Dupree, Houston Co., *McLennan* 6001001 (US); Florida: 5 mi. east of Greenville, Madison Co., *Hale* 17607 (US); Nittaw, Osceola Co., *Hale* 17711 (US); 5 mi. south of Tallahassee, Leon Co., *Hale* 16725 (US); Seffner, Hillsboro Co., *Cowan* s.n. (US); Upsala, Seminole Co., *Rapp* 660 (FLAS); 4 mi. northeast of La Belle, Glades Co., *Hale* 16867 (US); Louisiana: Grand Isles, Jefferson Parish, *Drouet* 9520 (F); Baton Rouge, East Baton Rouge Parish, *McFarland* 6 (WIS); 22 mi. south of New Orleans, Plaquemines Parish, *Smith* 12394 (US); Texas: Houston, Harris Co., *Fisher* 5199a (FH). MEXICO: Veracruz: 9 km. east of Jalapa, *Hale* 19421 (TNS, US); Teocello Canyon, south of Xico, *Hale* 21142 (MSC, US); Oaxaca: Northwest of Tehuantepec at Km. 719 on highway 190, *Hale* 20620 (DUKE, US); Chiapas: El Zapotal, Tuxtla Gutiérrez, *Hale* 19993 (S, US); Yucatán: Tekax, *Gaumer* 1210 (F). HONDURAS: Atlántida: Near Tela, *Standley* 53862 (F).

BAHAMAS: New Providence, *Britton* 3311 (FH); Soldiers Road, *Brace* 9790, 9907 (NY). CUBA: Without locality, *herb Montagne* (FH, K); Isle of Pines: La Cunagua, *Britton* 14586 (FH, NY); Pinar del Río: Valle de Silencio, Alturas de Pizarras, *Imshaug* 25293 (MSC, US); Habana: Santiago de las Vegas, *Hermann* 785 (F), *Roig* 1 (MO); Cojimar, *Arsène* 10859 (US); Camaguey: Camino Antón, *MacBride & Dahlgren* 74 (F); Oriente: La Prenda, *Manuel* 5692 (BPI); El Gato, Loma del Gato, *Imshaug* 24743 (MSC); Puerto Boniato Ridge, Santiago de Cuba, *Imshaug* 24653 (MSC). GRAND CAYMAN: Near Georgetown, *Imshaug* 24381 (MSC); East End Island, *Lewis* 12 (PH). HAITI: Behind Hotel Randan, east edge of Les Cayes, *Imshaug* 23127b (MSC, US); Bayeux, between Cap Haitien and Le Borgne, *Bartlett* 17783 (WIS). DOMINICAN REPUBLIC: Hayto Mayor, *Thomas* 33 (MO, NY); Santiago, *Imshaug* 23801 (MSC, US); Ciudad Trujillo, Santo Domingo, *Allard* 16182a (US); Valdesia Valley, Prov. Trujillo, *Allard* 17351, 17353 (US); along Río Inoa at Inoa, Santiago, *Imshaug* 23885 (MSC). JAMAICA: New Castle, *Cushman* 167 (FH); Clarks Town, Trelawny, *Imshaug* 16048 (MSC); Birch's Hill, Hanover, *Imshaug* 15672 (MSC); Stewart Town, St. Ann, *Imshaug* 16012 (MSC, US); Hope River below August Town, *Imshaug* 13629 (MSC, US); Hillshire Hummock, St. Catherine, *Imshaug* 13687 (MSC). PUERTO RICO: Aibonitó, *Fink* 1931 (FH); Manati, *Fink* 2120 (FH); Laguna Tortuguero, *Britton* 3869 (FH, NY); Río Piedras, *Johnston* 947a (FH, NY); San Juan, *Hioram* s.n. (FH, NY); Campo Alegre, *Stevenson* 2477 (US); near Cayey, *Sintenis* 38 (G). VIRGIN ISLANDS: St. Thomas: Mandal, *Britton* 1311 (FH, NY); Bonne Resolution, *Britton* 446 (FH, NY). GUADELOUPE: Basse Terre, *Le Gallo* 525 (MO); Rivières, *Le Gallo* 2602 (MSC). ST. BARTHELEMY: Vité, *Le Gallo* 409 (MO); Saline, *Le Gallo* 560 (MO). DOMINICA: Roseau, *Evans* 51, 60 (US, YU). MARTINIQUE:

Madiana Beach, *Degelius*, May 13, 1958 (DEGEL). TRINIDAD: Centeno, *Earle* s.n. (US); without locality, *Lassen* (C).

VENEZUELA: LARA: Near Barquisimeta, *Saer* 49 (US). FRENCH GUIANA: Cayenne, *Babington* s.n. (UPS). PERU: SAN MARTÍN: Tingo María, *Allard* 21453 (US). BRAZIL: Rio de Janeiro, *Milne* (K), *Widgren* (S, UPS); MINAS GERAIS: Rio Branco, Mareco, *Mexia* 5452a (US); RIO GRANDE DO SUL: Pareci Novo, *Lima* 82 (MO). PARAGUAY: Pilcomayo, Gran Chaco, *Malme*, Sept. 6, 1893 (S). ARGENTINA: TUCUMÁN: Pueblo Viejo, *Killip* 39515 (US).

GUINEA: 3–4 km. east of Divo, cercle of Grand Lahou, *Santesson* 10382a (UPS); 50 km. west of Guiglo, cercle of Man, *Santesson* 10487 (UPS). REPUBLIC OF CONGO: Brazzaville, *Degelius*, Mar. 12, 1960 (DEGEL, US). CONGO: Kabalo, Katanga, *Höeg*, Feb. 22, 1930 (TRH). UNION OF SOUTH AFRICA: TRANSVAAL: Wyllie's Poort, Zoutpansberg, *Almborn* 6410 (LD); NATAL: Somkili, Nogoma, *Höeg* s.n. (TRH).

INDIA: 4–5 mi. from Tanakpur, Uttar Pradesh, *Awasthi* 3370 (AWAS). SUMATRA: Tandjung Alai, *Groenhart* 8990 (BO); Sawahpari, *Groenhart* 9210 (BO); north bank of Lake Singdarak, *Groenhart* 9287 (BO). JAVA: Bandung, *Groenhart* 8856 (BO). NEW CALEDONIA: *Compton* s.n. (BM).

Additional localities cited by Hale (1959a) (as *P. sanctae-crucis* Vain.) from Georgia, Florida, Alabama, Louisiana, the West Indies, Honduras, Nicaragua, Guinea, and Japan are not repeated here.

22. Parmelia pseudotinctorum des Abbayes, Bull. Inst. Fr. Afr. Noire 13:973, 1951. PLATE 1

Parmelia nitens f. *isidiosa* Müll. Arg. Bot. Jahrb. Engler 20:255. 1894. Type collection: Ririre, Karapo, Seen region, Tanganyika, Africa, *Stuhlmann* 3301 (G, holotype; K, isotype?, as 3201).

P. soredica var. *neghelliensis* Cengia-Sambo, R. Accad. Ital. Miss. Biol. Paese Borana 380. 1939. Type collection: Borana, Ethiopia, *Cufodontis* 193a (FI, holotype).

P. neghelliensis (Cengia-Sambo) Dodge, Ann. Mo. Bot. 46:120. 1959.

P. pseudotinctorum f. *perrugosa* des Abbayes, Bull. Inst. Fr. Afr. Noire 13:974. 1951. Type collection: Dalaba, Fouta-Djalon, cercle de Mamon, Guinea. *des Abbayes* (REN, holotype).

P. stuhlmannii Dodge, Ann. Mo. Bot. Gard. 46:137. 1959. Based on *P. nitens* f. *isidiosa* Müll. Arg.

Type collection: Mt. Tonkoui, cercle de Man, Ivory Coast, *des Abbayes*, Aug. 14, 1948 (REN, lectotype; US, isotype).

Thallus saxicolous, loosely adnate, 8–15 cm. in diameter, light mineral gray; lobes rotund, 8–12 mm. wide, margins entire to crenate; upper surface dull, isidiate, isidia inflated and irregular, 0.2–0.3 mm. thick, coarsely branched with age, to 0.5 mm. high; lower side black and sparsely rhizinate, light brown, shiny, and naked in a broad zone along the margins. Apothecia rare, 2–4 mm. in diameter, amphithecium coarsely isidiate, disc perforate or imperforate; hymenium about 40 μ high; spores poorly developed, 5–8$\times$8–12 μ, episporium 1 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ red, P−, atranorine and lecanoric acid present.

Parmelia pseudotinctorum is identical with *P. tinctorum* Nyl. in habit and chemistry. It differs chiefly in having large inflated isidia, whereas *P. tinctorum* has uniformly thin cylindrical or even granular isidia.

Additional specimens examined:

IVORY COAST: Mont Tonkoui, cercle of Man, *Santesson* 10633 (*Almb. Lich. Africani* 30) (LD, UPS, US, WIS); Mankono, cercle of Seguela, *Santesson* 10711 (UPS).

23. Parmelia ramuscula Hale, sp. nov. PLATE 1

Thallus laxe adnatus, 8–10 cm. diametro, albicans, lobis rotundatis, 10–15 mm. latis, margine integris, centrum versus laciniato-dissectis, laciniis isidiiformibus, coralloideo-ramosis, usque ad 1 cm. altis, isidiis fatiscentibus, demum sorediatis, margine ciliatis, ciliis sparsis, 1 mm. longis, superne opacus, reticulatim rimosus in aetate, strato corticeo superiore 24–28 μ crasso, strato gonidiali 22–26 μ crasso, medulla alba, 110–140 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, sparse rhizinosus, ambitu fuscus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K+ rubra, C−, KC−, P+ aurantiaco-flava, atranorinum et acidum salacinicum continens.

Type in the British Museum, collected at Lawas, Sarawak, May 31, 1955, by W. M. A. Brooke (no. 10031; isotypes in L, US).

This species has the same coralloid fatiscent outgrowths (pl. 1) that characterize *P. flavotincta* Hale and *P. fasciculata* Vain. *Parmelia flavotincta* has a more membranous thallus and well-developed cilia. *Parmelia fasciculata* is very close except for chemistry. *Parmelia ramuscula* may have some relation to *P. cristifera* Tayl., a marginally sorediate species, in the same way that *P. fasciculata* is related to *P. dilatata* Vain.

Additional specimen examined:

PHILIPPINES: Rizal, Luzon, *Ramos* s.n. (H).

24 Parmelia rubifaciens Hale, sp. nov. PLATE 4

Thallus adnatus, 8–12 cm. diametro, viridi-glaucescens (in herbario olivaceo-glaucescens), lobis rotundatis, 5–8 mm. latis, margine sorediatis, soraliis plus minusve conglutinatis, partim submarginalibus, ciliis destitutis, superne opacus, rarius rugulosus et demum irregulariter rimosus, strato corticeo superiore 20 μ crasso, molli, strato gonidiali 20–25 μ crasso, medulla alba, 100–110 μ crassa, strato corticeo inferiore 12–18 μ crasso, inferne niger, sparse rhizinosus, versus ambitum castaneus, late nudus. Apothecia et pycnidia ignota. Thallus K+ flavescens; medulla K+ rubescens, C−, KC−, P+ aurantiaca vel lutea, atranorinum et acidum norsticticum continens.

Type in the Chicago Natural History Museum, collected in the vicinity of Casa Colorado, near El Crucero, summit of Sierra Managua, elev. 800–900 m., Managua, Nicaragua, May 14–25, 1947, by P. C. Standley (no. 8409; isotype in US).

Parmelia rubifaciens externally resembles *P. praesorediosa* Nyl. The soredia of *P. rubifaciens* however are somewhat more extensive, in part submarginal, and often become conglutinated in dense clumps. This species may be related to *P. crassescens* Stirt., a nonsorediate species which also contains norstictic acid, but the collections seen so far are smaller and more adnate than those of *P. crassescens*.

Additional specimens examined:

MEXICO: VERACRUZ: 24 km. northwest of San Andres Tuxtla, *Hale* 19777 (US); YUCATÁN: Tekax, *Gaumer* 1210d (F). GUATEMALA: PETÉN: La Libertad, *Lundell* 2237 (MICH); ZACAPA: Gualán, *Kellerman*, Jan. 3, 1906 (OS, US).

BRAZIL: MINAS GERAIS: No locality, *Burchell* 1105 (K).

25. Parmelia saccatiloba Tayl. London Journ. Bot. 6:174. 1847.

Parmelia tinctorum var. *inactiva* Zahlbr. Denkschr. Akad. Wiss. Naturw. Wien 81:271. 1908. Type collection: Malifa, Upolu, Western Samoa, *Rechinger* 4999 (W, lectotype).

P. inactiva (Zahlbr.) Vain. Bot. Mag. Tokyo 35:47. 1921.

Type collection: Pitcairn's Island, *Beechey* (FH–Tayl, lectotype; H, isotype).

Thallus large, loosely attached on bark, 8–15 cm. broad, mineral gray to buff; lobes broad and rotund, 10–20 mm. wide, older lobes broadly convoluted and saccate, margins smooth, cilia lacking; upper surface dull, reticulately cracked with age, moderately isidiate, isidia cylindrical, simple to branched, 0.03–0.08 mm. in diameter, 0.1–0.3 mm. high; lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia adnate, 5–8 mm. in diameter, disc imperforate; hymenium 110–130 μ high; spores 12–16 $\times$ 22–26 μ, episporium 2.5–3.0 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

The other syntypes listed by Taylor (Mauritius, *Wright*, FH–Tayl; Brazil, *Hook. Herb.*, BM) are *P. tinctorum* Nyl., a common pantropical species with lecanoric acid.

The name *P. saccatiloba* has only rarely been correctly used in the literature. Nylander (1885) reported that it was the same as *P. zollingeri* Hepp, a nonisidiate species. Vainio (1890) conceived of it as a nonsorediate form of *P. dilatata* Vain. Lynge (1913) was misled by these erroneous concepts and identified *P. mesotropa* Müll. Arg. as *P. saccatiloba*. The lectotype of *P. saccatiloba* is actually an isidiate plant, very similar externally to *P. tinctorum* Nyl. but with tall thin cylindrical isidia and different chemistry. *Parmelia*

peralbida Hale from tropical America has similar chemistry but a thinner thallus and smaller spores. *Parmelia saccatiloba* is apparently restricted to the South Pacific.

Additional specimens examined:

HENDERSON ISLAND: North end, *St. John & Fosberg* 15103 (BISH). FIJI: Ovalau Island, *Herre* 5719 (LD). MARSHALL ISLANDS: Arno Atoll, *Horwitz* 9102C (US).

26. Parmelia setchellii Vain. Univ. Calif. Publ. Bot. 12:5. 1924.

Type collection: Puadruu, Tahiti, *Setchell & Parks* (TUR, Vainio herb. no. 2456, holotype).

Thallus loosely adnate on bark, 4–8 cm. in diameter, mineral gray; lobes rotund, often becoming crowded, 5–9 mm. wide, margins crenate, cilia lacking; upper surface plane, often faintly maculate, faintly white reticulate at the tips, finely reticulately cracked with age, coarsely pustulate or isidiate-pustulate in a broad marginal zone, pustules to 0.3 mm. thick, breaking open but not becoming sorediate; lower side black and rhizinate, light tan, shiny, and naked in a distinct but narrow zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

This unique species is known only from the type collection. It is characterized by peculiar inflated isidia which often break open and erupt as pustules but do not become sorediate. The lower side has a relatively narrow bare zone. Further collections are needed before we can ascertain the range of variation and its relation to other species.

27. Parmelia soyauxii Müll. Arg. Linnaea 9:32. 1880.

Parmelia nitens Müll. Arg. Bot. Jahrb. Engler 20:255. 1894. Type collection: Bukoba, Seen region, Tanganyika, Africa, *Stuhlmann* 4[095] (G, holotype; BM, isotype).

Type collection: Pungo Andongo, Angola, *Soyaux* 246 (G, holotype).

Thallus saxicolous, adnate, 6–12 cm. across, whitish to ashy mineral gray; lobes rotund, 6–9 mm. wide, soon crowded and more or less imbricate toward the center, margins entire to crenate, cilia lacking; upper surface shiny at the tips, continuous or becoming cracked with age and darkening from superficial fungal infestations; lower side black and moderately rhizinate, dark brown and naked in a broad zone along the margins. Apothecia adnate to substipitate, amphithecium dull, disc usually perforate; hymenium 65–75 μ high; spores 5–7×12–13 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ deep red, KC+ deep red, P−, atranorine and lecanoric acid present.

Parmelia soyauxii is a saxicolous species apparently most common in the dry savannas of western Africa. The thallus is ashy white, externally similar to *P. breviciliata* Hale, another saxicolous species with alectoronic acid and cilia. The sorediate counterpart of *P. soyauxii* is *P. defecta* Hale.

Additional specimens examined:

ANGOLA: Morro de Lopollo, *Welwitsch* 25 (BM); above Sá da Bandeira, *Degelius*, Feb. 6, 1960 (DEGEL); between Sá da Bandeira and Vila Arriaga, Huila, *Degelius*, Feb. 3, 1960 (DEGEL). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Feb. 2, 1930 (TRH). MADAGASCAR: Mandruka, *Lemaitre* (H).

28. Parmelia tinctorum Nyl. Flora 55:547. 1872.

Parmelia latissima Fée f. *isidiosa* Müll. Arg. Linnaea 43:32. 1880. Type collection: Near Mayumba, mouth of Banya River, Gabon, Africa, *Pechuel-Loesche* (G, lectotype).

P. praetervisa Müll. Arg. Flora 63:276. 1880. Type collection: Java, *Zollinger* 449b (G, lectotype).

P. perlata var. *platyloba* Müll. Arg. Flora 65:316. 1882. Type collection: Japan, *Brauns* 5 (G, lectotype).

P. meiosperma var. *ecklonii* Dodge, Ann. Mo. Bot. Gard. 46:141. 1959. Type collection: Cape of Good Hope, Africa, *Ecklon* (FH-Tuck, holotype).

Type collection: Canary Islands, *Dèspréaux* (?) (H, holotype).

Thallus large, 8–20 cm. broad, loosely adnate on rock or bark, whitish mineral gray; lobes rotund, 10–15 mm. wide, margins entire, cilia lacking; upper surface plane, dull, densely isidiate, isidia papillate-granular to cylindrical, coarse, 0.06–0.10 mm. in diameter, to 2 mm. high, simple to rarely coralloid-branched; lower side black and sparsely rhizinate at the center, brown, shiny, and naked in a broad zone at the margins. Apothecia very rare, to 20 mm. in diameter, exciple isidiate-dentate, amphithecium rugose, white-maculate, isidiate, disc imperforate; hymenium 55–65 μ high; spores 7–10×13–15 μ, episporium 1.5 μ thick; pycnidia rare, conidia 12–15 μ long.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ red, P−, atranorine and lecanoric acid present.

This common weedy pantropical species is well known to all lichenologists. It is immediately identified by the brilliant C+ red reaction and by the simple often granular or papillate isidia. Vainio (1890) recognized this species as *P. coralloidea* (Mey. & Flot.) Vain. in preference to *P. tinctorum*, apparently because he used the concept of absolute priority. The name is illegitimate and, furthermore, a type fragment of *P. perlata* var. *coralloidea* Mey. & Flot. at Geneva seems to be a *Hypotrachyna* species, though too small for study. As Hillmann reported (1939), this specimen is C−.

Additional representative collections examined:

U.S.: KENTUCKY: 8 mi. northwest of Brownsville, Edmonson Co., *Hale* 13861 (US); VIRGINIA: Amburg, Middlesex Co., *Luttrell* 1709 (MO); NORTH CAROLINA:

Smith Island, *Morton* 2219 (US); between Atlantic Beach and Salterpath, Carteret Co., *Culberson* 6846 (DUKE, US); SOUTH CAROLINA: Beaufort, Beaufort Co., *Hale* 7622 (US); 12 mi. southwest of Andrews, Georgetown Co., *Hale* 16548 (US); Isle of Palms, Charleston Co., *Culberson* 9041 (DUKE, US); TENNESSEE: Sycamore, Cheatham Co., *Phillips* s.n. (US); GEORGIA: 3 mi. southwest of Hinesville, Liberty Co., *Hale* 16757 (US); 5 mi. southwest of Waycross, Ware Co., *Hale* 16826 (US); FLORIDA: 5 mi. east of Greenville, Madison Co., *Hale* 17616 (US); 8 mi. east of Ocala, Marion Co., *Hale* 17032 (US); northwest of Hilliard, Nassau Co., *Hale* 17623 (US); Tomoka State Park, Volusia Co., *Hale* 17068 (US); Sanford, Seminole Co., *Rapp, Merr. Lich. Exs.* 141 (BM, M, US); Indian River City, Brevard Co., *Degelius* s.n. (DEGEL, US); Crewsville, Hardee Co., *Hale* 16875 (US); near Pensacola, Escambia Co., *Hale* 7996 (US); ALABAMA: Oak Mountain Park, Shelby Co., *Hale* 7123 (US); Dothan, Houston Co., *McLennan* 6002002 (US); Pocosin, Pike Co., *McCullough* 467 (US); near Epps, Sumter Co., *McCullough* 627 (US); Wilmer, Mobile Co., *Hale* 7174 (US); MISSISSIPPI: Lucedale, George Co., *Hale* 7782 (US); Collins, Covington Co., *Hale* 7971 (US); Tupelo, Lee Co., *Hale* 7808 (US); LOUISIANA: 22 mi. south of New Orleans, Plaquemines Parish, *Smith* 12392 (US); Jefferson Island, Iberia Parish, *Drouet* 9059 (F); Lake Charles, Calcasieu Parish, *Drouet* 8743 (F); St. Martinsville, Martin Parish, *Langlois, Lich. Bor.-Amer.* 122 (H, M, MO, US), *Decades N. A. Lich.* 190 (BM, DUKE, US); ARKANSAS: Near Dallas, Polk Co., *Hale* 3941 (US); TEXAS: 7 mi. south of Silsbee, Hardin Co., *Whitehouse* 25955 (MO); near Avinger, Cass Co., *Hale* 5264 (US); near Woodville, Tyler Co., *Hale* 5226 (US); Karnack, Harrison Co., *Hale* 5324 (US); Nacogdoches, Nacogdoches Co., *Hale* 5435 (US). MEXICO: TAMAULIPAS: Between Mante and Antiguo Morelos, *Moore* 3636 (US); JALISCO: San Sebastian, *Mexia* 1541b (F); VERACRUZ: 96 km. east of Córdoba, *Hale* 19722 (COLO, LISU, MSC, US); Teocello Canyon, south of Xico, *Hale* 21163 (US); PUEBLA: St. Barbara, *Arsène* 808 (US); OAXACA: Km. 686 on highway 190, *Hale* 20647 (MSC, REN, US); CHIAPAS: south of Teopisca, *Hale* 20520 (S, TNS, US); El Sumidero, Tuxtla Gutiérrez, *Hale* 21210 (US); YUCATÁN: Chichankanab, *Gaumer* 2255 (F); Tekax, *Gaumer* 1210 (F). GUATEMALA: SACATEPÉQUEZ: Near Antigua, *Standley* 58822 (F). HONDURAS: COMAYAGUA: Siguatepeque, *Yuncker et al.* 6460 (F, MO), *Standley & Chacon* 6773 (F); MORAZÁN: El Zamorano, *Standley* 241, 12275 (F). BRITISH HONDURAS: EL CAYO: Cohune Ridge, *Mains* 3828 (MICH). EL SALVADOR: SAN VICENTE: Vicinity of San Vicente, *Standley* 3662 (F). NICARAGUA: JINOTEGA: Sierra west of Jinotega, *Standley* 10267 (F); CHONTALES: La Libertad, *Standley* 8789 (F). COSTA RICA: GUANACASTE: Tilarán, *Standley* 44476 (US); ALAJUELA: Cerros de Pata de Gallo, *Brenes* 222 (MICH); CARTAGO: North of Cartago, *Standley* 49590, 49631 (US). PANAMA: Chiriquí, *Wagner* 334 (M).

BERMUDA: Devonshire Marsh, *Britton* 167 (FH, NY). CUBA: PINAR DEL RÍO: Northwest of Hotel San Vicente, *Imshaug* 25232 (MSC, US); Sierra de los Organos, *Imshaug* 25375 (MSC, US); ORIENTE: El Gato, Loma del Gato, Sierra Maestra, *Imshaug* 24735 (MSC); Guantánamo, *Hioram* 18090 (M); Puerto Boniato Ridge, Santiago de Cuba, *Imshaug* 24661 (MSC). HAITI: Northwest of Jacmel, *Thomas* 66 (NY, US); west of Cap Haitien, *Imshaug* 22679 (MSC); below Citadelle, south of Milot, *Wetmore* 2849 (MSC); St. Michel de l'Atalaye, *Leonard* 8015a (FH, NY, US). DOMINICAN REPUBLIC: East of La Romana, *Hassler* 1330 (WIS); Ciudad Trujillo, Santo Domingo, *Allard* 15709, 16182, 17012 (US); Santiago, *Imshaug* 23800 (MSC, US); Gauma, *Wetmore* 3905 (MSC); Los Amaceyes, Cordillera Setentrional, *Wetmore* 3378 (MSC, US); Sousa Bay, Puerto Plata, *Wetmore* 3952 (MSC, US); without locality, *Raunkiaer* 495 (C).

JAMAICA: Flora River, St. Andrews, *Imshaug* 14401 (MSC, US); Albion, St. Ann, *Imshaug* 15896 (MSC), 15920 (MSC, US); Birches Hill, Hanover, *Imshaug* 15673 (MSC); summit of Montpelier, St. Catherine, *Imshaug* 14298 (MSC); Bulls Head, Clarendon, *Bengry* 334 (PH): New Market, *Britton* 534 (FH). PUERTO RICO: 7 mi. south of Caguas, *Heller* 308 (FH, NY); Lares to San Sebastian, *Britton* 2789 (NY); El Río, *Goll* 307 (US); Naranjito, *Fink* 295 (NY); Adjuntas, *Sintenis* 79 (M, NY), 87 (G); near Aibonito, *Sintenis* 55 p.p. (G); Mt. Morales, *Britton* 841 (FH, NY). U.S. VIRGIN ISLANDS: ST. THOMAS: Crown, *Raunkiaer* 415 (C); Signalhill, *Eggers* s.n. (FH); ST. JOHN: Bordeux, *Britton* 567 (FH, NY), *Raunkiaer* 402 (C). BRITISH VIRGIN ISLANDS: Virgin Gorda, *Fishlock* 324 (FH, NY); Tortola, *Eggers* 3192 (C). TRINIDAD: Port of Spain, *Degelius*, June 17, 1958 (DEGEL).

VENEZUELA: GUARICO: Between Uberito and Los Placeres, *Pittier* 12395 (US); FEDERAL DISTR.: Caracas, *Vogl* s.n. (M), *Dennis* 1516, 1519 (K); Maracay, *Mägdefrau* 401 (M). COLOMBIA: SANTANDER: Between El Roble and Tona, *Killip & Smith* 19445 (US); Mesa de los Santos, *Killip & Smith* 15148 (US). GALÁPAGOS ISLANDS: Santa Maria Isl., *Taylor* 864 (MO). PERU: SAN MARTÍN: Tingo María, *Allard* 21600, 22577 (US); CUZCO: Valle de Lacco, *Herrera* 2070 (US). BRAZIL: MINAS GERAIS: Viçosa Agricultural College, *Mexia* 5145a (US); Sitio, *Vainio, Lich. Bras. Exs.* 1082 (M), 614 (UPS); RIO DE JANEIRO: Rio de Janeiro, *Copeland* 2 (G), *Darwin* 463 (K); MATO GROSSO: Near Santa Cruz, *Moore* 719 (BM); Santa Anna da Chapada, *Malme. Lich. Austroamer.* 81 (H, LD, UPS); SÃO PAULO: Near Santos, *Schiffner* s.n. (M); Cruzeiro, *Robert* s.n. (BM). PARAGUAY: Cerro Negro, Paraguari, *Malme* 1480 (LD). ARGENTINA: Without locality: *Lorentz & Hieronymus* (M); JUJUY: Laguna de la Brea, Chaco, *Fries* 43a (S); SALTA: Urundel, Orán, *Grassi* 5642 (MO); northwest of Urundel, *Killip* 39624 (US); MISIONES: San Ignacio Gisela, *Montes* 36 (LD); without locality, *Borman* s.n. (MO).

CANARY ISLANDS: La Palma, *Bornmüller* 3283 (LD); Puerto de la Cruz, Tenerife, *Deglius*, Jan. 21, 1960 (DEGEL). IVORY COAST: Danane, cercle of Man, *Santesson* 10491a (UPS); Mt. Orombo-Boka, cercle of Dimbokro, *Santesson* 10724c (UPS). GUINEA: Mont Nimba, N'Zérékoré, *Santesson* 10515 (UPS). REPUBLIC OF CONGO: Brazzaville, *Degelius* s.n. (DEGEL). CONGO: South of Albertville, *Höeg* s.n. (TRH); Kabalo, Katanga, *Höeg* s.n. (TRH); Victoria Falls, *Höeg* s.n. (TRH); southwest side of Lake Kivu, *Degelius* s.n. (DEGEL). ANGOLA: MOXICO: Between Luso and Cachipoque, *Degelius* s.n. (DEGEL, US); BIÉ: Chinguar, *Degelius* s.n. (DEGEL); MALANJE: Duque de Bragança, *Degelius* s.n. (DEGEL); CUANZA-SUL: 10 km. north of Cassonque, *Degelius* s.n. (DEGEL); HUILA: North of Quilengues, *Degelius* s.n. (DEGEL). MOÇAMBIQUE: 3 km. north of Vila Luiza, Lourenço Marques, *Almborn* 6886 (LD). SOUTHERN RHODESIA: Matopo Hills, *Eyles* 1178 (BM); south of Felixburg Station, *Höeg* s.n. (TRH); between Cashel and Melsetler, *Schelpe* 4046 (BM). UNION OF SOUTH AFRICA: TRANSVAAL: 2 mi. north of Warmbad, Waterberg, *Almborn* 5895 (LD); near Punch Bowl, Zoutpansberg, *Almborn* 6332, 6487 (LD); NATAL: Boschfontein forest, Lions River Distr., *Almborn* 8677 (LD); Eschowe, *Almborn* 8492 (LD, US); Pietermaritzburg, *Almborn* 9629 (LD, US); Nottingham, *Clouston* 1564 (PRE); CAPE PROVINCE: Near Port Elizabeth, *Höeg* s.n. (TRH); Grahamstown, Albany, *Höeg* s.n. (TRH). MADAGASCAR: Mantasoa, *Decary* s.n. (P); Fort Dauphin, *Elliott* 2862 (BM).

NEPAL: Langtang Khola, *Polunin* M161 (BM). INDIA: Darjeeling, Himalayas, *Awasthi* 3874 (AWAS); Shembagar, Palni Hills, *Awasthi* 4089 (AWAS). THAILAND: Doi Chieng Dao, *Tsuyama* 14 (TNS); Pha Nok Kao, Loei, *P.S.*

(K); LAOS: Hase Plantations, *Tsuyama* 15, 22 (TNS). CHINA: Tien Tai Shan, Chekiang Prov., *Chiao* 14065 (US); Chihli Prov., *Clemens* 4014 (US). HONG KONG: *Wright* s.n. (US). JAPAN: Otani, Prov. Inaba, *Ikoma* 6228 (LD); near Mito, Ibaraki, *Sato, Lich. Jap.* 10 (LD); Ono, Koga, Omi Prov., *Kurokawa* 520026 (LD, TNS, US); Shakudai, Shimamoto, Prov. Settu, *Kurokawa* 57253 (TNS, US).

SUMATRA: Kebondjahe, *Depari* 4 (BO); Brastagi, *Breedveld* 21 (BO); Mt. Marapi, *Groenhart* 9152 (BO). JAVA: Kampong Koebang, *Neervoort* 2181 (BO); Tjibodas, *Neervoort* 41 p.p. (BO). BALI: Batoer, *De Voogd* s.n. (BO). NEW GUINEA: Nondugl, Western Highlands Distr., *Hoogland* 3194 p.p. (BM). GUAM: Agana, *Necker* 301 (US). MARSHALL ISLANDS: Inc Island, Arno Atoll, *Stone* 1120 (US). NEW HEBRIDES: Hog Harbor, *Baker* s.n. (BM). AUSTRAL ISLANDS: Naa Rurutu, *Fosberg* 12003 (BISH, MO). MANGAREVA ISLAND: Near Atituiti Point, *Fosberg* 11112 (BISH, MO, US); Mt. Duff, *St. John* 14489 (MO). SAMOA: Upolu, *Reinecke* 13 (BO, US). TAHITI: Papeari, *Herre* s.n. (LD, MICH). HAWAIIAN ISLANDS: KAUAI: Waiakale, *Faurie* 75 bis (BM). AUSTRALIA: Sydney, New South Wales, *Home* s.n. (BM).

29. Parmelia zollingeri Hepp *in* Zoll. Syst. Verz. 9. 1854. PLATE 6

Parmelia latissima var. *corniculata* Kremplh. Flora 61:463. 1878. Type collection: Cionega, Argentina, *Lorentz & Hieronymus* (M, holotype).

P. neocaledonica Nyl. Flora 68:609. 1885. Type collection: New Caledonia, *Vieillard* (H, Nyl. herb. no. 35304, holotype).

P. platyphyllina Vain. Hedwigia 46:168. 1907. Koh Chang, Thailand, *Schmidt* XXX (TUR, holotype; C, isotype).

P. latissima var. *minima* Lynge, Ark. Bot. 13, no. 13:45. 1914. Type collection: Buriti, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2243C** (S, holotype).

P. bogoriensis Zahlbr. Ann. Crypt. Exot. 1:206. 1928. Type collection: Buitenzorg Garden Java, *Overeem* 4 (W, holotype; BO, MICH, isotypes).

P. overeemii Zahlbr. Ann. Crypt. Exot. 1:204. 1928. Type collection: Mt. Tjibodas, Java, *Overeem* 94 (W, holotype; BO, isotype).

P. litoralis Dodge, Ann. Mo. Bot. Gard. 46:169. 1959. Type collection: Kilifi, Kenya, Africa, *Matt Cass*, September 1939 (K, holotype).

P. robertyi Dodge, Ann. Mo. Bot. Gard. 46:174. 1959. Type collection: Bouallé, Boka de Titièkro, Ivory Coast, *G. Roberty* 13941 (G, holotype).

Type collection: Bantam, Java, *Zollinger* 1241 (L, holotype; G, H, isotypes).

Thallus loosely adnate to bark, 10–20 cm. broad, olivaceous mineral gray; lobes broad and rotund, 15–18 mm. wide, margins entire or lobulate or sublobulate, frequently short ciliate in the axils of lobes, cilia 0.5–0.8 mm. long, sometimes branched; upper surface smooth, irregularly cracked with age, dull, soredia and isidia lacking; lower side black and sparsely rhizinate at the center, brown and naked in a broad zone at the margins. Apothecia common, 3–10 mm. in diameter, substipitate, amphithecium smooth, disc imperforate; hymenium 70–80 μ high; spores 7–10×18–22 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia 8–10 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

Parmelia zollingeri is a variable widespread pantropical species. Externally it is extremely close to *P. latissima* Fée, which differs principally in chemistry (K+ red, salacinic acid) and larger spores (28–32 μ long). Most specimens of *P. zollingeri* from tropical America lack cilia, but specimens from Asia often have more or less distinct axial cilia, up to 0.8 mm. long. We are, however, classifying *P. zollingeri* among the nonciliate species. Another area of variability is the development of marginal laciniae which may be richly developed, as in *P. latissima* var. *corniculata* Kremplh., to completely absent. Variability in the development of both cilia and laciniae is largely continuous and extremely difficult to classify. The only other species that can be compared with *P. zollingeri* is *P. disparilis* Nyl., which has laciniate lobes and apothecia, maculae, and somewhat smaller spores.

Additional specimens examined:

U.S.: FLORIDA: Watson Hammock, Big Pine Key, Monroe Co., *Killip* 40869 (US); Royal Palm Hammock, Dade Co., *Small* 7581 (US); Snapper Hammock, subtropical Florida, *Britton* 408 (NY, US). MEXICO: VERACRUZ: 7 km. north of Fortín de las Flores, *Hale* 19671 (US); Mirador, *Ross* 625 (M); CHIAPAS: 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20186 (COLO, DUKE, LISU, MSC, REN, S, TNS, US); Km. 916 on highway 190, west of Ocozocoautla, *Hale* 20600 (TNS, US); CAMPECHE: Calahmul, *Lundell* 1172 (F). GUATEMALA: PETÉN: La Libertad, *Lundell* 2237 (F); ALTA VERAPAZ: Between San Cristóbal and Verapaz, *Steyermark* 43881 (MO). HONDURAS: COMAYAGUA: Near Siguatepeque, *Yuncker* 6499 (US); ATLÁNTIDA: Near Tela, *Standley* 55431 (F). BRITISH HONDURAS: Belize River, *Lundell* 1824 (MICH). COSTA RICA: GUANACASTE: Los Ayotes, near Tilarán, *Standley* 45522 (US); Mt. Irazú, *Bruner* 9504 (MO).

BAHAMAS: New Providence, *Britton* 646 bis (NY); Watlings Island, *Britton* 6205, 6217 (FH, NY); Abaco, *Brace* 1983 (FH, NY). GRAND CAYMAN: Ironshore Area, Spotts Beach, *Imshaug* 24585 (MSC, US); near Georgetown, *Imshaug* 24398 (MSC, US). CUBA: Without locality, *Sagra* in 1836 (UPS); CAMAGUEY: La Gloria, *Shafer* 767 (FH); PINAR DEL RIO: San Diego de los Baños, *Leon* 5260 (FH); northwest of Hotel San Vicente, *Imshaug* 25245 (MSC, US); ORIENTE: Antilla, *Britton* 12523 (FH). HAITI: Furcy, *Leonard* (FH). DOMINICAN REPUBLIC: Sousa Bay, Puerto Plata, *Wetmore* 3926 (MSC). JAMAICA: Without locality, *Wright* s.n. (K), Newcastle, *Cushman* 168 (FH); Morces Gap, Blue Mountains, *Imshaug* 13295 (MSC), Dunns River, St. Ann, *Imshaug* 15753 (MSC, US).

VENEZUELA: BOLÍVAR: Salto de Auraima, Río Paragua, *Killip* 37371b (US). COLOMBIA: NORTE DE SANTANDER: Alto de Santa Inés, *Cuatrecasas* 12451 (US). PERU: CUZCO: Valle de Lacco, *Herrera* 2071 (US); Machupicchu, *Herrera* 3263 (US); LORETO: Mishuyacu, *Klug* 1108 (US). BRAZIL: Santarém, *Spruce* 112 (K). ARGENTINA: Without locality, *Lorentz & Hieronymus* (M).

MAURITIUS: *McGregor* s.n. (BM). LAOS: Hase Plantations, *Tsuyama* 6, 16 (TNS). FORMOSA: Kuraru, *Asahina* s.n. (TNS, US). JAVA: Without locality, *Horsfield* s.n. (BM); vicinity of Goenoeng Boender, *Palmer* 611 (US). PHILIPPINES: Mt. Malinao, Luzon, *Edaño* 37206 (K). TONGA: EUA: Fuai plantation, *Yuncker* 15302 (US).

2. Section *Subflavescentes* (Vain.) Gyel. (1932, p. 225)

Section *Amphigymnia** *Subflavescens* Vain. (1890, p. 35)
Section *Amphigymnia* subsection *Subflavescentes* (Vain.) Hillm. (1934, p. 234).

Type species: *Parmelia delicatula* Vain.

Thallus as in section *Amphigymnia* except margins and apices of lobes distinctly ciliate.

Subsection *Subflavescentes*

This subsection may be divided into two series: *Subflavescentes* with usnic acid and *Emaculatae* (p. 277) without usnic acid.

Series *Subflavescentes*

Thallus yellowish green, usnic acid present; lower side dark brown along the margins; apothecia imperforate.

This small series corresponds exactly to Vainio's original group *Subflavescentes*. All of the species contain usnic acid in abundance. Except for the pantropical *P. xanthina* and the African endemic *P. ochroglauca*, the species occur chiefly in tropical and subtropical America.

30. Parmelia aberrans (Vain.) des Abbayes, Bull. Inst. Fr. Afr. Noire, ser. A, 20:22. 1959.

Parmelia xanthina f. *aberrans* Vain. Ann. Acad. Soc. Faun. Fl. Fenn. 7, no. 7:37. 1890.

P. xanthina var. *ciliata* Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:175. 1909. Type collection: Mt. Jaraguá, near Taipas, São Paulo, Brazil, *Schiffner*, June 1901 (WU, holotype).

Type collection: Sitio, Minas Gerais, Brazil, *Vainio*, *Lich. Bras. Exs.* 664 (TUR, Vain. herb. no. 2758, holotype).

Thallus large, loosely attached on bark or humus, yellowish green, 10–15 cm. in diameter; lobes rotund, 10–15 mm. wide, margins broadly crenate to isidiate-dissected on older lobes, ciliate, cilia 1.0–3.0 mm. long; upper surface dull to shiny, smooth to minutely rugulose and finely reticulately cracked on older lobes, isidiate, especially in a zone near the margins, isidia simple to coralloid-branched and sometimes apically ciliate, isidia 0.04–0.06 mm. in diameter, to 0.6 mm. high; lower side black, moderately rhizinate, dark brown and naked in a broad zone at the margins. Apothecia very short-stalked, 2–4 mm. in diameter, amphithecium rugose, isidiate, disc imperforate; hymenium 65–75 μ high; spores 7–10$\times$10–16 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ more intensely yellow; medulla K—, C+ rose, KC+ deep red, P—, atranorine, usnic acid, and gyrophoric acid present.

In his original description Vainio gives the diagnostic color test as "Medulla $CaCl_2O_2$ non reagens." The holotype specimen however is clearly C+ rose and contains gyrophoric acid. Since the holotype takes precedence over the description, *P. aberrans* must be regarded as C+. The C— population is *P. xanthina* (Vain.) Müll. Arg. Des Abbayes (1958) followed Vainio's description when elevating f. *aberrans* to species rank and considered it to be C— and *P. xanthina* to be C+, a concept thus the opposite of ours. *Parmelia aberrans* is morphologically indistinguishable from *P. xanthina* (including *P. madagascariacea*) but has a more restricted distribution, known so far only in tropical America (see fig. 12).

Additional specimens examined:

MEXICO: CHIAPAS: Hacienda, *Matuda* s.n. (MICH); 8 km. east of Teopisca, *Hale* 20355 (DUKE, S, TNS, US). GUATEMALA: ZACAPA: Between Santa Rosalia and San Lorenzo, *Steyermark* 43179 (MO, US). COSTA RICA: GUANACASTE: Hacienda Santa María, *Dodge* 6708 (S). PANAMA: CHIRIQUÍ: Chiriquí, *Wagner* s.n. (M).

PERU: No locality, *Mathews* s.n. (BM). BRAZIL: MINAS GERAIS: Caraça, *Vainio, Lich. Bras. Exs.* 1181 (BM, M, TUR, UPS); RIO DE JANEIRO: Serra dos Orgãos, *Burchell* 2305 (K); MATO GROSSO: Bocca da Serra, *Malme* 2748 (S, UPS); Santa Anna da Chapada, *Malme* s.n. (S). PARAGUAY: No locality, *Grosse* s.n. (MO).

31. Parmelia conformata Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:36. 1890.

Parmelia conformata f. *ciliolifera* Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:36. 1890. Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 615 (TUR, Vain. herb. no. 2489, holotype; BM, isotype).

P. xanthina var. *subeciliata* Müll. Arg. Hedwigia 30:228. 1892. Based on *P. conformata* Vain.

Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 650 (TUR, Vain. herb. no. 2485, lectotype; FH, M, isotypes).

Thallus adnate, 6–10 cm. in diameter, yellowish green; lobes rotund, 7–10 mm. wide, margins entire to dentate or incised toward the center, sparsely ciliate, cilia 0.5–1.0 mm. long; upper surface plane, continuous or reticulately cracked with age, faintly white-reticulate at the tips, densely isidiate, isidia simple to branched, 0.04–0.07 mm. in diameter, 0.3–0.6 mm. high; lower side black and sparsely rhizinate in the center, brown and naked in a broad zone at the margins. Apothecia very rare, more or less pedicellate, amphithecium isidiate, disc imperforate; hymenium 50–60 μ high; spores 9–11×18–25 μ, episporium 1.5–2.0 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla P+ red, K+ brown, C— atranorine, usnic, protocetraric, and fumarprotocetraric acids present.

Parmelia conformata superficially resembles the other yellow isidiate species *P. xanthina* (Müll. Arg.) Vain. and *P. flavescens* (Krempih.) Nyl. It differs in chemical constituents, larger spores, and sparse

development of cilia. Vainio recognized a specimen with more conspicuous cilia as f. *ciliolifera* but this form has no taxonomic significance. Except for one locality in Africa, *P. conformata* is a tropical American species most common in pine forests at higher elevations in the West Indies.

Vainio listed as a synonym *P. caperata* f. *isidiosa* Müll. Arg. The type of this taxon (G) is a fragment that I tentatively identify as *P. cinerascens* Lynge, a *Hypotrachyna* species. Vainio supplied spore data for *P. conformata* from this specimen, but since Müller's plant is a different species, these spore data should be ignored.

Additional specimens examined:

MEXICO: CHIAPAS: 18 km. S.E. of San Cristóbal, *Hale* 20296 (US); 50 km. west of Tuxtla Gutiérrez, *Hale* 19930 (US); 40 km. southeast of Comitán, *Hale* 20477 (US). PANAMA: CHIRIQUÍ: Chiriquí, *Scholander*, February 1941 (MO, US).

HAITI: Mission, Fonds Varettes, *Leonard* 3887 (FH); summit of Montagne Noire, near Kenscoff, *Wetmore* 2767 (MSC); west of Forêt des Pins, *Wetmore* 3202 (MCS); summit ridge on Tête Etang, *Wetmore* 2659 (MSC). DOMINICAN REPUBLIC: Valle Nuevo, Constanza, La Vega, *Allard* 16540a, 16562b, 16582b, 17678 (US); Cerrazo, ridge from La Cumbre to Santiago, *Wetmore* 3842 (MSC); north side of Constanza, Cordillera Central, *Imshaug* 23722 (MSC). JAMAICA: Albion, St. Ann, *Imshaug* 15906 (MCS); Dolphin Head, Hanover, *Imshaug* 15652 (MSC); Cooper's Hill, Red Hills, St. Andrew, *Imshaug* 14156 (MSC).

BRAZIL: MINAS GERAIS: Sitio, *Vainio, Lich. Bras. Exs.* 538b (K, TUR), 650b (UPS), 981 (TUR).

ANGOLA: HUILA: Above Sá da Bandeira, Humpala Plateau, *Degelius*, Feb. 6, 1960 (DEGEL, US).

32. Parmelia delicatula Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:35. 1890.

Parmelia subcaperata f. *ciliata* Zahlbr. Bull. Herb. Boiss., II, 4:135. 1904. Type collection: Morro de São Sebastião, Brazil, *Damazio* 940 (W, holotype; G, isotype).

P. magna Lynge, Ark. Bot. 13, no. 13:83. 1914. Type collection: São João d'el Rey, Minas Gerais, Brazil, *Malme* 269 (S, holotype; LD, MO, UPS, isotypes).

P. radians Lynge, Ark. Bot. 13, no. 13:85. 1914. Type collection: São João d'el Rey, Minas Gerais, Brazil, *Malme* 203 (S, holotype; MO, isotype).

Parmelia microdactyla Hale, Contr. U.S. Nat. Herb. 36, part 1:21. 1960. Type collection: Rio de Janeiro, Brazil, *Widgren* (UPS, holotype; S, isotype).

Type collection: Caraça, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 1256 (TUR, Vain. herb. no. 2754, holotype; BM, FH, M, UPS, isotypes).

Thallus saxicolous, 5–15 cm. in diameter, yellowish green; lobes very variable, from rotund and monophyllous to rather narrow and subimbricate, 5–15 mm. wide, margins adnate to suberect, sparsely ciliate, cilia 1–2 mm. long; upper surface dull, often faintly white-pruinose, reticulately cracked with age, isidia and soredia lacking;

lower side black and moderately rhizinate, dark brown and naked in a zone along the margins. Apothecia adnate to substipitate, 4–10 mm. in diameter, disc imperforate; hymenium 55–75 μ high; pores 5–8×10–14 μ, episporium 1 μ thick; pycnidia abundant, conidia not seen.

Reactions: Thallus K+ more intensely yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine, usnic acid, and salacinic acid present.

Parmelia delicatula is a saxicolous species common in the area around Rio de Janeiro. The variability of the species is very great, as one can surmise from the number of synonyms. The basic characters are marginal cilia of varying development, lack of soredia and isidia, and presence of salacinic and usnic acids. The lobes may be broad and flattened, as in the type of *P. magna*, or rather narrow with ascending margins, as in the types of *P. delicatula* and *P. radians*. *Parmelia microdactyla*, first thought to be distinct because of the small marginal lobules, is apparently only a rare morphological variant.

Additional specimens examined:

BRAZIL: Paraná: Serrinha, *Dusén, Lich. Austroamer.* 85 (H, K, LD, MSC, S, UPS); Minas Gerais: Serra do Ouro Preto, *Damazio, Zahlbr. Lich. Rar. Exs.* 80 (BPI, FH, UPS); Serra de Caldas, *Mosén* 2318a, b (S). URUGUAY: Rocha: Estancia Cerros, *Hosseus* 111 (H).

33. Parmelia flavescens (Krempih.) Nyl. Flora 68:607. 1885. Plate 11

Parmelia glaberrima β flavescens Krempih. Flora 52:223. 1869.

P. glaberrima f. *flavescens* (Krempih.) Krempih. Flora 59:73. 1876.

P. latissima f. *flavescens* (Krempih.) Müll. Arg. Linnaea 43:37. 1880.

P. mauriensis Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:201. 1899. Type collection: Abrededores, San Luis de Potosí, Mexico, *Maury* 7651 (P, holotype).

P. protoflavescens Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:176. 1909. Illegitimate name based on *P. glaberrima β flavescens* Krempih.

P. pseudoflavescens Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:176. 1909. *Nomen nudum.*

Type collection: Brazil, *Glaziou* 1833 (M, holotype; H, isotype).

Thallus saxicolous, expanded, up to 25 cm. broad, coriaceous, yellowish green; lobes rotund, 9–12 mm. wide, margins entire to lacerate or dissected, often isidiate, sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface opaque, reticulately cracked with age, moderately isidiate, isidia simple or sparingly branched, 0.06–0.1 mm. in diameter, to 0.6 mm. high, infrequently ciliate; lower side black and sparsely rhizinate, dark brown and naked in a broad zone along the margins. Apothecia common, to 10 mm. in diameter, amphithecium rugose, maculate, sparcely isidiate, disc imperforate or rarely perforate; hymenium 40–55 μ high; spores 6–8×10–12 μ, episporium 1 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow or more intensely yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine, usnic acid, and salacinic acid present.

Parmelia flavescens is typically a saxicolous species characterized by salacinic acid and isidia. All other isidiate yellow species contain K− substances and are usually corticolous. The apothecia of *P. flavescens* are adnate and most frequently imperforate, although rarely perforate.

The nomenclatorial confusion created by Zahlbruckner has already been discussed (Hale, 1960). The identity of *P. mauriensis* Hue and *P. flavescens* is interesting in that *P. mauriensis* was formerly thought to be a synonym of *P. subcrinita* Nyl., an isidiate species lacking usnic acid.

Additional specimens examined:

MEXICO: Isla Socorro, *Herrera* 18 (MSC). GUATEMALA: Jalapa: Hills northeast of Jalapa, *Standley* 76788 (MO, US); Jalapa, *Standley* 76530 (M). HONDURAS: Morazán: El Zamorano, *Standley & Williams* 465 (F, US), *Standley* 1691 (MO).

VENEZUELA: Between Caracas and La Guaira, west of Silla de Caracas, *Santesson* 6670 (S). COLOMBIA: Norte de Santander: Vicinity of Toledo, elev. 1700–1900 m., *Killip & Smith* 20514 (US); Cundinamarca: Bogotá, *Weir* 58 (BM, K); Antioquia: Medellín, *Charetier* 191 (US). BRAZIL: Rio de Janeiro: Serra dos Orgãos, *Burchell* 2385 (K).

34. Parmelia miranda Hale, sp. nov. Plate 11

Thallus late expansus, membranaceus vel rigidulus, usque ad 10 cm. latus, viridi-flavicans vel stramineo-albicans, lobis rotundatis, vage ramosis, margine sinuato-incisis, sorediatis, soraliis globosis vel elongatis, lobis sorediatis plus minusve involutis, ciliatis, ciliis inconspicuis, 0.5–2.0 mm. longis, superne laevigatus, opacus, demum leviter albo-pruinosus, continuus vel paulo rimosus in aetate, strato corticeo superiore 12–14 μ crasso, strato gonidiale 26–35 μ crasso, medulla alba 65–70 μ crassa, strato corticeo inferiori 13–15 μ crasso, inferne niger dense rhizinosus, rhizinis atris, nitidis, ambitu fusco-castaneus, late nudus. Apothecia ignota. Thallus K−; medulla K+ rubra, C−, KC−, P+ aurantiaca, acidum salacinicum et acidum usnicum continens.

Type in the U.S. National Herbarium, collected on pine-scrub oak mountainside, Km. 686 on Hwy. 190, northwest of Tehuantepec, Oaxaca, Mexico, Mar. 31, 1960, by M. E. Hale (no. 20653). (Isotypes in COLO, DUKE, LISU, MSC, REN, S, TNS).

Parmelia miranda is characterized by the large yellowish green thallus and marginal soralia and cilia. There are only two other comparable species in the subgenus *Amphigymnia*, *P. viridiflava*

Hale and *P. ochroglauca* Hale. *Parmelia viridiflava* is very close to *P. miranda* but differs in chemistry (protocetraric and fumarprotocetraric acids). *Parmelia ochroglauca*, an African species, has distinctly revolute sorediate lobes and contains protolichesteric acid. *Parmelia miranda* is endemic to Mexico where it occurs in open oak-pine forests.

Additional specimens examined:

MEXICO: OAXACA: 77 km. northwest of Tehuantepec at km. 719 on highway 190, *Hale* 20615 (US); CHIAPAS: 8 km. east of Teopisca, *Hale* 20346 (US); 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20165 (S, US).

35. Parmelia ochroglauca Hale, sp. nov.

Thallus laxe adnatus, 8–15 cm. diametro, obscure viridiflavus, lobis rotundatis, 8–12 mm. latis, margine subcrenatis, ciliatis, ciliis 0.5–1.5 mm. longis, sorediatis, sorediis granulosis, partim submarginalibus, lobis sorediatis plus minusve revolutis, superne planus vel rugulosus, minute rimosus in aetate, strato corticeo superiore 13–16 μ crasso, strato gonidiali 20–25 μ crasso, medulla alba, 80–90 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K−, C−, KC−, P−, atranorinum, acidum protolichestericum et acidum usnicum continens.

Type in the Museum of the Royal Norwegian Society (TRH), collected near Barretts Berlin Mine, Barberton, Transvaal, Africa, Aug. 8, 1929, by O. A. Höeg (isotypes in LD, US).

Although *P. ochroglauca* is known from only one collection, it appears to be amply distinct because of a unique combination of characters. At first glance it seems to be *P. xanthina* (Müll. Arg.) Vain., an isidiate species with identical chemistry. However, *P. ochroglauca* is distinctly though not conspicuously sorediate, the soredia originating for the most part submarginally and eventually causing the lobe margins to become more or less revolute. The revolution is similar to but not so pronounced as that in *P. perlata* (Huds.) Ach. The soredia here are rather sparse and granular. This species is probably endemic to South Africa.

36. Parmelia viridiflava Hale, sp. nov.

Thallus laxe adnatus, membranaceus, mollescens, usque ad 10 cm. diametro, viridiflavicans, lobis rotundatis, parum lobatis, 9–12 mm. latis, integris vel centrum versus dentato-incisis, margine sorediatis, soraliis irregulariter sinuato-elongatis, centrum versus praecipue in axillis ciliatis, ciliis 1.0–1.5 mm. longis, superne laevigatus, nitidulus, aetate rimosus, ad apicem levissime albo-reticulatus, strato corticeo superiore 13–15 μ crasso, strato gonidiali 18–20 μ crasso, medulla alba, 85–90 μ crassa, strato corticeo inferiore 16–18 μ, inferne niger, modice

rhizinosus, ambitu castaneus atque late nudus, nonnunquam albo-variegatus. Apothecia pycnidiaque ignota. Thallus K—; medulla K—, C—, KC+ fugiter rosea vel fulvescens, P+ aurantiaca, acidum usnicum, acidum protocetraricum et acidum fumarprotocetraricum, rarius atranorinum continens.

Type in the U.S. National Herbarium, collected in mature pine forest, elev. 1220 m., at Lagos de Monte Bello, 50 km. southeast of Comitán, Chiapas, Mexico, Mar. 25, 1960, by M. E. Hale (no. 20415; isotypes in DUKE, REN, S, TNS).

This species reminds one at once of *P. miranda* Hale or *P. dominicana* Vain. The former species differs in having salacinic acid and more conspicuous soralia, the latter in lacking cilia. *Parmelia viridiflava* and *P. conformata* Vain, are the only *Amphigymnia* species with fumarprotocetraric acid. The cilia are often sparse and irregular but definitely occur at the tips as well as in the axils of the lobes. It seems to be an endemic Caribbean species related to *P. conformata*.

Additional specimens examined:

HAITI: Montagne Noire, near Kenscoff, elev. 5500 ft., *Wetmore* 2761 (MSC); west of Forêt des Pins, *Wetmore* 2923, 3219 (MSC), *Imshaug* 22846, 22869 (MSC); summit of Tête Etang, between Kenscoff and Furcy, *Imshaug* 22559 (MSC). DOMINICAN REPUBLIC: Gap on main ridge between Pico del Yaque and L. Chinguela, elev. 7000 ft., *Wetmore* 3701, 3706 (MSC).

37. Parmelia xanthina (Müll. Arg.) Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:37. 1890.

Parmelia chrysantha Tuck. Syn. N. A. Lich. 55. 1882. Type collection: Blue Ridge, Virginia, *Tuckerman* (FH–Tuck, holotype). Invalid name in syn.

P. proboscidea Tayl. var. *xanthina* Müll. Arg. Flora 67:616. 1884.

P. perlata var. *xanthina* (Müll. Arg.) Stizenb. Bericht. St. Gall. Naturw. Gesell. 1888–1889:156. 1889.

P. xanthina f. *isidiosa* Müll. Arg. Hedwigia 30:229. 1891. Based on *P. proboscidea* var. *xanthina* Müll. Arg.

P. caperata var. *madagascariacea* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:181. 1899. Type collection: Ambositra, Madagascar, *Rodriguez*, 1889. (P, holotype).

P. madagascariacea (Hue) des Abbayes, Bull. Inst. Fr. Afr. Noire, ser. A, 20:22. 1958.

P. nyasensis Dodge, Ann. Mo. Bot. Gard. 46:126. 1959. Type collection: Mt. Nchisi, Nyasaland, Africa, *Brass* 16922 (NY, holotype).

Type collection: Central Madagascar, *Hildebrandt* (G, holotype).

Thallus loosely attached, 8–20 cm. in diameter, saxicolous or corticolous, yellowish green; lobes rotund 8–12 mm. wide, margins isidiate-dissected on older lobes, ciliate, cilia 1.0–2.5 mm. long; upper surface plane, dull, reticulately cracked with age, densely isidiate, especially near the margins of lobes, isidia simple to coralloid branched, 0.05–0.08 mm. thick, 1 mm. high or more, often apically ciliate;

lower side black and rhizinate at the center, shiny dark brown and dark brown in a broad zone along the margins. Apothecia and pycnidia lacking.

Reactions: Thallus K+ more intensely yellow; medulla K−, C−, KC+ red, P−, atranorine, protolichesteric acid, usnic acid, and a KC+ unknown substance recrystallizing as clustered needles in G.E.; or K−, C−, KC−, P−, atranorine, protolichesteric acid, and usnic acid present.

Des Abbayes (1958) has studied and attempted to typify the various yellow isidiate Amphigymnias. He considered *P. xanthina* to be C+ rose (gyrophoric acid). Two other morphologically identical strains were also recognized: *P. aberrans* (Vain.) des Abb. (C−) and *P. madagascariacea* (Hue) des Abb. (KC+ red). Although des Abbayes was not able to find a satisfactory type for *P. proboscidea* var. *xanthina*, I received from Geneva a well-developed specimen from Madagascar which is apparently Müller's holotype. It is C− and contains protolichesteric acid. Furthermore, the holotype of *P. xanthina* f. *aberrans* Vain. actually contains gyrophoric acid, contrary to Vainio's report of a C− reaction (see discussion of *P. aberrans*). Hence the name *P. aberrans* should be applied to the tropical America population that reacts C+ rose. Typical *P. xanthina* with protolichesteric acid alone and *P. madagascariacea* (including *P. chrysantha* and *P. nyasensis*) with a KC+ unknown have identical ranges in North America, Africa, and Asia (figs. 10, 11). By our definition, they should be considered as chemical strains of one species, *P. xanthina*. In North America, *P. xanthina* is common on rock outcrops and on oaks in open swamps in the southeastern United States.

Additional specimens examined:

Protolichesteric acid present:

U.S.: ALABAMA: Oak Mountain State Park, Shelby Co., *Hale* 7143 (US); GEORGIA: Near Trenton, Dade Co., *Hale* 7387 (US); Vogel State Park, Union Co., *Hale* 7355 (US); Cloudland Canyon, Walker Co., *Anderson* 12969 (DUKE, US). MEXICO: CHIAPAS: 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20163 (US); Km. 956 on highway 190, west of Ocozocoautla, *Hale* 20594 (US). NICARAGUA: JINOTEGA: southwest of Jinotega, *Standley* 10137 (F). SOUTHERN RHODESIA: Zimbabwe Hill, *Höeg* s.n. (TRH). MADAGASCAR: Road between Ivato and Ambatofinandrahana, *des Abbayes, Lich. Madagasc. Borb. Sel. Exs.* 19 (M, REN, UPS, US).

Unknown KC+ substance and protolichesteric acid present:

U.S.: VIRGINIA: Natural Bridge, Rockbridge Co., *Hermann* 15087 (US); NORTH CAROLINA: 8 mi. south of Raeford, Hoke Co., *Culberson* 7600 (DUKE); Dardin, Martin Co., *Culberson* 6684 (DUKE); 1 mi. east of Wise Fork, Jones Co., *Culberson* 4926 (DUKE); SOUTH CAROLINA: 12 mi. southwest of Andrews, Georgetown Co., *Hale* 16543 (US); King Mountain State Park, Cherokee Co., *Hale* 7707 (US); TENNESSEE: Cliff Springs, Overton Co., *Phillips* 307 (US); GEORGIA: Near Claxton, Evans Co., *Hale* 7451 (US); Neels Gap, Lumpkin Co., *Hale* 7538 (US);

10 mi. northeast of Midway, Bryan Co., *Hale* 16799 (US); Unicoi State Park, White Co., *Culberson* 7291 (DUKE); ALABAMA; Cheaha State Park, Clay Co., *McCullough* 571 (US); 4 mi. south of Alexander City, Tallapoosa Co., *McCullough* 1042 (US); FLORIDA: 5 mi. east of Greenville, Madison Co., *Hale* 17613 (US); near Pensacola, Escambia Co., *Hale* 7991 (US); Dog Lake Recreation Area, Leon Co., *Hale* 16713 (US). MEXICO: OAXACA: 53 km. northwest of Oaxaca, *Hale* 20799 (US); Km. 686 on highway 190, northwest of Tehuantepec, *Hale* 20646 (DUKE, REN, TNS, US); CHIAPAS: El Zapotal, Tuxtla Gutiérrez, *Hale* 19975 (US).

MADAGASCAR: Road from Antsirabe to Fianarantsoa, Km. 202, *des Abbayes, Lich. Madagasc. Borb. Sel. Exs.* 20 (M, REN, UPS, US).

INDIA: Coonoor, Nilgheries Mountains, *Gray* s.n. (P).

Additional localities cited by Hale (1959b) from Kentucky, Virginia, North Carolina, South Carolina, Tennessee, Georgia, Alabama, Florida, Arkansas, Costa Rica, and Madagascar are not repeated here.

Series *Emaculatae*, ser. nov.

Thallus cinereo-albicans, acido usnico destitutus, lobis ciliatis, superne emaculatus, subtus margine nigricans, castaneus, rarius albo-variegatus vel albicans.

Type species: *Parmelia crinita* Ach.

This large series of 41 species includes 10 cosmopolitan species, 12 endemic to Africa, and 10 endemic to the Americas. It includes some of the more familiar temperate species such as *P. arnoldii*, *P. crinita*, *P. perlata*, and *P. stuppea*. Chemical and morphological diversity is very great, but no further subdivision of the series seems possible at this time.

38. Parmelia abnuens Nyl. Flora 68:610. 1885. PLATE 7

Parmelia callitricha Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:178. 1909. Type collection: Between São Amaro and Barra Mansa, and near Palmeiras de São Lourenzo, São Paulo, Brazil [one collection] *Schiffner*, June 1901 (W, holotype).

Type collection: Brazil, *Glaziou* 1835 (H, Nyl, herb. no. 35290, lectotype).

Thallus loosely attached on bark, 4–8 cm. across, mineral gray; lobes rotund, 8–15 mm. wide, becoming quite laciniate, laciniae 1×2–4 mm., often appearing canaliculate below, margins densely ciliate, cilia 3–5 mm. long; upper surface shiny, distinctly to faintly maculate, pitted-rugose with age; lower side black and sparsely rhizinate at the center, dark brown to mottled tan and naked at the margins. Apothecia common, stalked, 5–10 mm. in diameter, amphithecium rugose, strongly maculate, disc imperforate; hymenium 90–110 μ high; spores 12–18×24–35 μ, episporium 2.5–3.0 μ thick; pycnidia present, conidia 6–8 μ long (after Nylander).

Reactions: Thallus K+ yellow; medulla K—, C+ deep orange red, KC+ deep orange red, P—, atranorine and olivetoric acid present (proved with chromatography).

Parmelia abnuens is superficially near *P. melanothrix* (Mont.) Vain. and related nonsorediate, nonisidiate species. It is separated by the deep C+ red reaction. The only close relative is *P. amboimensis* Dodge, an African species with small spores and an even more laciniate thallus. The differences in spore size between the types of *P. abnuens* (20–24 μ) and *P. callitricha* Zahlbr. (30–36 μ) are much larger than we expect to find in Parmelias, but there seems to be no justification for recognizing two species on spore size alone.

The second syntype on which Nylander based the name *P. abnuens* is a Lorentz collection from Uruguay. This specimen in Nylander's herbarium is *P. argentina* Krempelh.

39. Parmelia amboimensis Dodge, Ann. Mo. Bot. Gard. 46:158. 1959.

PLATE 7

Type collection: Amboim, Capir, Cuanza Sul, Angola, *Gossweiler* 9993 (K, holotype; US, isotype).

Thallus large, loosely attached, more or less suberect, 10–15 cm. across, mineral gray; lobes 10–12 mm. wide, irregularly branched and richly laciniate, laciniae 1–2×10 mm., appearing canaliculate below, margins sparsely ciliate, cilia 1–2 mm. long; upper surface smooth, dull to shiny; lower side black and sparsely rhizinate, dark brown to mottled tan and naked at the margins. Apothecia stalked, 8–15 mm. in diameter, amphithecium rugose, faintly maculate, disc imperforate hymenium 70–75 μ high; spores 7–8×10–13 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ deep orange red, KC+ deep orange red, P−, atranorine and olivetoric acid present (proved with chromatography).

This species has a decidedly everniiform appearance with broadly caniculate secondary lobes. The main lobes, however, are wide and the apothecia are stalked and rugose, unlike any species in *Pseudevernia* Zopf. The closest relative is the Brazilian species *P. abnuens* Nyl., which differs in having less laciniate lobes and larger spores.

Additional specimens examined:

ANGOLA: CUANZA SUL: Carloaongo-Cuvo, Capir, Amboim, *Gossweiler* 10008, 10038 (US).

40. Parmelia appendiculata Fée, Ess. Crypt., Suppl. 118, *pl. 38, fig. 3.* 1837.

Parmelia cristata Nyl. Flora 52:291. 1869. Type collection: Caripe, Venezuela, *Moritz* (H, holotype, Nyl. herb. no. 35293).

P. merrillii Lynge, Ark. Bot. 13, no. 13:79. 1914. Type collection: Coxipó, Igreja, near Cuyabá, Mato Grosso, Brazil, *Malme* 2198B (S, holotype). Not *P. merrillii* Vain. (1909).

P. cornuta var. *crocea* Lynge, Ark. Bot. 13, no. 13:78. 1914. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2477 bis (S, holotype; W, isotype). (Unidentified anthraquinone pigment present in addition to K− yellow pigments.)

P. lyngeana Zahlbr. Cat. Lich. Univ. 6:243. 1929. Based on *P. merrillii* Lynge.

P. crocea (Lynge) Gyel. Repert Sp. Nov. Fedde 29:287. 1931. [Non *P. crocea* (Ach.) Spreng. =*Solorina*.]

Type collection: Bourbon, s.c. (G, isotype).

Thallus loosely adnate to bark, 3–6 cm. in diameter, buff mineral gray in herbarium, lobes rotund, 5–8 mm. wide, laciniate, laciniae 1 mm. wide, 3–8 mm. long, margins of lobes sparsely ciliate, cilia 1 mm. long; upper surface dull, reticulately cracked with age, soredia and isidia lacking; medulla white or in part pale to deep yellow-orange; lower side black and sparsely rhizinate, dark brown, naked and rugulose in a broad zone along the margins. Apothecia short-stalked, exciple dentate to dentate-laciniate, sparsely ciliate, amphithecium maculate, disc imperforate; hymenium 100–130 μ high; spores 14–16×26–32 μ, the episporium 2.5–3.0 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K— or K+ yellowish, C+ yellowish, KC+ yellowish, P—, atranorine, an unidentified pigment, and unknown substances present.

Although *P. appendiculata* was described some 125 years ago, the name has only rarely appeared in the literature. The type was carefully illustrated by Fée but the most critical character, the chemistry, was not known. Fortunately an isotype found at Geneva has enabled us to characterize the species accurately for the first time. The medulla is white to pale yellow and distinctly yellow under the apothecia, with a K— pigment identical with that in *P. araucariarum* Zahlbr. and others. The marginal laciniae are well developed but cilia are sparse and short. This species is extremely rare and known only from the type collections cited above.

Des Abbayes (1956) compared *P. appendiculata* and *disparilis* Nyl. on the basis of Fée's illustration and on his own collections from Madagascar. These two species are indeed similar externally, but *P. disparilis* contains protocetraric acid, lacks any pigment, and has smaller spores.

41. Parmelia arnoldii Du Rietz, Nyt Mag. Naturv. 62:80. 1924.

Type collection: Munich, Germany, *Arnold Exs.* 136b (UPS, lectotype; DUKE, FH, H, LD, isotypes).

Thallus loosely attached to bark, 8–20 cm. in diameter, light mineral gray; lobes 8–15 mm. wide, with dentate marginal laciniae, 2–4 mm. wide, 5–10 mm. long, crowded toward the center; upper surface shiny, faintly maculate, sorediate, soredia developing mostly on the laciniae, submarginal, eventually coalescing into extensive soralia, tips of sorediate lobes usually revolute, margins ciliate, cilia rather sparse, 1.0–2.5 mm. long; lower side black and rhizinate at the center,

brown and naked in a broad zone at the margin. Apothecia very rare, hymenium 80 μ high; spores 9.5–12×15–22 μ; conidia 10.5–11.5 μ long (after Hillmann, 1934).

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ reddish orange, P—, atranorine and alectoronic acid present; rhodophyscin also present in the lower medulla in some specimens, reacting K+ purple.

Parmelia arnoldii is a temperate species of both Northern and Southern Hemispheres (fig. 16) (cf. Degelius, 1935). It is distinguished by the sublaminal soredia and the presence of alectoronic acid, often accompanied by rhodophyscin. *Parmelia margaritata* Hue, which differs only in having salacinic acid and lacking rhodophyscin, has a restricted distribution in North America (fig. 9).

The typification of *P. arnoldii* is somewhat involved. Du Rietz proposed it as a new name for "*P. nilgherrensis* Nyl." (1874) non *P. nilgherrensis* Nyl. (1869) and a number of other misidentified literature reports by Hue and Lynge. *Parmelia nilgherrensis* Nyl. (1874) is a specimen (*Arnold Lich. Exs.* 136b) from Germany which Nylander had misidentified. The original *P. nilgherrensis* (1869) is an Asian species. The most appropriate lectotype for *P. arnoldii* is *Arnold* 136b, a typically developed specimen widely distributed in the larger herbaria.

Additional specimens examined:

CANADA: BRITISH COLUMBIA: Cedar Hill, Vancouver Island, *Melburn* 90 (US); Spring Island, Vancouver Island, *Szczawinski* 418 (US). U.S.: MAINE: Mt. Katahdin, *Degelius* s.n. (US); WEST VIRGINIA: 5 mi. northeast of Thornwood, Pocahontas Co., *Hale* 12362 (US); Spruce Knob, Pendleton Co., *Hale* 15460 (US); MICHIGAN: Isle Royale, Keweenaw Co., *Welmore* 5044 (LD); MINNESOTA: 2 mi. northwest of Illgen City, Lake Co., *Spross* s.n. (US); VIRGINIA: Hawksbill Mountain, Madison Co., *Hale* 18937 (US); Whitetop Mountain, Washington Co., *Hale* 18739 (US); TENNESSEE: Roan Mountain, Carter Co., *Phillips* 374 (US); KENTUCKY: Rockcastle River at Route 192, Pulaski Co., *Reed* 56753 (Reed Herbarium); WASHINGTON: Hoh River, Jefferson Co., *Brown* 160 (US); Longbeach, Pacific Co., *Howard* 4851 (WIS); OREGON: Road between Bridal Veil Falls and Larch Mountain, Multnomah Co., *Hale* 21587 (US); CALIFORNIA: Pilarcitos Creek Canyon, San Mateo Co., *Thomson* 4761 (WIS), *Cain* 26388 (TRT, US), *Herre* 825 (MO); Near Saratoga, Santa Clara Co., *Cain* 26394a (TRT, US); Mt. Tamalpais, Marin Co., *Morton & Howell* 11905 (US). MEXICO: MEXICO: Popocatepetl, *Cain* 27595 (TRT, US); 10 km. southwest of Cahuacán, *Madrigal* 1426 (US); PUEBLA: Near Llano Grande, *Hale* 19302 (DUKE, MSC, REN, S, TNS, US); OAXACA: Cerro San Felipe, *Hale* 20708 (US). GUATEMALA: CHIMALTENANGO: Region of Santa Elena, *Standley* 58718 (MO).

HAITI: Near summit of Morne Macaya, *Wetmore* 3352 (MSC), 3358 (MSC, US); summit of Tête Étang, *Imshaug* 22614 (MSC, US). DOMINICAN REPUBLIC: Summit of Alto de la Bandera, *Wetmore* 3483 (MSC, US); southwest slope of La Rucilla, Maciso de los Yaques, *Imshaug* 23614 (MSC, US); La Nevera, Cordillera Central, *Wetmore* 3450 (MSC, US), *Imshaug* 23342 (MSC, US). GUADELOUPE: *Palmer* s.n. (FH).

CHILE: VALPARAISO: Alto del Puerto, Valparaiso, *Santesson* 2761, 2798, 2878 (S); CONCEPCIÓN: Coronel, *Santesson* 2379 (S); VALDIVIA: Malihue, Río San Perdo, *Santesson* 3348 (S); Corral, *Santesson* 2329 (S); Enco, Lago Riñihue, *Santesson* 7595 (S); AYSÉN: Puerto Aysén, *Santesson* 6934 (S).

FRANCE: Lorges, *des Abbayes, Lich. Armor. Spect. Exs.* 32 (LD). GERMANY: Munich, *Arnold, Lich. Monac.* 492 (MICH); Bleckenau, Schwaben, *Förster, Lich. Alp.* 194 (LD, M, US). POLAND: Puszcza Bukowa, Bieszczady Zachodnie, *Glanc* in *Lich. Polonica* 173 (UPS). NORWAY: Rogaland, *Havaas, Lich. Norv. Occ. Exs.* 84 (LD).

42. Parmelia bangii Vain. Bot. Tidsskr. 29:104. 1909.

Type collection: La Paz, Bolivia, *Bang* 13 (H, holotype, Nyl. herb. no. 35500).

Thallus loosely attached to bark, 8–15 cm. in diameter, turning buff in the herbarium; lobes rotund, irregular, 5–8 mm. wide, margins entire, very sparsely ciliate, cilia 1.0–1.5 mm. long, mostly along the lateral edges; upper surface dull, continuous or reticulately cracked with age, cortex distintegrating in large areas near the margins and developing into sorediate pustules; lower side black and moderately rhizinate, light brown, shiny, and naked along the margins. Apothecia adnate, amphithecium pustulate, disc imperforate; hymenium 70–80 μ high; spores 11–16$\times$26–36 μ, episporium 3–4 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow, C−, KC−, P+ pale orange red, atranorine and stictic acid present.

This is a rare species apparently endemic to tropical South America. The spore size and chemistry place it close to *P. perlata* (Huds.) Ach., but the development of extensive laminal sorediate pustules is unique.

Additional specimen examined:

COLOMBIA: Chapinero, *Ariste-Joseph* A355a (US).

43. Parmelia blanchetii Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:199. 1899.

Type collection: Bahia, Brazil, *Blanchet* (P, holotype; BM, isotype).

Thallus loosely adnate on rock, 8–10 cm. in diameter, light mineral gray; lobes rotund to irregular, 5–8 mm. wide, margins crenate to dentate-lobulate, especially toward the center, more or less black-rimmed, ciliate, cilia 1.5–2.5 mm. long; upper surface plane, shiny, reticulately cracked with age, isidia and soredia lacking; lower side black and sparsely rhizinate, dark brown and naked in a broad zone along the margins. Apothecia stalked, 4–6 mm. in diameter, amphithecium slightly rugose, disc imperforate; hymenium 50–60 μ high; spores 5–6$\times$12–15 μ, episporium 1 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, KC+ reddish orange, fading rapidly, P+ orange red, atranorine and protocetraric acid present.

This unique species is known from only two collections. It is apparently saxicolous. Externally it is rather close to *P. eciliata* (Nyl.) Nyl., a corticolous species which has stictic acid and large spores.

Additional specimen examined:

COLOMBIA: VAUPES: Mesa de Yambí, Río Karurú, *Schultes* 19125 (FH, US).

44. Parmelia breviciliata Hale, sp. nov.

Parmelia latissima f. *microspora* Lynge, Ark. Bot. 13, no. 13:45. 1914.

Type collection: Near Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2244* (S, lectotype).

Thallus laxe adnatus, saxicola, rigidulus, cinereo-albicans, 5–15 cm. latus, lobis rotundatis, 8–12 mm. latis, margine integris vel aetate irregulariter lobulatis, modice ciliatis, ciliis brevibus, 1–2 mm. longis, superne planus, opacus, continuus vel aetate plus minusve rimosus, medulla alba, subtus niger, sparse rhizinosus, ambitu castaneus, nudus. Apothecia 4–10 mm. diametro, primo urceolata, substipitata, disco imperforato, amphithecio opaco, excipulo integro; hymenium 45–55 μ altum; sporae 6–10×12–17 μ, episporio 1.0–1.5 μ lato. Thallus K+ flavescens; medulla K—, C—, KC+ rosea, P—, atranorinum et acidum alectoronicum continens.

Type in Lund University, collected 4 miles southeast of Pilgrims Rest, Transvaal, Union of South Africa, Oct. 10, 1953, by Ove Almborn (no. 7800; isotype in US).

Parmelia breviciliata is most common on rocks in South Africa, although there are disjunct localities in South America and Thailand (fig. 23). It resembles most closely *P. wainii* A. L. Sm., which differs chiefly in having intermediate spores, strongly stalked maculate apothecia, a ciliate exciple, and corticolous habit. *Parmelia soyauxii* Müll. Arg., another saxicolous African lichen, is superficially very similar but lacks cilia and contains lecanoric acid. A second Malme collection (2244) from Mato Grosso was tentively identified by Lynge as *P. proboscidea* f. *incrassata* Lynge; this specimen (S) is *P. breviciliata*.

Additional specimens examined:

BRAZIL: MATO GROSSO: Near Bocca de Serra, Serra da Chapada, *Malme* s.n., 2244 (S).

IVORY COAST: Mont Tonkoui, cercle of Man, *Santesson* 10634 (UPS). CAMEROONS: Bafut-Ngem Forest Reserve, *Brunt* 773 (K, US). UGANDA: Entebbe, *Proctor* s.n. (K). ANGOLA: HUILA: North of Sá-da-Bandeira, *Degelius* s.n. (DEGEL, US). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH, US). UNION OF SOUTH AFRICA: TRANSVAAL: 6 mi. north of Houtbosch, *Almborn* 6720 (US); Barberton, *Höeg* s.n. (TRH); Fairy Glen, Pretoria, *Bottomly* 719 (PRE); NATAL: Table Mountain, Pietermaritzburg, *Almborn* 8591, 8592 (LD). MADAGASCAR: Ambositra, *Forsyth* 629 (BM); road from Tananarive to Ankazobe, Km. 48, *des Abbayes, Lich. Madagasc. Borb. Sel. Exs.* 15 (M, REN, UPS, US). THAILAND: Kao Krading, *Kerr* L23 (K).

45. Parmelia corniculans Nyl. Flora 68:607. 1885.

Type collection: Java, *Horsfield* (H, lectotype, Nyl. herb. no. 35308).

Thallus loosely attached, 7–12 cm. broad, light mineral gray; lobes rotund, 10–13 mm. wide, margins smooth to more or less crenate, more or less dentate-laciniate with age, ciliate, cilia to 2 mm. long; upper surface dull, plane, soredia and isidia lacking; lower side black and sparsely rhizinate, dark brown to brown and naked in a broad zone along the margins. Apothecia 4–8 mm. in diameter, stalked, exciple more or less dentate, short-ciliate, amphithecium rugulose, maculate, disc perforate; hymenium 80–85 μ; spores 16–18×30–35 μ, episporium 3 μ thick; pycnidia numerous, conidia 5–6 μ long.

Reactions: Thallus K+ yellow; medulla K−, KC+ reddish orange, C−, P−, atranorine and alectoronic acid (mixed with α-collatolic acid) present; rhodophyscin often present in the lower medulla, K+ purple.

This species seems to be restricted to Malaysia and is therefore quite separated geographically from comparable species with alectornic acid in Africa and America. The only really closely related species is *P. maclayana* Müll. Arg., which lacks such conspicuous laciniae and has small spores. *Parmelia merrillii* Vain., an Asian species, has similar laciniae and large spores, but differs in containing protocetraric acid and having imperforate apothecia.

Additional specimens examined:

PHILIPPINES: Luzon: Mt. Tonglon, *Ramos* 5493 (US); Baguio, Benguet, *Elmer* 8563 (US). JAVA: Mt. Gedeh, *Groenhart* 8812 (BO). LAOS: Hase Plantation, *Tsuyama* 13 (TNS).

46. Parmelia cornuta Lynge, Ark. Bot. 13, no. 13:76, *pl. 2, fig. 5*. 1914.

Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *G. A. Malme* 2477 (S, holotype).

Thallus loosely attached, 10–15 cm. across, buff mineral gray in herbarium; lobes rotund, 7–10 mm. wide, margins entire, becoming dentate-laciniate towards the center, ciliate, cilia sparse, 2–3 mm. long; upper surface dull, more or less rugulose, cracked with age, isidia and soredia lacking; medulla lemon yellow; lower side black, sparsely rhizinate in the center, brown to tan and naked in a broad zone at the margins. Apothecia substipitate, exciple dentate and ciliate, amphithecium maculate, disc imperforate; hymenium 110–130 μ high; spores 13–15×26–32 μ, episporium 3 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla lemon yellow, K−, C−, KC−, P−, atranorine and vulpinic acid present.

Parmelia cornuta is superficially very near to *P. appendiculata* Fée except for the presence of vulpinic acid. Both species have

dentate-laciniate apothecia, sparse cilia, and large spores. *Parmelia sulphurata* Nees & Flot., an isidiate species, is the only other *Parmelia* with vulpinic acid. *Parmelia cornuta* is still known only from the Mato Grosso region.

Additional specimen examined:

BRAZIL: MATO GROSSO: Buriti, *Malme* s.n., 2243B (S).

47. Parmelia crinita Ach. Syn. Lich. 196. 1814. PLATE 1

Parmelia proboscidea Tayl. *in* Mack. Fl. Hibern. 143. 1836. Type collection: Near Dunkerron, Ireland (FH-Tayl, holotype; isotype in BM).

P. perlata var. *ciliata* f. *dissectula* Nyl. *in* Leight. Lich. Fl. Gr. Brit. 120. 1879. Type collection: Killery Bay, Connemara, Ireland, *Larbalestier* s.n. (BM, holotype).

P. chlorocarpa Müll. Arg. Flora 63:265. 1880. Type collection: Caracas, Venezuela, *Ernst* in 1879 (G, holotype).

P. schweinfurthii Müll. Arg. Proc. Roy. Soc. Edinburgh 2:459. 1882. Type collection: Socotra, Africa, *Schweinfurth* (G, holotype).

P. proboscidea var. *dissectula* (Nyl.) Müll. Arg. Flora 67:616. 1884.

P. catharinensis Müll. Arg. f. *isidiosa* Müll. Arg. Flora 74:378. 1891. Type collection: Southern Brazil, *Leyland* (K, holotype; G, isotype).

P. perlata var. *dissectula* (Nyl.) Müll. Arg. Bull. Soc. Bot. Belg. 32:127. 1893.

P. pilosella Hue, Journ. de Bot. 12:247. 1898. Type collection: Coatloch Forest, Finistère, France, *Picquenard* in 1898 (P, lectotype; BM, isotype).

P. pilosella f. *excrescens* Hue, Journ. de Bot. 12:249. 1898. Type collection: Munich, Germany, *Arnold Lich. Exs.* 655a (P, lectotype; BM, isotype).

P. crinita f. *pilosella* (Hue) Merrill, Bryol. 11:95. 1908. Based on *P. pilosella* Hue.

(?) *P. tuckermanii* Du Rietz, Nyt Mag. Naturvid. 62:70. 1924. Type collection: *Wright, Lich. Cubae* 69 (UPS, holotype; FH, M, US, YU, isotypes).

P. pseudocatharinensis Gyel. Repert. Sp. Nov. Fedde 29:289. 1931. Based on *P. catharinensis* Müll. Arg. f. *isidiosa* Müll. Arg.

Type collection: North America, *Muhlenberg* (H, holotype).

Thallus adnate to loosely attached, 8–25 cm. in diameter, mineral gray; lobes rotund to irregularly dissected, 6–12 mm. wide, margins crenate, often isidiate and dissected on older lobes, ciliate, cilia 1–2 mm. long; upper surface dull, plane, moderately to densely isidiate, isidia simple to coralloid-branched, 0.05–0.1 mm. thick, to 2 mm. high, often apically ciliate; lower side black and sparsely rhizinate, dark brown to tan, more or less rugose, shiny, and naked in a broad to rather narrow zone at the margins. Apothecia rare, 3–8 mm. in diameter, substipitate, amphithecium isidiate, disc imperforate; hymenium 65–80 μ high; spores 12–16×25–30 μ, episporium 3–4 μ thick; pycnidia rare, conidia 3–4 μ long (after Asahina).

Reactions: Thallus K+ yellow; medulla K+ yellow, C—, KC—, P+ pale orange yellow, atranorine and stictic acid present.

Parmelia crinita is a very common cosmopolitan species known to all lichenologists. It has a remarkable range of climatic adaptability,

from purely tropical areas to temperate and even subboreal forests (fig. 17) (cf. Degelius, 1935). The isidia vary widely from simple and sparse to densely coralloid-branched and ciliate. The lobes are rather small and have a relatively narrow, shiny, often rugose bare zone below. It is the only isidiate species in the subgenus with stictic acid. *Parmelia subcrinita* Nyl., which contains salacinic acid, is in general a more robust plant with a broad bare zone below. *Parmelia mellissii* Dodge in a few cases has coralloid isidia that could be confused with those of *P. crinita* but it is K— (alectoronic acid) and has smaller spores.

Parmelia internexa Nyl., which is classified in the subgenus *Parmelia*, differs chiefly in size. It has adnate lobes at most 4 mm. wide and a narrow papillate zone below.

Parmelia tuckermanii Du Rietz was described from a Wright Cuban collection that contains spores significantly smaller (about 18 μ long) than in any specimens of *P. crinita* that I have examined. Since spore size is the only difference between it and *P. crinita*, sterile specimens must be referred to *P. crinita*. I believe the smaller spores are juvenile or otherwise abnormal.

Additional representative specimens examined:

CANADA: Nova Scotia: Hunt's Point, *Denison* (US). Ontario: Hibbard Bay, Algoma Distr., *Cain* 26882, 26884 (TRT, US); Brighton, *Macoun* 67, 175 (US). U.S.: Maine: Mt. Desert Island, Hancock Co., *Davis* 68 (US); Rockland, Knox Co., *Merrill, Lich. Exs.* 124 (FLAS, US); Connecticut: Aton Forest, Litchfield Co., *Hale* 71 (US, YU); New York: Jamesville, Onondaga Co., *Cook* s.n. (US); Maryland: 6 mi. west of Town Hill, Alleghany Co., *Hale* 14503 (US). West Virginia: 4 mi. east of Baker, Hardy Co., *Hale* 15024 (US); Bluestone Dam, Summers Co., *Hale* 11707 (US); Jaeger, McDowell Co., *Hale* 10832 (US); Ohio: Junction of routes 374 and 56, Hocking Co., *Hale* 13299 (US); Kentucky: Near Forest Cottage, Cumberland Co., *Hale* 13714 (US); Wisconsin: Upper Brule River, Douglas Co., *Thomson* s.n. (WIS); Michigan: Lower Tahquamenon Falls, Chippewa Co., *Imshaug* 19906 (MSC, US); Iron Bridge, Cheboygan Co., *Robinson* s.n. (US); Minnesota: Grand Portage Island, Cook Co., *Fink* 114 (US); Duluth, St. Louis Co., *Kimball* s.n. (US); Iowa: Fayette Co., *Fink* s.n. (US); Missouri: Near Ava, Douglas Co., *Hale* 4327 (US); Laquey, Pulaski Co., *Hale* 4079 (US). Virginia: Mountain Lake Biological Station, Giles Co., *Hale* 18414 (US); 2 mi. east of Buena Vista, Rockbridge Co., *Hale* 18345 (US); Browntown Valley Overlook, Skyline Drive, Rappahannock Co., *Hale* 14732 (US); Doughat State Park, Bath Co., *Hale* 12401 (US); North Carolina: 2 mi. south of West Jefferson, Ashe Co., *Culberson* 6306 (DUKE); Cleveland, Rowan Co., *Culberson* 6132 (DUKE); Gastonia, Gastonia Co., *Hale* 8144 (US); Forney Ridge, Great Smoky Mountains, *Degelius* s.n. (US); South Carolina: Near Greenville, Greenville Co., *Hale* 7762 (US); 5 mi. east of Walterboro, Colleton Co., *Hale* 16502 (US); Tennessee: 2 mi. north of Carters Gap, Carter Co., *Hale* 18003 (US); Cliff Springs, Overton Co., *Phillips* 301 (US); Georgia: Chatsworth, Murry Co., *Hale* 7416 (US); Neels Gap, Lumpkin Co., *Hale* 7559 (US); Alabama: Oak Mountain State Park, Shelby Co., *Hale* 7156 (US); 4 mi. southeast of Troy, Pocosin area, *McCullough* 472, 476 (US); Florida: 8 mi. east of Ocala, Marion

Co., *Hale* 17033 (US); Oleno State Park, Alachua Co., *Hale* 16739 (US); Highlands Hammock State Park, Highlands Co., *Hale* 16937 (US); ARKANSAS: Nogo, Pope Co., *Hale* 2975 (US); Dardanelle, Yell Co., *Hale, Lich. Amer. Exs.* 16 (BM, C, CAN, FH, FU, ID, ILL, L, LD, LISU, M, MO, NY, S, TENN, TRT, UC, US, W, WIS); OKLAHOMA: South of Albion, Pushmataha Co., *Hale* 4976 (US); TEXAS: Near Woodville, Tyler Co., *Hale* 5218 (US); Jasper, Jasper Co., *Hale* 5411 (US); ARIZONA: Santa Rita Mountains, Santa Cruz Co., *Darrow* 4394 (Darrow Herbarium); MEXICO: VERACRUZ: 33 km. northeast of Perote, *Hale* 20871 (US), 20892 (COLO, US); OAXACA: Cerro San Felipe, *Hale* 20787 (LISU, US); CHIAPAS: 50 km. west of Tuxtla Gutiérrez on highway 190, *Hale* 19907 (DUKE, S, TNS, US); 14 km. west of San Cristóbal, *Hale* 20566 (US). GUATEMALA: QUETZALTENANGO: Between Zunil and Cantel, *Standley* 83905 (MO). HONDURAS: El Paraiso, Güinope, *Valerio* 1816 (MO). NICARAGUA: JINOTEGA: West of Jinotega, *Standley* 9766 (F); MASAYA: Region of Las Nubes, *Standley* 8749 (F). COSTA RICA: GUANACASTE: Aguilares, *Standley* 46355 (US); CARTAGO: Along the Río Reventado, *Standley* 49601 (US); 1 mi. south of Cartago, *Danilson* 17 (MICH); ALAJUELA: San Pedro de San Ramón, *Brenes* 457 (UPS).

CUBA: LAS VILLAS: Trinidad Mountains, *Imshaug* 24599 (MSC); ORIENTE: El Gato, Loma del Gato, Sierra Maestra, *Imshaug* 24819 (MSC, US), 24926 (MSC, US), 24768 (MSC), *Hioram* 8467 (FH), *Leon* 10613 (NY); Loma San Juan, Guantánamo, *Hioram* 10268 p.p. (FH); summit of Pico Turquino, *Imshaug* 25105 (MSC). HAITI: Near summit of Morne Macaya, *Imshaug* 23252 (MSC, US); summit of Tête Étang, *Imshaug* 22587 (MSC). DOMINICAN REPUBLIC: Along road at Los Amaceyes, *Wetmore* 3399 (MSC); near Cerrazos, on ridge from La Cumbre to Santiago, *Wetmore* 3856 (MSC, US), 3862 (MSC); summit of Pico de Isabel de Torres, near Puerto Plata, *Imshaug* 23939 (MSC, US). JAMAICA: Coopers Hill in the Red Hills, *Imshaug* 13721, 13729, 13744, 14125, 14141 (MSC); Dolphin Head, Hanover, *Imshaug* 15647 (MSC); Blue Mountain Peak Trail, St. Thomas, *Imshaug* 12951 (MSC, US); Hollymount, Mt. Diablo, *Imshaug* 14190 (MSC, US), 14192, 14212 (MSC); Newcastle, *Cushman* 40 (FH); without locality, *Eggers* 3779 (C). PUERTO RICO: Mt. Torrecella, *Sintenis* 32 (G). VIRGIN ISLANDS: ST. THOMAS: Signal Hill, *Eggers* s.n. (S); Crown, *Britton* 1441 p.p. (NY).

VENEZUELA: MÉRIDA: Río Chama Valley, Mérida, *Dennis* 2335 (K). COLOMBIA: CUNDINAMARCA: Near Zipaquirá, *Schultes* 11441 (FH, US); TOLIMA: Between Cajamarca and summit of Divide, *Killip* 34678b (US). CHILE: CAUTIN: Llainia, *Gunckel* 19453 (MO); VALDIVIA: Lago Riñihue, *Santesson* 3510, 3732, 7146 (S); CHILOÉ: Petrohué, *Hosseus* 187 (M); Isla Chiloé, Peninsula Lacui, *Santesson* 4092 (S), 4116 (S, US); JUAN FERNANDEZ: *Reed* s.n. (BM), *Hassler* s.n. (K).

SCOTLAND: Dungallan Parks, Argyll, *Lindahl* 176 (UPS). ENGLAND: Sussex, *Borrer* s.n. (US). NORWAY: Skarås, Regefjord, Rogaland, *Hasselrot* (S). FRANCE: Forêt du Cranou, Finistère, *Almborn*, Aug. 20, 1954 (LD, US); St. Thurial, Ille-et-Vilaine, *Santesson* 10084a (UPS, US). HUNGARY: Near Rónafüred, *Szatala, Fl. Hung. Exs.* 416 (LD, US). ITALY: Mt. Mulatto, near Predazzo, *Arnold, Lich. Exs.* 1151 (US); Deserto di Santa Anna, Cogoleto, *Gresino* 11445 (F). SPAIN: 2 km. northwest of Irurita, Navarra, *Santesson* 13291j (UPS). PORTUGAL: Near Pena, Serra de Sintra, Estremadura, *Tavares, Lich. Lusit. Sel. Exs.* 117 (LD, US, WIS).

KENYA: Tinderet Forest Reserve, Kisumu-Londiani, Nyanza Prov., *Maas Geesteranus* 11162 (L). UNION OF SOUTH AFRICA: TRANSVAAL: 5 mi. east of Mokobulaan, Lydenberg, *Almborn* 7495 (LD); north of Louis Trichardt, Zoutpansberg, *Almborn* 6542 (LD); NATAL: Eschowe, *Höeg* s.n. (TRH); Polela

Forest, Polela, *Almborn* 9504 (LD); near Pietermaritzburg, Umgeni, *Höeg* s.n. (TRH); Cathedral Peak Area, Bergville, *Almborn* 8872 (LD); CAPE PROVINCE: Tzitzikama Mountains, *Maas Geesteranus* 6624 (L); Fern Kloof, Albany, *Almborn* 10729 (LD); Paarl Rock, Paarl, *Almborn* 5422 (LD); east slope of Table Mountain, Wynberg, *Almborn* 11311 (LD); Blauwkrantz, Humansdorp, *Höeg* s.n. (TRH).

CHINA: Fukien Prov., *Sowerby* s.n. (US). JAPAN: Ohito, Prov. Idu, *Kurokawa* 58025 (TNS, US).

JAVA: Mt. Gedeh, Tjibodas, *Groenhart* 8550, 8764 (BO). FIJI: Mba, Viti Levu, *Smith* 4912 (US). AUSTRALIA: Ravenshoe, Duma Creek, *Sherrin* s.n. (BM).

48. Parmelia cryptoxantha des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:115. 1961.

Type collection: 30 km. northeast of Ankazobe, Forêt d'Ambohitantely, Centre Moyen, Madagascar, *des Abbayes* (REN, lectotype; US, isotype).

Thallus 8–15 cm. in diameter, membranous, loosely attached, light mineral gray; lobes rotund, 8–15 mm. wide, margins crenate to short lobulate-dentate, conspicuously ciliate, cilia dense, 3–5 mm. long; upper surface plane to rugulose-pitted, cortex fragile and easily breaking away, becoming coarsely sorediate-pustulate in a broad zone along the margins; medulla very pale yellow to white; lower side black and sparsely rhizinate, black to brown, shiny, and naked in a broad zone along the margin. Apothecia substipitate, to 5 mm. in diameter, exciple short lobulate, sparcely ciliate, amphithecium rugose, maculate, disc imperforate; hymenium 75–90 μ; spores 10–12×24–28 μ, episporium 1.5–2.0 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medula K+ yellow, C−, P+ pale orange yellow, protolichesteric acid, atranorine, unknown P+ acids, and a pale yellow pigment present.

The morphological characters of *P. cryptoxantha* are rather peculiar: Laminal sorediate pustules, similar to those of *P. rimulosa* Dodge but more sparsely developed, long cilia, and a membranous, fragile thallus. The chemical components are unknown except for atranorine and protolichesteric acid. The pigment is pale and easily overlooked.

Additional specimen examined:

NATAL: Forest south of Nkandhla, Nkandhla Distr., *Almborn* 8065 (LD, US).

49. Parmelia diacidula Hale, sp. nov. PLATE 13

Thallus expansus, membranaceus, laxe adnatus, 10–20 cm. diametro, viridi-glaucescens, lobis rotundatis, 10–15 mm. latis, margine integris vel late crenatis, centrum versus plus minusve breve dissectis, ciliatis, cillis sparsis, 0.5–2.5 mm. longis, sorediatis, soraliis linearibus, irregularibus, sorediis granulosis, superne planus, nitidus, levissime albomaculatus, cortice fragili, strato corticeo superiore

8–10 μ crasso, strato gonidiali 24–26 μ crasso, medulla alba, 75–90 μ crassa, strato corticeo inferiore 13–15 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia pycnidiaque ignota. Thallus K+ flavescens; medulla K−, C+ rosea, KC+ rubescens, P—, atranorinum, acidum gyrophoricum et acidum protolichestericum (et caperaticum?) continens.

Type in Lund University, collected in Boschfontein Forest, Lions River, Natal, Africa, Oct. 31, 1953, by Ove Almborn (no. 8679; isotype in US).

This species superficially resembles *P. dilatata* Vain, especially in the formation of soredia on irregularly dissected lobe margins. Cilia, however, are consistently produced even at the lobe tips and the thallus is more membranous. No other species of *Amphigymnia* produces gyrophoric and protolichesteric acids together, although this combination is known in the *P. cirrhata* group of the *Evernii-formes*. *Parmelia diacidula* is rather well collected and seems to be endemic to Natal.

Additional specimens examined:

UNION OF SOUTH AFRICA: NATAL: Indumeni Forest, Cathedral Peak Area, Bergville, *Almborn* 9189 (LD); Ingeli Forest, Alfred, *Almborn* 10250 (LD); Impetyne Forest, near Weza, *Almborn* 9961 (LD); forest south of Nkandhla, Nkandhla, *Almborn* 8068 (LD).

50. Parmelia direagens Hale, sp. nov.

Thallus laxe adnatus, 5–15 cm. diametro, cinereo-albicans, lobis rotundatis, 6–12 mm. latis, suberectis, margine integris, sinuatis vel breve laciniato-lobatis, sorediatis, soraliis linearibus, ciliatis, ciliis 1.5–2.5 mm. longis, superne nitidus, levissime albomaculatus, strato corticeo superiore 15–18 μ, strato gonidiali 15–20 μ, medulla alba, 80–100 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K−, C−, KC+ rosea, P−, soralia P+ citrina, atranorinum, acidum alectoronicum et acidum P+ ignotum continens.

Type in the British Museum, collected near Kimberly, Cape Province, South Africa, by John Shaw (isotype in US).

This remarkable species could easily be misidentified as *P. sancti-angelii* Lynge, but it differs significantly in chemistry. When P is applies to the medulla, no reaction is observed, but the soredia are P+ deep yellow. Alectoronic acid is produced throughout the medulla and the soredia, but the soredia also contain the P+ yellow unknown. There is no other *Parmelia* species with this reaction. The upper surface tends to be faintly white-maculate, whereas *P. sancti-angelii* is not clearly maculate.

Additional specimen examined:

UNION OF SOUTH AFRICA: TRANSVAAL: 5 mi. east of Mokobulaan, Lydenburg, *Almborn* 7499 (LD).

51. Parmelia eciliata (Nyl.) Nyl. *in* Fournier, Mex. Pl. 3. 1872.

Parmelia crinita var. *eciliata* Nyl. Flora 52:291. 1869.

P. resupina Stirton, Scot. Nat. 4: 298. 1877–78. Type of collection: Near Knysna, Cape Prov., Africa, *Knobel* (BM, holotype).

(?)*P. eurycarpa* Stein. & Zahlbr. Bot. Jahrb. Engler 60:530. 1926. Type collection: Amani, East Usambara, Africa, *Brunnthaler s.n.* (W, holotype).

Type collection: Orizaba, Mexico, *Bourgeau* (H, Nyl. herb. no. 35295, holotype; P, isotype).

Thallus loosely adnate, often found on twigs, membranous, up to 10 cm. wide, mineral gray; lobes rotund, soon more or less convoluted and crowded, margins crenate to lobulate-dissected, lobules to 3 mm. long, more or less canaliculate, ciliate, cilia 1.0–1.5 mm. long; upper surface plane, shiny, maculate near the base of apothecia, isidia and soredia lacking; lower side black and sparsely rhizinate, brown to tan or white variegated and naked in a broad zone along the margins. Apothecia common, stalked, up to 18 mm. in diameter, amphithecium rugose, strongly white-maculate, disc imperforate; hymenium 120–150 μ high; spores 12–18×23–30 μ, episporium 3 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow, C−, KC−, P+ pale orange yellow, atranorine and stictic acid present.

Parmelia eciliata has no close relatives among species with stictic acid. It is morphologically rather similar to *P. blanchetii* Hue and *P. abnuens* Nyl., both of which differ in chemistry and in various minor morphological characters. This species occurs mainly in the Caribbean area where it is common on branches of deciduous trees, but it is also rather common in southern South America and in South Africa (fig. 18). The type of *P. eurycarpa* is placed in synonymy tentatively because the holotype is in poor condition; the presence of stictic acid and lack of soredia make it highly probable that it is identical with *P. eciliata*.

Additional specimens examined:

MEXICO: HIDALGO: Chapulhuacan, *Lundell* 7214e (MICH); VERACRUZ: 36 km. southwest of Orizaba, *Hale* 19582 (S, US); 64 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19549 (US). NICARAGUA: JINOTEGA: Cerro de la Cruz, west of Jinotega, *Standley* 11091 (F).

CUBA: ORIENTE: Loma del Gato, *Hioram* 6693 (BPI); Gran Piedra, Sierra Maestra, *Imshaug* 25035 (MSC). HAITI: Summit of ridge on Tête Etang, elev. 5850 ft., *Wetmore* 2661 (MSC); summit of Montagne Noire, elev. 5500 ft., *Wetmore* 2798 (MSC); summit of ridge north of Forêt des Pins, elev. 5800 ft., *Imshaug* 22705 (MSC). JAMAICA: No locality, *Wolle*, 1875 (US).

BRAZIL: Rio de Janeiro: Serra dos Orgãos, *Burchell* 2251 (K). ARGENTINA: Near Salta, *Smith* 4676 (US); Delta of Río Paraná, Buenos Aires, *Sentesson* 109, 110, 1186 (S); no locality, *Lorentz & Hieronymus*, 1872–76 (M).

UNION OF SOUTH AFRICA: Transvaal: Kaaimansgat Forest, Woodbush, *Mogg* 1990 (PRE); Cape Prov.: Dassies Krantz, Grahamstown, *Almborn* 4017 (LD); 6 mi. N. of Knysna, Knysna, *Almborn* 2619 (LD, US).

52. Parmelia erasmia Hale, sp. nov.

Thallus laxe adnatus, saxicola, 5–10 cm. diametro, cinereo-glaucescens, lobis rotundatis, 8–10 mm. latis, margine ciliatis, ciliis 2.0–2.5 mm. longis, superne opacus, aetate rimosus, isidiatus, frequenter superficie neque margine, isidiis tenuibus ramosisque, strato corticeo superiore 20–25 μ crasso, strato gonidiali 18–20 μ crasso, medulla 60–70 μ alta, parte superiore alba, inferiore pro parte crocea, strato corticeo inferiore fusco, 15–20 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia et pycnidia ignota. Thallus K+ flavescens; medulla alba K−, C−, KC+ rosea, P−, medulla crocea K+ atropurpurea, atranorinum, acidum alectoronicum, et pigmentum croceum ignotum continens.

Type in the Chicago Natural History Museum, collected in the vicinity of El Zamorano, Morazán, Honduras, Nov. 26, 1946–Jan. 9, 1947, by P. C. Standley (no. 210; isotype in US).

Parmelia erasmia has the gross appearance of the widespread *P. crinita* Ach. The isidia are normal with no obvious tendency to become pustulate or sorediate. It might accidentally be placed with specimens of *P. mellissii* Dodge that have more normal isidia and well-developed pigments. However it is easy to prove with chromatography that the pigment in *P. mellissii* is rhodophyscin and that in *P. erasmia* is the same unknown anthraquinone found in *P. hypomiltoides* Vain. *Parmelia hypomiltoides* has coarsely sorediate margins. All three species must be carefully studied morphologically and chemically before identifications are made. In any event *P. erasmia* is a rare species apparently endemic to pine-oak forests in Mexico and Central America, where it is probably more common than the few records indicate.

Additional specimens examined:

MEXICO: Veracruz: Tcocclo Canyon, south of Xico, *Hale* 21139 (US). HONDURAS: Comayagua: Siguatepeque, *Standley & Chacón* 6257 (F. US); Morazan: Quebrada el Gallo, northeastern slopes of Cerro de Uyuca, *Morton* 7044 (REN, US).

53. Parmelia eurysaca Hue, Nouv. Arch. Mus. Paris, ser 4, 1:194. 1899. Plate 8

Type collection: Mexico, *Bourgeau* 1865–66 (P, holotype).

Thallus loosely adnate to bark, coriaceous, ashy white to mineral gray, 10–20 cm. broad; lobes rotund, 10–14 mm. wide, conspicuously dentate-laciniate toward the center, laciniae 1–2×5–10 mm., margins

ciliate, cilia 1–4 mm. long; upper surface plane, opaque to rather shiny, reticulately cracked with age, isidia and soredia lacking; lower side black and rhizinate in the center, brown to white-variegated in a broad zone at the margins. Apothecia 5–15 mm. in diameter, substipitate, amphithecium rugose, white-maculate, disc perforate; hymenium 35–45 μ high; spores 6–8×9–12 μ, episporium 1 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia eurysaca is characterized by heavily pycnidiate marginal laciniae, which are always present in some degree. This is the only ciliate species with salacinic acid that lacks soredia or isidia. A very close sorediate relative is *P. stuppea* Tayl., which lacks distinct laciniae. *Parmelia eurysaca* is endemic to central and northern Mexico and the adjacent United States, occurring very commonly on oak trees on dry open hillsides along with *P. stuppea* and *P. praesignis* Nyl.

Additional specimens examined.

U.S.: Texas: Head of Camp Verde Creek, Bandero Co., *Parks* 1068 (US, WIS). Arizona: Cave Creek, Chiricahua Mountains, Cochise Co., *Weber et al.* 24741 (US). MEXICO: San Luis Potosí: Without locality, *Parry* 1022 (K); Alvarez, *Palmer* 465, 466 (US); Jalisco: San Sebastian, Sierra Madre Occidental, *Mexia* 1381, 1545c (F), 1904a (US); Hidalgo: Cuyamaloya, *Pringle* 10753 (US); El Hiloche, *Martinez* s.n. (US); Sierra de Pachuca, *Madrigal* 1415 (US); Veracruz: 64 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19535 (US); 33 km. northeast of Perote, *Hale* 21220 (US); Mexico: North of Acambay, *Cain* 27597a (TRT, US); Sierra de las Cruces, *Pringle* 168 (COLO, US); Michoacán: 65 km. east of Morelia, *Hale* 20988 (US); Cerro Azul, Morelia, *Arsène* 3737 (US); 61 km. northwest of Zitácuaro, *Hale* 20861 (COLO, US); Oaxaca: Cerro San Felipe, *Hale* 20692 (DUKE, REN, S, TNS, US), 20709 (MSC, US).

54. Parmelia flavotincta Hale, sp. nov. Plate 6

Thallus expansus, laxe adnatus, membranaceus, 10–15 cm. latus, lobis rotundatis, 8–15 mm. latis, margine integris, centrum versus demum laciniatis, laciniis isidiiformibus, coralloideo-ramosis, apice granulato-fatiscentibus (ut in *P. fasciculata* Vain.), margine ciliatis ciliis 1–2 mm. longis, superne nitidus, planus, strato corticeo superiore 20–26 μ crasso, strato gonidiali 15–18 μ crasso, medulla alba, 90–125 μ crassa, strato corticeo inferiore 14–18 μ crasso, inferne niger, sparse rhizinosus, ambitu fusco-castaneus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K+ flavescens, C−, KC−, P+ flavotincta, atranorinum solum continens.

Type in Kew Herbarium, collected at Cross Line, 8 mi. east of Berbice, British Guiana, July 17, 1919, by A. A. Abrahamson (no. 229; isotype in US).

Parmelia flavotincta is the only *Amphigymnia* species that contains atranorine in the medulla. Morphologically it is close to *P. fasciculata* Vain. and *P. ramuscula* Hale in the formation of coralloid isidial structures but differs in having a more membranous thallus and distinct cilia.

Additional specimen examined:

COLOMBIA: VAUPÉS: Cachivera de Jirijirimo, *Schultes & Cabrera* 11986 (FH, US).

55. Parmelia fracta Hale, sp. nov.

Thallus expansus, laxe adnatus, 10–15 cm. latus, stramineo-flavicans, lobis rotundatis, usque ad 20 mm. latis, margine integris, centrum versus pro parte dentato-laciniatis, ciliatis, ciliis 1–2 mm. longis, pro maxima parte in lobis lateralibus, superne opacus, rugulosus, demum pustulato-sorediatus, cortice partim comminuente, strato corticeo superiore 15–18 μ crasso, strato gonidiali 14–16 μ crasso, medulla alba, 75–95 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia magna, pedicellata, usque ad 15 mm. diametro, amphithecio valde rugoso, albomaculato, disco imperforato; hymenium 120–140 μ altum; sporae 16–20×30–38 μ, episporio 3–4 μ crasso; pycnidia rara, conidiis non visis. Thallus K+ flavescens; medulla K−, C−, KC+ rosea, P+ aurantiaca, atranorinum, acidum usnicum, et acidum protocetraricum continens.

Type in the Farlow Herbarium, Harvard University, collected in Colombia, South America, by Lindig (no. 740; isotypes in H, M, US).

The upper cortex of *P. fracta* is quite fragile, flaking off and developing broad pustulate-sorediate areas, reminiscent of *P. bangii* Vain. and *P. rimulosa* Dodge. It is known only from the type collection. Nylander had given it the herbarium name of "*P. latissima* f. *flavida*."

56. Parmelia grayana Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:184. 1899.

Parmelia cinereoplumbea Harm. *in* Pitt. & Harm. Bull. Soc. Bot. Fr. 58, suppl. 22:32. 1911. Type collection: Riscos de Casitas, Canary Islands, *Pitard* 2001 (DUKE, holotype).

P. simodensis Asahina, Journ. Jap. Bot. 17:73, *fig. 79*. 1941. Type collection: Simoda, Prov. Izu, Hondo, Japan, *Asahina* (TNS, holotype).

Type collection: Coonoor, Nilgherries, India, *Gray*, 1893 (P, holotype).

Thallus saxicolous, adnate to loosely attached, 3–6 cm. in diameter, coriaceous, whitish gray; lobes rotund, rather narrow, 4–8 mm. wide, crowded, margins crenate, often ascending, sorediate, soralia linear to subglobose, ciliate, cilia sparse to conspicuous, 0.5–1.5 mm. long, rather coarse; upper surface opaque, often pruinose, irregularly cracked with age, often capitate-sorediate near the margins, coalescing with the marginal soredia; lower side black and rhizinate at the

center, dark brown and naked or in part papillate along the margins. Apothecia rare, adnate, to 4 mm. in diameter, disc perforate; hymenium 50–60 μ high; spores 5–7×12–14 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

Parmelia grayana is a saxicolous species with wide distribution in Asia and Africa (fig. 19). It is superficially like *P. praesorediosa* Nyl., which is sometimes saxicolous but lacks cilia. The thallus of *P. grayana* is usually coriaceous, the upper cortex white pruinose, and the cilia thick and coarse.

Additional specimens examined:

UNION OF SOUTH AFRICA: TRANSVAAL: Pretoria, *Smith* 6276 (PRE); Punch Bowl Inn, *Almborn* 6483 (LD, US); Louis Trichardt, Zoutpansberg, *Almborn* 6098 (LD); NATAL: Indumeni Forest, Cathedral Peak Area, *Almborn* 8929 (LD, US); 1 mi. west of Cathedral Peak Hotel, Bergville Distr., *Almborn* 9130 (LD); CAPE PROVINCE: Mataliele, *Hõeg* s.n. (TRH).

JAPAN: Mt. Buzan, Shimoda, Prov. Izu, *Kurokawa* 58630 (TNS, US).

57. Parmelia hololoba Hale, sp. nov.

Thallus laxe adnatus vel suberectus, rigidiusculus, usque ad 10 cm. diametro, albicans, parum lobatus, lobis magnis, rotundatis, 10–20 mm. latis, margine sinuatis, ciliatis, ciliis 1.0 mm. longis, superne opacus, laevigatus, leviter rimosus in aetate, cortice continuo, strato corticeo superiore 12–16 μ crasso, strato gonidiali 10–15 μ crasso, medulla alba, 70–85 μ crassa, strato corticeo inferiore 8–10 μ crasso, inferne niger, sparse rhizinosus, margine castaneus, late nudus. Apothecia 5–10 mm. diametro, pedicellata, disco perforato, amphithecio albo-maculato in aetate; hymenium 60–70 μ altum; sporae 7–8×10–12 μ; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K−, C+ rubra, KC+ rubra, P−, atranorinum et acidum lecanoricum continens.

Type in the Kew Herbarium, collected at Entebbe, Uganda, Africa, Mar. 3, 1959, by Proctor (packet A; isotype in US).

Although *P. hololoba* is known only from the type locality, the material is well developed and exhibits a unique combination of characters. The presence of cilia in a species with lecanoric is particularly unusual. It is probably near *P. cooperi* Stein. & Zahlbr., which is sorediate, and may eventually prove to be the nonsorediate phase of this species. Except for the presence of cilia, it is very close to *P. andina* Mull. Arg.

58. Parmelia hypomiltoides Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:35. 1890.

Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs. s.n.* (TUR, Vain. herb. no. 2543, holotype).

Thallus loosely adnate, membranaceous, 5–8 cm. in diameter, mineral gray; lobes rotund, margins entire to incised, ciliate, cilia 1.5–2.5 mm. long, sorediate, soredia granular; upper surface shiny, faintly maculate, sorediate near the margins, soralia at first punctiform, granular, coalescing irregularly, developing short subisidial growths; lower side black and sparsely rhizinate, brown and rugulose, naked, in a zone along the margin. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ reddish orange, P—, in part orange red, reacting K+ purple, atranorine, alectoronic acid, and an unknown anthraquinone present.

The type of *P. hypomiltoides* is a very poor fragment. The chief diagnostic characters are the orange-red medulla, quite conspicuous even near lobe tips, and the coarsely sorediate or even isidiate-sorediate laminal and submarginal soralia. By chromatography it is possible to show that the red pigment is not rhodophyscin, which is otherwise so common in *Amphigymnia* species with alectoronic acid. It is an unnamed pigment (No. 1) also found in *P. erasmia* Hale and *P. mesogenes* Nyl. *Parmelia hypomiltoides* could be confused with *P. rampoddensis* Nyl. which has rhodophyscin and marginal farinose soredia or with *P. mellissii* Dodge which also has rhodophyscin and distinct sorediate-isidia. In both of the latter species the pigment is associated with older or decomposed parts of the medulla, but it is still desirable to make chromatographic tests. *Parmelia hypomiltoides* is extremely rare and confined to southern Brazil, although it will probably be found eventually in Central America.

Additional specimen examined:

BRAZIL: São Paulo: Cruzeiro, *Robert*, November 1900 (BM).

59. Parmelia inexspectata des Abbayes, Bull. Inst. Fr. Afr. Noire 20:16. 1958.

Type collection: Mt Tonkoui, cercle de Man, Ivory Coast, *des Abbayes* (REN, holotype; US, isotype).

Thallus to 10 cm. broad, loosely attached, mineral gray; lobes rotund, 10–15 mm. wide, margins subcrenate, ciliate, cilia 3–6 mm. long, upper surface plane, dull, soredia and isidia lacking, lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia (from original description) to 15 mm. in diameter, pedicellate, exciple entire to dentate, amphithecium rugose, disc imperforate; spores 11–14×23–28 μ.

Reactions: Thallus K+ yellow; medulla K+ orange red, C—, KC—, P—, atranorine and an unidentified K+ substance present.

This species is characterized by a P—, K+ medullary reaction. As des Abbayes (1958) has pointed out, *P. eurysaca* Hue is somewhat similar in general appearance but contains salacinic acid, and, we might add, has perforate apothecia and small spores. Actually

P. inexpectata seems to have no close relatives and more collections must be seen before we can assess the range of variation.

Additional specimens examined:

IVORY COAST: Near Cinchona station, Mont Tonkoui cercle de Man, *Santesson* 10618b, 10619a (UPS).

60. Parmelia lophogena des Abbayes, Bull. Inst. Fr. Afr. Noire 20:19. 1958.

Type collection: Dalaba, Fouta-Djalon, Guinea, Africa, *des Abbayes* (REN, holotype; US, isotype).

Thallus loosely adnate on bark, 5–8 cm. broad, mineral gray; lobes rotund, 7–10 mm. wide, margins entire, ciliate, cilia 1.0–1.5 mm. long; upper surface shiny, plane, continuous, densely lobulate-isidiate, isidia inflated, pustulate, irregular, 0.2–0.3 mm. thick, to 0.5 mm. high, fragile; lower side black and moderately rhizinate, pale brown to mottled ivory in a broad zone at the margins. Apothecia poorly developed, spores not seen.

Reactions: Thallus K+ yellow; medulla K—, C+ rose, KC+ blood red, P—, atranorine and gyrophoric acid present.

The more or less lobulate pustulate isidia set *P. lophogena* apart from all other species of *Amphigymnia*. It is still known only from the type collection.

61. Parmelia maclayana Müll. Arg. Flora 74:376. 1891. PLATE 7

Type collection: South of Tropic of Capricorn, Africa, *Maclay* (K, holotype; G, isotype).

Thallus loosely attached, more or less coriaceous, 6–10 cm. in diameter, mineral gray; lobes rotund, 10–15 mm. wide, margins entire, become short, coarsely digitate-lobulate toward the center, ciliate, cilia rather sparse, to 2 mm. long, more common on lateral margins; upper surface plane, dull or rather shiny, very faintly maculate in part, continuous to more or less cracked with age; isidia and soredia lacking; lower side black, sparsely rhizinate, brown to tan and naked in a broad zone along the margins. Apothecia substipitate, 8–12 mm. in diameter, amphithecium maculate, rugulose, disc perforate; hymenium 50–70 μ high; spores 6–10×12–15 μ, episporium 1.0–1.5 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ orange red, P—, atranorine and alectoronic acid present.

Parmelia maclayana is differentiated from three other nonsorediate African *Amphigymnia* species containing alectoronic acid (*P. breviciliata* Hale, *P. procera* Stein. & Zahlbr., and *P. wainii* A. L. Sm.) by perforate apothecia. *Parmelia ornatula* Hale is saxicolous and has dense cilia. *Parmelia maclayana* is known only from three widely separated localities in Africa.

Additional specimens examined:

SIERRA LEONE: Kaballa, *Thomas* 2192 (K). TANGANYIKA: Peramiho, *Dietrich* s.n. (M).

62. Parmelia margaritata Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:193. 1899. PLATE 9

Type collection: Ohio, *Sullivant* (P, lectotype).

Thallus loosely attached, 5–15 cm. in diameter, corticolous, mineral gray; main lobes rotund, 7–10 mm. wide, soon branching irregularly and developing numerous marginal laciniae, 1.5–2.0 mm. wide, 3–5 mm. long, margins sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface dull to shiny, faintly maculate, reticulately cracked with age, sorediate, soralia originating near the tips of laciniae in orbicular groups, coalescing into extensive irregular soralia, sorediate lobes usually becoming revolute; lower side black and sparsely rhizinate, dark brown and naked in a broad or rather narrow zone at the margins. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

The soralia of *P. margaritata* originate on the surface of small marginal laciniae, eventually extending to the margins and causing the laciniae to become revolute. It is virtually identical therefore with *P. arnoldii* Du Rietz except for the more restricted distribution (fig. 9) and different chemistry. These two species have quite different distribution patterns in the deciduous forests of eastern United States, *P. margaritata* being more common in mesic forests and *P. arnoldii* being more common at higher elevations.

Additional specimens examined:

U.S.: MASSACHUSETTS: Scavern's Woods, *Faxon* s.n. (DUKE); PENNSYLVANIA: Conewago, Lancaster Co., *Heller* s.n. (US); DISTRICT OF COLUMBIA: Rock Creek, *Miller* 116 (US); WEST VIRGINIA: Pineville, Wyoming Co., *Hale* 11861 (US); OHIO: Near Cincinnati, *Lea* 14 (PH); MARYLAND: Red Run, Baltimore Co., *Plitt* 233 (BPI); KENTUCKY: Stanton, Powell Co., *Prescott* 66 (WIS); 6 mi. southwest of London, Laurel Co., *Reed* 58147 (Reed Herbarium); WISCONSIN: Coon Valley, Vernon Co., *Thomson* 1907 (WIS); IOWA: Fayette Co., *Fink* s.n. (US); VIRGINIA: Browntown Valley Overlook, Skyline Drive, Rappahannock Co., *Hale* 14734 (US); 2 mi. east of Buena Vista, Rockbridge Co., *Hale* 18263 (US); Hone Quarry, Rockingham Co., *Hale* 18212 (US); near Evington, Campbell Co., *Hale* 15993 (US); Mountain Lake, Giles Co., *Hale* 12671 (US); 6 mi. east of Burnt Chimney, Franklin Co., *Hale* 15940 (US); NORTH CAROLINA: 12 mi. northeast of Pinnacle, Stokes Co., *Culberson* 6336 (DUKE); 8 mi. east of Weaverville, Buncombe Co., *Culberson* 7161 (DUKE); 3 mi. east of Lenoir, Caldwell Co., *Culberson* 7224 (DUKE); between Sands and Meat Camp, Watauga Co., *Culberson* 5982 (DUKE); TENNESSEE: Cliff Springs, Overton Co., *Phillips* s.n. (US); ARKANSAS: Eureka Springs, Carroll Co., *Hale* 2755 (US); 8 mi. south of Hollis, Perry Co., *Hale* 3097 (US); Mt. Ida, Montgomery Co., *Hale* 3035 (US); near Dallas, Polk Co., *Hale* 3957 (US); Ponca, Newton Co., *Hale* 2820 (US); Gateway, Benton Co.,

Hale 4010 (US); Mt. Magazine Park, Logan Co., *Hale* 3419, 3442 (US); Mountainburg, Crawford Co., *Hale* 2669 (US).

63. Parmelia mellissii Dodge, Ann. Mo. Bot. Gard. 46:134. 1959. PLATE 1

Parmelia crinita var. *inactiva* Magn. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:104. 1944. Type collection: Between Haelaau and Nakalalua, Maui, Hawaii, *Selling* 5801 (S, holotype).

P. allardii Hale, Bryol. 62:123. 1959. Type collection: Constanza, La Vega, Dominican Republic, *Allard* 16529 (US, holotype).

Type collection: St. Helena, *Melliss* 23 (K, holotype).

Thallus loosely adnate, corticolous, light mineral gray, 5–10 cm. broad; lobes rotund, 6–12 mm. wide, margins crenate to isidiate and dissected, ciliate, cilia 1–3 mm. long, KOH+ blue or K—; upper surface plane, dull, isidiate, especially near the margins, or sorediate-isidiate, isidia eventually becoming granular and sorediate, at maturity densely coralloid branched and ciliate, up to 3 mm. high; medulla white or in part reddish orange near the lower cortex; lower side black and rhizinate, naked and brown to tan or mottled white in a broad zone near the margins. Apothecia very rare, to 5 mm. wide, disc imperforate; hymenium 80–90 μ high; spores 10–14×16–22 μ; episporium 1.5–2.0 μ; pycnidia and conidia lacking.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ red or orange red, P—, pigmented medulla K+ purple, atranorine, alectoronic acid, and frequently rhodophyscin present.

Dodge's type specimen, although poorly developed, has typical coralloid sorediate isidia. The medullary reaction that he gives, KC—, is erroneous since alectoronic acid is present. His specimen lacks the pigment rhodophyscin which is present in about half of the specimens examined, especially those that show signs of decay. Rhodophyscin appears to be produced whenever the thallus ages or begins to disintegrate and seemingly has no taxonomic value.

Parmelia mellissii is pantropical with northward extensions into temperate United States and Japan. It had been identified as *P. arnoldii* Du Rietz in Japan because most specimens, as in the United States, are predominantly coarsely sorediate-isidiate. The range of variation from distinct coralloid isidia with scant development of soredia to the sorediate phase is very great and cannot be easily classified. Confusion with *P. arnoldii* and even *P. rampoddensis* Nyl. is possible, but the origin and type of soredia separate these species.

Additional specimens examined:

U.S.: TENNESSEE: Fall Creek Falls, Van Buren Co., *Phillips* 348 (US); SOUTH CAROLINA: Honey Hill, Berkeley Co., *Culberson* 10300 (DUKE); GEORGIA: Near Chatsworth, Murray Co., *Hale* 7439 (US); ALABAMA: Bankhead National Forest, Winston Co., *McCullough* 574 (US); FLORIDA: 6 mi. southwest of Talla-

hassee, Leon Co., *Hale* 16986 (US); Alum Bluff, Apalachicola River, Liberty Co., *Thomson* 5144 (WIS); Texas: Pineland, Sabine Co., *Hale* 5161 (US). MEXICO: Chiapas: Lagos de Monte Bello, *Hale* 20961 (DUKE, MSC, REN, TNS, US); El Suspiro, 10 km. north of Berriozábal, *Hale* 20235 (S, US). GUATEMALA: San Marcos: Barranco Eminencia, *Standley* 86498 (MO). HONDURAS: Morazán: Lower slopes of Cerro de Uyuca, *Standley* 12034 (F). COSTA RICA: Cuesta de Terraza, *Tonduz* s.n. (G).

CUBA: Oriente: Gran Piedra, Sierra Maestra, *Imshaug* 25044 (MSC, US). HAITI: Eastern end of Montagne Noire, near Kenscoff, *Imshaug* 22541 (MSC, US); vicinity of Forêt des Pins, SHADA Station, *Wetmore* 3212 (MSC, US), 2925, 3074 (MSC), *Imshaug* 22756 (MSC, US); summit of Pic La Selle, *Imshaug* 22982 (MSC, US), *Wetmore* 3130 (MSC). DOMINICAN REPUBLIC: Summit of Isabel de Torres, near Puerto Plata, *Imshaug* 23927 (MSC); southwest slope of La Rucilla, Maciso Central, *Imshaug* 23595 (LD, MSC, US); between Pico del Yaque and Chinguela, Cordillera Central, *Wetmore* 3698, 3735 (MSC, US). JAMAICA: Without locality, *Cummings* 43 (FH, NY); Abbey Green Woodland, *Harris* 10028 (BM); Hollymount, Mt. Diablo, *Imshaug* 14235 (MSC, US); Sir Johns Peak, Blue Mountains, *Imshaug* 15175 (MSC). PUERTO RICO: Adjuntas, *Sintenis* 99, 110a (G). MARTINIQUE: Piton Dumauzé, *Degelius* s.n. (DEGEL).

COLOMBIA: Vicinity of Medellín, *Charetier* 188 (US); San Isabel, s.c. (G). BRAZIL: Minas Gerais, *Warming* 272 (M).

CANARY ISLANDS: Teneriffe, *Cook* 1130 (US).

INDIA: Above Kurseong, Darjeeling, *Awasthi* 3923 (AWAS). LAOS: Hase Plantations, *Tsuyama* 1 (TNS). CHINA: Near Yunnanfu, Yunnan, *Handel-Mazzetti* 66 (WU). JAVA: Gegerbentang, *Neervoort* 3048 (BO); Tjinjiroea, *Van Slooten* s.n. (BO). JAPAN: Tanjo-ji: Kominato, Prov. Awa, *Kurokawa* 56572 (TNS, US); Matsukawa-ura, Prov. Iwaki, *Kurokawa* 58088 (TNS, US).

Additional records from the United States, Cuba, Jamaica, Venezuela, and Formosa listed by Hale (1959b) as *P. allardii* are not repeated here.

64. Parmelia merrillii Vainio, Phil. Journ. Sci. 4:658. 1909 Plate 8

Type collection: Mt. Halcon, Mindoro, Philippine Islands, *Merrill* 6163 (TUR, lectotype).

Thallus large, loosely attached, 8–10 cm. in diameter, mineral gray; lobes 10–15 mm. wide, rotund, margins laciniate toward the center of the thallus, laciniae 0.5–1.0×2–5 mm., sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface dull, reticulately cracked with age, isidia and soredia lacking; lower side black, sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia abundant, 4–10 mm. in diameter, exciple dentate-laciniate, ciliate, amphithecium rugose, white-maculate, disc imperforate; hymenium 90–110 μ high; spores 12–16×26–34 μ, episporium 2.5–3.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ orange red, P+ brick red, atranorine and protocetraric acid present.

Parmelia merrillii has long narrow laciniae on the lobes and frequently on the exciple of the apothecia. It could be confused superficially with *P. corniculans* Nyl., another Asian species, which differs

chiefly in chemistry (alectoronic acid present) and in having perforate apothecia. *Parmelia pachyspora* Hale, an African species, has similar chemistry and large spores, but differs in having sparse cilia and in lacking distinct marginal laciniae.

Additional specimens examined:

BOLIVIA: Cochabamba: Schuenca-Carrasco, *Cardenas* 5284 (US).

FORMOSA: Chokakurai, *Masuda* F.546 (TNS, US). BORNEO: Marai Parai, Mt. Kinabalu, *Clemens* 32425 (BO). CELEBES: B. Watoewila, *Kjellberg* 41L (BO). SUMATRA: Batang Paloepoeh, *Jacobson* s.n. (BO). JAVA: S.1., *Horsfield* (BM).

65. Parmelia ornatula Hale, sp. nov. Plate 10

Thallus adnatus, saxicola, 5–10 cm. diametro, albicans vel cinereo-albicans, lobis rotundatis, contiguis, elongatis, 4–7 mm. latis, margine suberectis, crenatis, dense ciliatis, ciliis suberectis, 1–2 mm. longis, sorediis isidiisque destitutis, superne nitidus, continuus, planus vel late concavus, irregulariter rimosus in aetate, strato corticeo superiore 13–17 μ crasso, strato gonidiali 15–26 μ crasso, medulla alba, 50–65 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, modice rhizinosus, ambitu castaneus, anguste nudus. Apothecia pedicellata, 4–7 mm. diametro, excipulo ciliato, amphithecio rugoso, albomaculato, disco perforato; hymenium 40–50 μ altum; sporae 5–7×10–13 μ, episporio 1.5 μ; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K—, C—, KC+ rubescens, P—, atranorinum et acidum alectoronicum continens.

Type in herbarium of Gunnar Degelius, collected near Faz. Canjangue, Vila Flor, Huambo, Angola, Africa, Feb. 18, 1960, by G. Degelius (isotype in US).

This is a saxicolous species with rather narrow crowded lobes and dense suberect marginal cilia, as well as a few laminal cilia. It would appear to be a distant relative of another saxicolous species with alectoronic acid, *P. breviciliata* Hale, which is a larger species with imperforate apothecia. *Parmelia ornatula* is known only from the type collection and is probably endemic to Angola.

66. Parmelia pachyspora Hale, sp. nov.

Thallus laxe adnatus, expansus, 12–20 cm. diametro, cinereo-albicans, lobis rotundatis, 10–15 mm. latis, margine plus minusve crenatis, saepe dentato-laciniatis, suberectis, sparse ciliatis, ciliis 1.0–2.5 mm. longis, sorediis isidiisque destitutis, superne opacus, planus, continuus vel irregulariter rimosus, strato corticeo superiore 13–17 μ crasso, strato gonidiali 20–26 μ crasso, medulla alba, 75–100 μ crassa, strato corticeo inferiore 15–18 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus vel eborinus, late nudus. Apothecia pedicellata, 5–8 mm. diametro, excipulo plus minusve ciliato-dentato,

amphithecio valde rugoso atque albomaculato, disco imperforato; hymenium 80–90 μ altum; sporae 13–15×30–34 μ, episporio 3 μ crasso; pycnidia numerosa, conidiis 1×5–6 μ. Thallus K+ flavescens; medulla K−, C−, KC+ rosea, P+ aurantiaca, atranorinum et acidum protocetraricum continens.

Type in the herbarium of Gunnar Degelius, collected 10 km. north of Sá da Bandeira, Huila, Angola, Africa, Feb. 3, 1960, by G. Degelius (isotype in US).

The apothecia of *P. pachyspora* are stalked and conspicuous. The closest related species is *P. merrillii* Vain., an Asian species with long marginal laciniae. *Parmelia pachyspora* is known from several localities in southern Africa.

Additional specimens examined:

ANGOLA: Moxico: Between Luso and Cochipoque, *Degelius*, Feb. 16, 1960 (DEGEL); Cuanza Sul: Amboim, *Gossweiler* 10006 (BM). NYASALAND: Kyimbila, *Stolz* 2760 (C); Mt. Massangulo, *Gomez* 8 (K). SOUTHERN RHODESIA: Salisbury, *Moss* 2217 (PRE). MOÇAMBIQUE: Nampula Distr., *Gomes* 2134 (PRE).

67. Parmelia perlata (Huds.) Ach. Meth. Lich. 216. 1803.

Lichen perlatus Huds. Fl. Angl. 448. 1762.

Parmelia coniocarpa Laurer, Linnaea 2:39. 1827. Type collection: Australia, *Sieber* 50 (M, holotype; S, isotype).

P. coriacea var. *perlata* (Huds.) Eschw. *in* Mart. Fl. Bras. 1:206. 1833.

P. schweinfurthii f. *sorediata* Müll. Arg. Flora 70:59. 1887. Type collection: East Gippsland, Australia, *Walter* (M, holotype; G, isotype).

P. trichotera Hue, Journ. de Bot. 12:245. 1898. Type collection: France, *Malbranche, Lich. Norm.* 65 (P, lectotype; DUKE, isotype).

P. piloselloides Zahlbr. Svensk. Vet. Akad. Handl. 57, no. 6:43. 1917. Type collection: Masatierra, Cumberland Bay, Juan Fernandez, *Skottsberg* (W, holotype; S, isotype).

P. protosorediata Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. Based on *P. schweinfurthii* f. *sorediata* Müll. Arg.

P. cristifera f. *pallida* Räs. Ann. Bot. Soc. Zool. Bot. Fenn. Vanamo 3:3. 1944. Type collection: Carrasco, Montevideo, Uruguay, *Herter*, 1929 (H, holotype).

Type collection: Specimen and *pl. 20, fig. 39B*, Dillenius Hist. Musc. 147. 1741 (OXF, lectotype).

Thallus adnate to loosely attached, 5–15 cm. in diameter, mineral gray; lobes 8–15 mm. wide, margins entire, ciliate, cilia sparse, 0.3–2.0 mm. long, submarginally sorediate, soredia originating in linear soralia, soon eroding a large area and causing the margins to become strongly revolute; upper surface smooth, opaque; lower side black and moderately rhizinate, dark brown, shiny, and naked in a broad to narrow zone along the margins. Apothecia very rare, 3–5 mm. in diameter, disc imperforate; hymenium 70–80 μ high; spores 13–16× 22–30 μ, episporium 3 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ persistent yellow, C−, KC−, P+ pale orange yellow, atranorine and stictic acid present.

I recently made a study (1961) of the typification of this common species in order to stabilize its name. The diagnostic characters are the conspicuous submarginal soralia, revolute lobes, and the presence of stictic acid. Specimens from Juan Fernandez named as *P. piloselloides* Zahlbr. have more extensive sublaminal soredia than normal but still fall within the range of *P. perlata*. The narrow, shiny and often rugose naked zone below suggests a relationship between *P. perlata* and isidiate *P. crinita* Ach., which also produces stictic acid. *Parmelia perlata* is widespread in temperate regions of all continents (fig. 20). In Scandinavia it is an oceanic species (Almborn, 1948) with a distribution pattern similar to that of *P. arnoldii* Du Rietz and *P. crinita* Ach.

Additional specimens examined:

CANADA: Nova Scotia: Hunt's Point, *Denison* (US); Uclucet, Vancouver Island, *Macoun, Canad. Lich.* 44 (DUKE). U.S.: Pennsylvania: 2 mi. east of Worlds End State Park, Sullivan Co., *Hale* 17226 (US); West Virginia: Near West Union, Doddridge Co., *Hale* 10385 (US); Wellford, Kanawha Co., *Hale* 10862 (US); Kentucky: Near Baldrock, Laurel Co., *Reed* 58118 (Reed Herbarium); Virginia: 1 mi. north of Gillespie, Bedford Co., *Hale* 15762 (US); Whitetop Mountain, Washington Co., *Hale* 18490 (US); Tennessee: Near Elkmont, Sevier Co., *Cain* 85 (US); Cliff Springs, Overton Co., *Phillips* 313 (US); North Carolina: Near Yadkin Valley, Caldwell Co., *Culberson* 6507 (DUKE, US); near Candler, Buncombe Co., *Green* s.n. (US); summit of Mt. Mitchell, Yancey Co., *Imshaug* 22358 (MSC); Georgia: 5 mi. east of Hiawassee, Towns Co., *Culberson* 7289, 7264 (DUKE); Oregon: Cape Blanco, Port Oxford, *Imshaug* 17655 (MSC); California: Freshwater, Humboldt Co., *Becking* 61060012 (US); Woodside, San Mateo Co., *Cain* 26378 (TRT, US); Point Reyes, Marin Co., *Imshaug* 17686 (MSC). MEXICO: San Luis Potosí: Alvarez, *Palmer* 467 (US); Hidalgo: 20 mi. southwest of Jacala, *Cain* 27619 (TRT, US); Puebla: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19645 (US); Mexico: La Cima, *Pringle* 10725 (US); Veracruz: 33 km. northeast of Perote, *Hale* 19354 (US). PANAMA: Chiriquí: Chiriquí volcano, *Scholander* s.n. (MO).

HAITI: Summit of Tête Étang, *Imshaug* 22614 (MSC), 22620 (MSC, US).

CHILE: Juan Fernandez, *Skottsberg* s.n. (S), s.c. (K); Coquimbo: Fray Jorge, *Sparre* 3020 (S); Valparaiso: Lago Peñuelas, *Santesson* 7002 (S); Valdivia: Corral, *Santesson* 7064 (S); Lago Riñihue, *Santesson* 3511; Cautín: Temuco, *Gunckel* 18204 (MO); Chiloé: Ancud, Isla Chiloé, *Santesson* 4234 (S); Laraquete, *Hosseus* 75 (M).

IRELAND: Galway, *Degelius* s.n. (UPS). SCOTLAND: Between Salen and Drumlang, Argyll, *Lindahl* 95d (UPS). ENGLAND: Bilsdale, Yorkshire, *Baker* s.n. (US). NORWAY: Seljuåsen, Sokndal, *Santesson* s.n. (US).

NETHERLANDS: Goes, Zeeland, *Maas Geesteranus* s.n. (US). POLAND: Puszcza Bukowa, *Glanc, Lich. Polon.* 173 (LD). FRANCE: St. Thurial, Ille-et-Vilaine, *Santesson* 10080 (US); Rennes Woods, *des Abbayes, Lich. Armor. Spect. Exs.* 107 (LD); Le Trayas, Estrel, *Suza, Crypt. Exs. Vind.* 3657 (US);

Troyes, *Culberson* 1026 (DUKE, US). SPAIN: South of the Santuario, Covadonga, *Santesson* 13085b (UPS). PORTUGAL: Near Azoia, Estremadura, *Tavares, Lich. Lus. sel. Exs.* 141 (LD, US, WIS); Pinhal, Douro Litoral, *Tavares* 4199 (US); Peso, Minho, *Tavares* s.n. (WIS). ITALY: Torriglia, Liguria, *Almborn* s.n. (LD); Arenzano, *Sbarbaro* s.n. (WIS); Veneto, *Mass. Lich. Ital.* 325 (UPS).

AZORES: Santa Maria, *Baldwin* 14196 (US); St. Michel, *Persson* s.n. (UPS). TUNISIA: Ain Draham, *Runemark* s.n. (LD). CANARY ISLANDS: Cumbu Nueva, *Pitard* 2008 (DUKE). MADEIRA: Funchal, *Paton* s.n. (BM). TRISTAN DA CUNHA: Gong Island, *van der Merwe* 51a (LD). KENYA: Tinderet Forest Reserve, Kisumu-Londiani, Nyanza Prov., *Maas Geesteranus* 11167 (L). UNION OF SOUTH AFRICA: TRANSVAAL: Houtbosch, Pietersburg, *Almborn* 6768 (LD); NATAL: Polela Forest, Polela, *Almborn* 9514 (LD, US); Upper Umkomaas, Impendhle Distr., *Höeg* s.n. (TRH); CAPE PROVINCE: 3 mi. west of Heidelberg, Swellendam, *Höeg* s.n. (TRH); Kirstenbosch, Wynberg, *Almborn* 1389 (LD).

JAPAN: Mt. Oodake, Musashi, *Kurokawa* 59147 (TNS, US); Shikkari, Prov. Mutsu, *Kurokawa* 550310 (TNS, US). HAWAIIAN ISLANDS: Kauai, *Kraus* 1128 (Darrow Herbarium). AUSTRALIA: Illawarra, New South Wales, *Kirton* s.n. (BM). NEW ZEALAND: Plymouth, *Thomson* s.n. (BM); Wellington, *Buchanan* s.n. (BM).

68. Parmelia permutata Stirton, Scot. Nat. 4:252. 1877–78.

Type collection: Near Brisbane, Australia, *Bailey* (BM, holotype; GLAM, isotype).

Thallus 5–15 cm. broad, loosely attached, mineral gray; lobes rotund, 8–15 mm. wide, margins often suberect, entire, ciliate, cilia 2.0–4.5 mm. long, sorediate, soralia elongate, sinuous, rarely submarginal; upper surface smooth, opaque, reticulately cracked with age; medulla white in upper half, becoming orange yellow in lower half; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, pigment K−, atranorine, gyrophoric acid, and an unidentified yellow pigment present.

Parmelia permutata has a pale orange-yellow medulla with the same pigments that are found in *P. araucariarum* Zahlbr., *P. myelochroa* Hale, and others. In *P. permutata* the pigments are definitely localized in the lower half of the medulla and the upper half is white. When pigments are heavily concentrated in *P. sancti-angelii* Lynge, which is also C+ rose, it is easy to confuse these two species, but the pigment in *P. sancti-angelii* is rhodophyscin, which reacts K+ purple. *Parmelia rampoddensis* Nyl., which is C−, KC+ red (alectoronic acid), is also very similar externally and may produce rhodophyscin. In doubtful cases chromatography should be used to identify the pigments. *Parmelia permutata* is a rather rare species known only from Australia, Africa, and Asia and a single locality in the West Indies.

Additional specimens examined:

HAITI: Near Furcy, *Bro. Fabius*, July 1962 (US).

IVORY COAST: Danané, cercle de Man, *des Abbayes*, Oct. 19, 1951 (TUR). KENYA: NYANZA: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 4954, 4956 pr. p. (L). UNION OF SOUTH AFRICA: NATAL: Pietermaritzburg, *Almborn* 9633 (LD); TRANSVAAL: Near "Punch Bowl," Louis Trichardt, Zoutpansberg, *Almborn* 6245 (LD).

INDIA: Darjeeling, *Thomson*, s.d. (GLAM). THAILAND: Hase, *Tsuyama* 20 (TNS). SUMATRA: Between Lubuk Selasih and Aer Batumbuk, *Groenhart* 9355 (BO).

69. Parmelia procera Stein. & Zahlbr. Bot. Jahrb. Engler 60:537. 1926.

PLATE 10

Type collection: Near Amani, Tanganyika, *Brunnthaler*, August 1890 (W, lectotype).

Thallus large, 10–15 cm. in diameter, coriaceous, loosely attached, buff, mineral gray; lobes rotund, 8–15 mm. wide, often becoming convoluted and crowded toward the center, margins smooth or becoming short lobulate-dentate or laciniate, laciniae suberect, sparsely to moderately ciliate, cilia 2–4 mm. long; upper surface smooth, at length finely reticulately cracked, faintly maculate at the base of apothecia; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia very large, to 30 mm. in diameter, stalked, amphithecium maculate, disc imperforate; hymenium 60–70 μ high; spores 5–6$\times$12–16 μ, episporium 1 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Parmelia procera belongs to that variable difficult group of nonsorediate, nonisidiate species with alectoronic acid. It differs from *P. maclayana* Müll. Arg. and *P. ornatula* Hale in having imperforate apothecia. *Parmelia breviciliata* Hale is saxicolous, and *P. wainii* A. L. Sm. has long cilia and intermediate spores.

Additional specimens examined:

TANGANYIKA: Amani, *Greenway* 1001 (K). MOÇAMBIQUE: Massangulo *Sandrone* (F). NYASALAND: Mt. Massangulo, *Sousa* 8 (K). ANGOLA: Capir, Cuanza Sul, *Gossweiler* 9907 (US).

THAILAND: Doi Sutep, *Tsuyama* 7 (TNS, US).

NEW CALEDONIA: *Compton* 1471 (BM).

70. Parmelia pseudocrinita des Abbayes, Bull. Inst. Fr. Afr. Noire 20:19. 1958.

Parmelia braunii Dodge, Ann. Mo. Bot. Gard. 46:135. 1959. Type collection: Tanganyika, *Braun, Inst. Amani* 8603 (EA, holotype).

P. mannii Dodge, Ann. Mo. Bot. Gard. 46:136. 1959. Type collection: Ilha Principe, Africa, *Mann*, 1861 (K, holotype).

Type collection: Dalaba, Fouta-Djalon Mountains, Guinea, *des Abbayes*, Feb. 5, 1951 (REN, lectotype; US, isotype).

Thallus large, 10–15 cm. in diameter, rather coriaceous, loosely attached, mineral gray; lobes rotund, 8–12 mm. wide, margins crenate, ciliate, cilia coarse, 1–2 mm. long, upper surface smooth, dull, becoming rugulose or fissured on older lobes, isidiate, isidia simple to rarely coralloid branched, 0.05–0.07×0.2–0.5 mm., rarely ciliate apically; medulla white, rarely orange red near the lower cortex; lower side black and sparsely rhizinate, brown, shiny, and naked in a broad zone at the margins. Apothecia rare, short stalked, 2–3 mm. in diameter, amphithecium isidiate, disc imperforate; hymenium 50–65 μ high; spores 7–8×11–13 μ, episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, pigmented medulla K+ purple, atranorine, gyrophoric acid, and (if pigmented) rhodophyscin present.

Parmelia pseudocrinita is a rather common lichen in southern Africa. The overall external appearance reminds one at once of *P. crinita* Ach., but the cilia are coarse, the spores small, and the medulla K−, C+ rose.

Additional specimens examined:

ANGOLA: Huila: Between Coporolo and Chingorvi, *Degelius*, Feb. 2, 1960 (DEGEL); Bié: Coemba, *Degelius*, Feb. 10, 1960 (DEGEL). CONGO: 15 km. west of Goma, Goma, North Kivu, *Degelius*, Mar. 16, 1960 (DEGEL); Yangambi, Luweo Plateau, *Louis* 8151, 8155 pr. p. (BR); north of Elisabethville, *Höeg*, Apr. 16, 1930 (TRH). SOUTHERN RHODESIA: Matopos, *Borle* 54a (PRE). UNION OF SOUTH AFRICA: Near Solheim, Eschowe (Zululand), *Höeg*, Sept. 5, 1929 (TRH); Natal: 1 mi. north of Umzumbi, Umzinto, *Almborn* 9870 (LD).

71. **Parmelia rampoddensis** Nyl. Acta Soc. Sci. Fenn. 26, no. 10:7. 1900.
Parmelia proboscidea var. *sorediifera* Müll. Arg. Flora 67:615. 1884. Type specimen: Central Madagascar, *Hildebrandt* (G, lectotype).
P. proboscidea f. *sorediifera* (Müll. Arg.) Müll. Arg. Bull. Soc. Bot. Belg. 30:53. 1891.
P. proboscidea f. *bulbifera* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:197. 1899. Type collection: Coonoor, Nilgherries, India, *Gray*, 1883 (P, holotype).
P. poolii Dodge, Ann. Mo. Bot. Gard. 46:146. 1959. Based on *P. proboscidea* var. *sorediifera* Müll. Arg.
P. subinvoluta Hale, Bryol. 62:130, *fig. 4*. 1959. Type collection: 4 mi. west of Midway, Liberty Co., Georgia, *Hale* 16807 (US, holotype).

Type collection: Ramboda, Ceylon, *Almquist* (H, Nyl. herb. no. 35555, holotype; S, isotype).

Thallus large, expanded, 10–30 cm. wide, loosely attached, whitish to mineral gray; lobes broad and rotund, 12–20 mm. wide; margins entire, sorediate, soralia linear, 0.2–0.5 mm. wide, sorediate margins more or less involute, ciliate, cilia conspicuous, 3–6 mm. long; upper surface plane, rugulose with age; medulla white, often in part orange red near the lower cortex; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia rare, 3–10 mm. in diameter, amphithecium sorediate, disc imperforate;

hymenium 65–75 μ high; spores 6–7×10–12 μ, episporium 1 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, pigmented medulla K+ purple, atranorine, alectoronic acid and (if pigmented) rhodophyscin present.

After describing *P. subinvoluta*, I had an opportunity to examine the type of *P. rampoddensis* Nyl. from Ceylon, which proved to be identical. Further collections of the species were soon found. It is in reality a pantropical lichen, although most common in southern United States and the Caribbean area. Rhodophyscin is found in a small percentage of the specimens. When the pigment is abundant, one might identify a specimen as *P. hypomiltoides* Vain., which differs in having more or less submarginal isidiate soredia and a different anthraquinone.

Additional specimens examined:

U.S.: North Carolina: 5 mi. east of Calypso, Duplin Co., *Culberson* 6675 (DUKE); South Carolina: 3 mi. northeast of Darlington, Darlington Co., *Culberson* 7648 (DUKE); Alabama: Pocosin area 4 mi. southeast of Troy, Pike Co., *McCullough* 492 (US); Florida: Tomoka State Park, Volusia Co., *Hale* 17062 (US); 5 mi. east of Greenville, Madison Co., *Hale* 17615 (US); Crewsville, Hardee Co., *Hale* 16876 (US); Louisiana: Near Alexandria, Rapides Parish, *Logan* 881b (WIS), 881c (MO); Texas: 7 mi. south of Silsbee, Hardin Co., *Whitehouse* 25955 (MO); Jasper, Jasper Co., *Hale* 5416 (US). MEXICO: Oaxaca: 47 mi. south of Oaxaca, *Kramer* 2333 (KANU, US); Veracruz: Mirador, *Purpus* 86 (US); Chiapas: 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20171, 20185 (US); El Zapotal, Tuxtla Gutiérrez, *Hale* 20004 (US).

HAITI: Eastern end of Montagne Noire, *Imshaug* 22543 (MSC). DOMINICAN REPUBLIC: North of San José de las Matas, Santiago, *Wetmore* 3897 (MSC). JAMAICA: Mandeville, *Cushman* 12 (FH); trail above Mavis Bank Road, St. Andrew, *Imshaug* 14429 (MSC).

COLOMBIA: Antioquía: Medellín, *Daniel* 925 (US). BOLIVIA: 20 km. west of San José de Chiquitos, Santa Cruz, *Cutler* 7071 (F). BRAZIL: Minas Gerais: São João d'el Rey, *Malme* 270 (S).

CAMEROONS: *Staudt* 692 (BM). MOÇAMBIQUE: 2 km. east of Namaacha, Lourenço Marques, *Almborn* 7107 (LD). UNION OF SOUTH AFRICA: Transvaal: Blaauwberg, Pietersburg, *Leemann* 1533 (PRE). MADAGASCAR: Ambatolaona, *Benoist* 326 (LD).

INDIA: Senchal, Darjeeling, *Togashi* s.n. (TNS). FORMOSA: Renegechi, *Asahina* F.55 (TNS, US). NEW GUINEA: Mt. Arfak, *Kostermanns* 3017 (BO). AUSTRALIA: Parramatta, New South Wales, s.c. (BM).

Additional records from the United States, Jamaica, Dominican Republic, and Honduras listed by Hale (1959b) as *P. subinvoluta* are not repeated here.

72. Parmelia rimulosa Dodge, Ann. Mo. Bot. Gard. 46: 133. 1959. Plate 1

Type collection: Table Mountain, Cape of Good Hope, Union of South Africa, *MacGillivray* (K, holotype).

Thallus 5–15 cm. in diameter, loosely attached, light mineral gray membranous; lobes rotund 7–12 mm. wide, becoming crowded,

imbricate and convoluted with age, margins entire to dentate-laciniate, ciliate, cilia rather sparse, 2–3 mm. long; upper surface plane, becoming quite rugose, reticulately cracked with age, cortex cracking apart and flaking away in a broad zone along the margins, becoming sorediate or isidiate-pustulate, clearly maculate only at the base of apothecia; medulla white, sometimes orange red near the lower cortex; lower side black and rhizinate, brown to mottled tan and naked in a broad zone along the margins. Apothecia rare, 8–15 mm. in diameter, stalked, amphithecium rugose, maculate, disc perforate; hymenium 70–80 μ high; spores 10–13×20–22 μ, episporium 1.5–2.0 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, sometimes pigmented orange red near the lower cortex, K+ purple, atranorine, alectoronic acid, and if pigmented rhodophyscin present.

Parmelia rimulosa is a typical South African species extremely common and confined largely to Natal and the Cape Province. The outstanding character is the cracking and flaking of the upper cortex, usually giving rise to extensive laminal pustulate-sorediate areas. The plants are quite thin and membranous. There seem to be no close relatives, although heavily sorediate specimens might be confused with *P. natalensis* Stein. & Zahlbr., a maculate species with distinct laminal soredia.

Additional specimens examined:

KENYA: NYANZA: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 11160 (L). UNION OF SOUTH AFRICA: NATAL: South of Nkandhla, Nkandhla, *Almborn* 8069 (LD); along "Mountain Road," Cathedral Peak Area, Bergville, *Almborn* 9375 (LD); Mgnalsheni, Pohla, *Höeg*, Oct. 9, 1929 (TRH); Pietermaritzburg, Umgeni, *Höeg*, Sept. 29, 1929 (TRH); Impendhla, *Höeg*, Oct. 8, 1929 (TRH); CAPE PROVINCE: Deepwells, Knysna, *Almborn* 10916 (LD), *Maas Geesteranus* 12163–12165, 12176 (L); Knysna, *Knobel*, Apr. 12, 1878 (BM); 6 mi. N. of Knysna, *Almborn* 2697 (LD); Grootvadersbosch, Swellendam, *Almborn* 2174 (LD); Tzitzikama Mtns., *Maas Geesteranus* 6624 pr. p. (L); Grahamstown, Albany, *Höeg*, December 1929 (TRH); Fern Kloof, Albany, *Almborn* 10734, 10739 (LD); Skeleton Stream, east slopes of Table Mountain, Wynberg, *Almborn* 11158, 11161 (LD); near upper Cableway Station, Table Mountain, *Almborn* 1731, 1733, 1892, 1897 (LD); Table Mountain, *Arnell* 1009 (LD); Jonkershoek, Stellenbosch, *Almborn* 1968, 11397, 11401 (LD).

73. Parmelia sancti-angelii Lynge, Ark. Bot. 13, no. 13:35. 1914.

Parmelia pseudohyporysalea Asahina *in* Kihara, Faun. Fl. Nepal Himalaya 54, *fig. 19.* 1955[?]. Type collection: Downside of Katunje Bazar, Nepal, *Kihara* (TNS, lectotype).

Type collection: Colonia Santo Angelo, near Cachoeira, Rio Grande do Sul, Brazil, *Malme s.n.* (S, holotype).

Thallus large, 10–20 cm. in diameter, loosely attached, light mineral gray, rather coriaceous; lobes rotund, 8–15 mm. wide, margins entire to broadly crenate, often ascending, ciliate, cilia 2–4 mm. long,

sorediate, soralia linear, sorediate lobes often becoming involuted; upper surface dull, continuous to finely cracked with age, rarely sorediate submarginally; medulla white, frequently orange red near the lower cortex; lower side black and sparsely rhizinate, light brown to mottled ivory and naked in a broad zone along the margins. Apothecia rare, more or less adnate, disc imperforate; hymenium 65 μ high; spores 7–10×13–18 μ, episporium 1 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, pigmented medulla K+ purple, atranorine, gyrophoric acid, and (if pigmented) rhodophyscin present.

Parmelia sancti-angelii is a very common pantropical, corticolous or less commonly saxicolous species which, surprisingly, has only one synonym. Rhodophyscin occurs in about half of the specimens, including the type of *P. pseudohyporysalea* but not the type of *P. sancti-angelii*. *Parmelia rampoddensis* Nyl. is externally very similar but contains alectoronic acid (C−, KC+). *Parmelia permutata* Stirt. has a different K− pigment. These three species are closely related and chemical tests are sometimes necessary for certain identification.

Additional specimens examined:

MEXICO: Hidalgo: Huasco, near Pachuca, *Wood* s.n. (F); Veracruz: Mirador, *Sartorius* s.n. (M), *Purpus* 215 (US); 9 km. east of Jalapa, *Hale* 19433 (S, TNS, US), 21109 (US); northeast of Huatusco, *Hale* 19505 (DUKE, MSC, REN, US); Puebla: Xuchitl, *Arsène* 8236 (US); Michoacán: Morelia, *Arsène* 4460 (US). GUATEMALA: Hotel Tzanjuyu, Panajachel, *Gay* s.n. (F). COSTA RICA: Río Torres, *Pittier* 5051 (M); vicinity of Cartago, *Standley* 35468 (US).

HAITI: Citadel la Ferriore, *Thomas* 47 (MO, NY, US); between Petionville and Ft. Jacques, *Thomas* 36c (NY, US). DOMINICAN REPUBLIC: Guama, Santiago, *Wetmore* 3904 (MSC, US); vicinity of Constanza, La Vega, *Imshaug* 23318 (MSC, US), *Allard* 16543 (US); north side of Constanza, Cordillera Central, *Imshaug* 23721 (MSC, US). JAMAICA: Without locality, *Cummings* 38 (NY).

VENEZUELA: Miranda: Corrada del Guayado, *Dennis* 1565 (K); Los Chorros, *Dennis* 1524A (K); Mérida: El Valle, *Mägdefrau* 584 (M). COLOMBIA: Cauca: La Capilla, *Killip* 38483 (US). CHILE: Cautín: Pucon, *Gunckel* 18119 (MO). BRAZIL: Mato Grosso: Santa Anna da Chapada, *Sladen* 321 (BM); São Paulo: Piquete, *Robert* s.n. (BM); Santa Albertina, *Hemmendorff* s.n. (S). ARGENTINA: Misiones: San Ignacio, *Oniroga* K54 bis (S).

CONGO: Yangambi, Luweo Plateau, *Louis* 8155 p.p. (BR). KENYA: Rift Valley Prov.: Eastern Mau Forest Reserve, *Maas Geesteranus* 11313 p.p. (L); Nyanza Prov.: Tinderet Forest Reserve, Kisumu-Londiani Distr., *Maas Geesteranus* 4956 p.p., 5532, 11160 (L). SOUTHERN RHODESIA: Zimbabwe, *Hõeg* s.n. (TRH). UNION OF SOUTH AFRICA: Natal: Boschfontein Forest, Lions River Distr., *Almborn* 8701 (LD). MADAGASCAR: Tananarive, *des Abbayes* s.n. (REN, US); 30 km. north of Ankazoba, *des Abbayes* s.n. (REN, US).

SIKKIM: Yokusam, *Hara et al.* s.n. (TNS, US). INDIA: Darjeeling, *Hara et al.* s.n. (TNS, US). THAILAND: Doi Chieng Dao, *Tsuyama* 12 (TNS, US). LAOS: Ban Phu Phao, *Tsuyama* 8 (TNS,US); Hase Plantations, *Tsuyama* 9

(TNS, US). SUMATRA: Raja Karohoogvlakte, *Lörzing* 7051 p.p. (BO); near Aer Batumbuk, *Groenhart* 8363 (BO); Pagar-alam, *Steup* 1024 (BO). CHINA: Kushan, near Foochow, Fukien, *Chung* F217 (FH, MICH). CELEBES: Rante Lemo, *Kjellberg* 33 (BO). JAVA: Mt. Gedeh, Tjibodas, *Groenhart* 8551 (BO).

74. Parmelia stuppea Tayl. London Journ. Bot. 6:175. 1847. PLATE 9

Parmelia perforata var. *claudelii* Harm. Bull. Soc. Sci. Nancy, n.s. 14: 223. 1896. Type collection: Docilles, France, *Claudel*, August 1890 (DUKE, holotype).

P. maxima Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:193. 1899. Type collection: Chimaleapan, near Lerma, Mexico, *Maury* 3318 (P, holotype).

P. claudelii (Harm.) Vain. Bot. Tidskr. 29:105. 1909.

P. trichotera Hue var. *claudelii* (Harm.) Du Rietz, Nyt Mag. Naturv. 62:77. 1924.

P. claudelii (Harm.) Tavares, Port. Acta Biol., ser. B, 1:152. 1945. Superfluous combination.

Type collection: Monterey, California, *Beechey* (FH-Tayl, holotype; BM, K, isotypes).

Thallus loosely attached to bark, 10–20 cm. in diameter, mineral gray; lobes rotund, 10–15 mm. wide, margins often ascending and suberect, sorediate, soralia terminal, linear, ciliate, cilia 2–3 mm. long; upper surface dull, continuous to cracked with age; lower side black and sparsely rhizinate, dark brown to brown and naked in a broad zone along the margins. Apothecia (known mostly from collections in western United States) very large, 10–30 mm. in diameter, stalked, disc perforate or rarely imperforate; hymenium 40–55 μ high; spores 6–9$\times$12–17 μ, episporium 1.0–1.5 μ thick; pycnidia present, conidia 4–6 μ long.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia stuppea is represented by a very fragmentary type specimen from California. Although badly decomposed, it has marginal soredia, a few cilia, and salacinic acid. It is thus similar to modern collections of a species that has been called *P. claudelii* in Europe or *P. trichotera* in North America. It is common in the mountains of North America, central America, and Europe, and more rarely in Africa and Asia (fig. 21). It is especially common on oak trees in dry forests. It intergrades with *P. cristifera* Tayl. in that a sterile specimen with sparse axial cilia could be identified as *P. stuppea* or as an abnormally ciliate form of *P. cristifera*. These two species in their typical forms are of course quite different in cilia and spore size. *Parmelia stuppea* may also be related to the Mexican species *P. eurysaca* Hue, which lacks soredia and has marginal laciniae.

Additional specimens examined:

U.S.: VERMONT: Scanlon Swamp, Leicester, *Dutton* 1620 (DUKE); MASSACHUSETTS: 5 mi. west of Blanchard, *Culberson* 4564 (DUKE); CONNECTICUT: 1 mi.

south of Colebrook, Litchfield Co., *Hale* 15406 (US); DELAWARE: Faulkland, *Commons* s.n. (PH); PENNSYLVANIA: 1 mi. east of Shunk, Sullivan Co., *Hale* 17442 (US); 2 mi. north of Red Rock, Luzerne Co., *Hale* 16160 (US); MARYLAND: 1 mi. east of Oldtown, Alleghany Co., *Hale* 14492 (US); WEST VIRGINIA: Clear Creek, Raleigh Co., *Hale* 11773 (US); Panther Knob, Pendleton Co., *Hale* 14302 (US); near Mace, Pocahontas Co., *Hale* 12482 (US); WISCONSIN: Park Falls, Price Co., *Culberson* 1818 (WIS); VIRGINIA: Mountain Lake Biological Station, Giles Co., *Hale* 18422 (US); Hawksbill Mountain, Madison Co., *Hale* 18884 (US); Hungry Mother State Park, Smyth Co., *Hale* 11931 (US); NORTH CAROLINA: 3 mi. north of Buckcreek Gap, McDowell Co., *Culberson* 4864 (DUKE); southeast of Rainbow Springs, Macon Co., *Anderson* 12911 (DUKE); near Waynesville, Haywood Co., *Standley* 5784 (US); TENNESSEE: Cliff Springs, Overton Co., *Phillips* 314 (US); CALIFORNIA: Pilarcitos Canyon, San Mateo Co., *Cain* 26381, 26384 (TRT, US); 2 mi. east of Pt. Reyes Station, Marin Co., *Koch* 393 (US); between Gilvey and Salinas, San Benito Co., *Herre* s.n. (US). MEXICO: VERACRUZ: 11 km. east of Las Vigas, *Hale* 21117 (US); PUEBLA: 69 km. east of Puebla, *Hale* 19327 (US); 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19611 (S, TNS, US); MEXICO: west of Río Frio, *Hale* 19281 (US); MICHOACÁN: 61 km. northwest of Zitácuaro, *Hale* 20838 (DUKE, MSC, REN, US); Cerro Azul, Morelia, *Arsène* 3996, 4016 (US); OAXACA: 53 km. northwest of Oaxaca, *Hale* 20814 (COLO, US); Cerro San Felipe, *Hale* 20694 (LISU, S, TNS, US); CHIAPAS: 14 km. west of San Cristóbal, *Hale* 20543 (MSC, REN, US). GUATEMALA: HUEHUETENANGO: Cumbre de la Sierra de los Cuchumatanes, *Standley* 81167 (MO). COSTA RICA: SAN JOSÉ: Santa Maria de Dota, *Standley* 43176 (US).

GERMANY: Munich, *Arnold, Lich. Exs.* 145 (MICH); Stuttgart, Wurttemberg, *Putzler* s.n. (LD). PORTUGAL: Serra de Sintra, Estremadura, *Tavares* 4783 (US); Serra do Bucaco, Beira Litoral, *Tavares* 23 (H).

UNION OF SOUTH AFRICA: NATAL: Eschowe, south of Solheim, *Höeg* s.n. (TRH). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH).

INDIA: Shembaganur, Madurai Distr., *Awasthi* 4345 (AWAS).

75. Parmelia subarnoldii des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:113. 1961.

Type collection: Forêt de Manjakatompo, Ankaratra, Centre Nord, Madagascar, *des Abbayes* (REN, lectotype; US, isotype).

Thallus loosely adnate, 8–12 cm. across, mineral gray; lobes rotund, 7–10 mm. wide, margins often ascending, rather conspicuously ciliate, cilia 3–6 mm. long, sorediate, soralia, terminal, linear, sorediate lobes sinuous; upper surface plane, shiny, continuous; lower side black, sparsely rhizinate, brown, shiny, and naked in a broad zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

Parmelia subarnoldii is a rare pantropical species. Externally it is very close to *P. sancti-angelii* Lynge but differs significantly in chemistry. It has no relation to *P. arnoldii* Du Rietz, a temperate species with distinct sublaminal soredia. Extreme ciliate forms of *P. dilatata* Vainio, such as occur in the West Indies, are virtually identical with *P. subarnoldii* except that the soredia are coarse and irregular and the cilia erratically produced.

Additional specimens examined:

MEXICO: CHIAPAS: 50 km. west of Tuxtla Gutiérrez, *Hale* 19904 (US), 19935 (DUKE, REN, S, US).

BRAZIL: SÃO PAULO: Santa Albertina, *Hemmendorff*, July 3, 1898 (S).

MADAGASCAR: Manjakatompo, Centre Moyen, *Benoist* 1355 (LD).

NEW GUINEA: Mt. Arfak, Angi Gita Lake, *Kostermanns* 3012 (BO). JAVA: Tjinnivrang, *Ogata* 1001 (TNS).

76. Parmelia subcorallina Hale, Journ. Jap. Bot. 37:345, *fig.* 1. 1962.

P. proboscidea var. *corallina* Müll. Arg. Flora 67:616. 1884 (p.p.).

Type collection: Keitau, Taichu, Formosa, *Asahina* 3312 (TNS, holotype; US, isotype).

Thallus loosely adnate, 10–15 cm. in diameter, mineral gray; lobes rotund, 8–15 mm. wide, margins entire or subcrenate, in part isidiate-dissected, ciliate, cilia 1.5–3.0 mm. long; upper surface plane, continuous or reticulately cracked with age, faintly white-maculate, toward the margins moderately granulate-isidiate or isidiate, isidia cylindrical to inflated, simple or irregularly branched, 0.08–0.1 mm. in diameter, to 0.2 mm. high, often apically ciliate; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia not seen; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine, protocetraric acid, and protolichesteric acid present.

Parmelia subcorallina is distinguished by the chemistry and by the usually granular isidia, in part close to those of *P. mellissii* Dodge. Since the publication of this species, two additional records from Java have been found. It is apparently endemic to Asia and the Madagascar region. The photograph in my original publication is enlarged two times.

Additional specimens examined:

JAVA: Tjibodas, *Meijer* 8928 (BO), *van Woerden* 2192 (BO).

MAURITIUS: *Robillard* s.n. (G). SÃO TOMÉ: *Moller* 70 pp. (H).

77. Parmelia subcrinita Nyl. Lich. Japon. 26. 1890.

Type collection: Hirosaki, Japan, *Almquist* (H, Nyl. herb. no. 35479, neotype).

Thallus loosely adnate, 10–20 cm. broad, mineral gray; lobes rotund, 6–12 mm. wide, margins crenate, ciliate, cilia 1–2 mm. long; upper surface plane dull to shiny, at times faintly white-maculate, becoming white-pruinose towards the tips, reticulately cracked in older parts, moderately isidiate, isidia cylindrical, simple to coralloid-branched, to 0.08 mm. in diameter and 0.3 mm. high, often ciliate apically; lower side jet black and rhizinate, dark brown, shiny, and naked in a broad zone at the margins. Apothecia rather rare, 3–6

mm. in diameter, disc imperforate; hymenium 65–75 μ high; spores 8–10×12–14 μ, episporium 1 μ thick; pycnidia rare, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

The typification of *P. subcrinita* has presented some problems. Nylander cited a collection by Almquist from Shimonoseki, Japan, in his original description. This collection could not be found at Helsinki or Stockholm. We have therefore selected as a neotype another specimen from Japan identified in Nylander's handwriting. *Parmelia subcrinita* is easily separated from *P. crinita* Ach. by chemical tests as well as by the smaller spore size, coarser cilia, and the more robust thallus. The upper cortex may be faintly maculate, as in the neotype, dull and opaque, or even pruinose. Reticulate fissuring with age may be pronounced. Another isidiate species with similar range and chemistry is *P. subtinctoria* Zahlbr., a species typically with distinct maculae and a uniformly pale lower side, or if darkened, short rhizines or papillae to the margin below.

Additional specimens examined:

U.S.: West Virginia: 3 mi. southwest of Jordan Run, Grant Co., *Hale* 14997 (US); Wisconsin: Flambeau River State Forest, Sawyer Co., *Hale* 2053 (WIS); Virginia: 6 mi. east of Wallaceton, Norfolk Co., *Ireland* 4177 (US); Little Stony Man Cliffs, Page Co., *Hale* 15177 (US); North Carolina: 10 mi. east of Fayetteville, Cumberland Co., *Hale* 17507 (US); 3 mi. north of Silver Valley, Davidson Co., *Culberson* 6446 (DUKE, US); 4 mi. east of Hayesville, Clay Co., *Culberson* 5299 (DUKE); South Carolina: Near Hodges, Greenwood Co., *Culberson* 7457 (DUKE, US); Santee State Park, Orangeburg Co., *Hale* 16494 (US); 12 mi. southwest of Andrews, Georgetown Co., *Hale* 16555 (US); Tennessee: Cliff Springs, Overton Co., *Phillips* s.n. (US); Georgia: Near McRac, Telfair Co., *Hale* 7573 (US); Toccoa, Stephens Co., *Culberson* 7346 (DUKE); Alabama: 15 mi. southeast of Birmingham, Shelby Co., *McCullough* 346 (US); Cheaha State Park, Cleburne Co., *Hale* 7086 (US); 2 mi. west of Cedar Cove, Tuscaloosa Co., *McCullough* 404 (US); Florida: 1 mi. east of Monticello, Jefferson Co., *Hale* 16461 (US); Sanford, Seminole Co., *Rapp* 495 (FLAS); Suwanee River State Park, Suwanee Co., *Hale* 17650 (US); Mississippi: Near Morton, Scott Co., *Hale* 7923 (US); near Durant, Holmes Co., *Hale* 7892 (US); near Tupelo, Lee Co., *Hale* 7830 (US); Arkansas: Near Hollis, Perry Co., *Hale* 3129 (US); Buffalo River Park, Marion Co., *Hale* 4483 (US); Oklahoma: Near Broken Bow, *Hale* 4925 (US); near Ludlow, Le Flore Co., *Hale* 5044 (US). MEXICO: Veracruz: 15 km. south of Catemaco, *Hale* 19850 (US); Mirador, *Liebmann* 117 (UPS); Michoacán: Rincón, Morelia, *Arsène* 4407 (US); Colima: Isla Socorro, *Herrera* 17 (MSC); Oaxaca: Cuyamecalco, *Conzatti* 3496 (US); Chiapas: 8 km. east of Teopisca, *Hale* 20335 (S, US); Hacienda, *Matuda* s.n. (MICH). HONDURAS: Morazán: Above El Zamorano, *Standley* 336 (MO).

DOMINICAN REPUBLIC: Along Río Inoa, at Inoa, *Imshaug* 23861 (MSC, US). JAMAICA: Clydesdale, *Plitt* sn.. (BPI, US). MARTINIQUE: Caravelle, *Degelius* s.n. (DEGEL).

VENEZUELA: Northeast of Puerto Ayacucho, Orinoco, *Mägdefrau* 115 (M, US). COLOMBIA: Norte de Santander: La Cabuya, *Cuatrecasas*

12057 (US). ECUADOR: GALAPAGOS ISLANDS: Santa Maria Island, *Taylor* 868 (MICH). BRAZIL: BAHIA: Serra Chugue, *Luetzelburg* 408 (M); MINAS GERAIS: Caldas, *Regnell* s.n. (S).

AZORES: St. Jorge, *Persson* s.n. (UPS).

JAPAN: Nirayama, Prov. Idzu, *Asahina* 56105 (TNS, US), *Kurokawa* 58009 (TNS, US). JAVA: West Bantam, *Groenhart* 9740 (BO); Gegerbentang, *Neervoort* 1187 (BO). NEW CALEDONIA: Nepouis Valley, *Williams* 14 (BISH, US).

78. Parmelia sulphurata Nees & Flot. Linnaea 9:501. 1835.

Parmelia persulphurata Nyl. *in* Cromb. Journ. Linn. Soc. Lond. 16:219. 1877. Type collection: Bahia, Brazil, *Crombie* (BM, holotype).

P. brisbanensis Stirton, Trans. Proc. Roy. Soc. Victoria 17:69. 1881. Type collection: Brisbane, Queensland, Australia, *Bailey* 228 (BM, holotype; GLAM, isotype.)

Type collection: Cuba, *Wright* 72 (UPS, neotype; BM, FH, K, M, US, isotypes).

Thallus adnate to loosely attached to bark, 6–10 cm. in diameter, yellowish to turtle green; lobes rotund, 5–8 mm. wide, soon irregularly branched, margins entire to dissected, ciliate, cilia variable, 1–4 mm. long; upper surface plane, dull, reticulately cracked in older parts (with yellow medulla showing through), sparsely to densely isidiate, isidia cylindrical, simple to branched, 0.03–0.05 mm. in diameter, to 3 mm. high; medulla deep lemon yellow; lower side black and rhizinate at the center, naked and brown in a broad zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ more intensely yellow; medulla K−, C−, KC−, P−, atranorine and vulpinic acid present.

This species has been correctly identified by most lichenologists because of the brilliant lemon-yellow medulla. Nylander, however, consistently called it *P. persulphurata* Nyl. and identified specimens of *P. endosulphurea* (Hillm.) Hale as *P. sulphurata*. *Parmelia endosulphurea* has different yellow pigments and lacks cilia. The Pöppig type of *P. sulphurata*, destroyed at Berlin, had been seen earlier by Hillmann (1939), who was able to confirm that the current concept of the species is correct. I have therefore selected as a neotype a widely distributed exsiccate from the type locality. The species is very common in the Caribbean, though not nearly as common as *P. endosulphurea*, and occurs widely in other tropical areas (fig. 22).

Additional specimens examined:

U.S.: FLORIDA: 5 mi. south of Silver Glenn Springs, Marion Co., *Hale* 17579 (US); Eldorado, Lake Co., *Underwood* 2313 (FH); Sanford, Seminole Co., *Rapp, Merr. Lich Exs.* 76 (US); LOUISIANA: Grand Bayou, *Langlois* 42 (US). MEXICO: CAMPECHE: Tuxpeña, *Lundell* 1303 (F); YUCATÁN: Tizimin, *Swallen* 2538 (MICH). HONDURAS: COMAYAGUA: Comayagua, *Standley* 5829 (F). PANAMA: CANAL ZONE: Barro Colorado Island, *Scholander* s.n. (US).

CUBA: PINAR DEL RÍO: Northwest of Hotel San Vicente, *Imshaug* 25235 (MSC); San Diego de los Baños, *Earle* 275 (FH). DOMINICAN REPUBLIC: Consuelo, *Taylor* 152 (FH); north of San José de los Matas, *Welmore* 3878 (MSC); Piedra Blanca, La Vega, *Allard* 16856 (US).

FRENCH GUIANA: Belizon, River Combé, *Degelius* s.n. (DEGEL). SURINAM: Without locality, s.c. (G, M). VENEZUELA: Cerro Pavón, Río Atabapo, *Mägdefrau* 285 (M). PERU: LORETO: Santa María, *Allard* 22470 bis (US).

IVORY COAST: 5 km. north of Abidjan, *Santesson* 10325 (UPS); 6–7 km. north-northeast of Tai, cercle de Man, *Santesson* 10463b (UPS). CONGO: Luweo Plateau, Yangambi, *Louis* 8172 (BR). REPUBLIC OF CONGO: Subluali, Maiumbe, *Gossweiler* 8136 (BM).

SUMATRA: *Steup* s.n. (BO).

79. Parmelia wainii A. L. Smith, Journ. Linn. Soc. London, Bot. 46:85. 1922.

Parmelia proboscidea var. *ornatula* Zahlbr. Bull. Herb. Boiss., Ser. 2, 4:135. 1904. Type collection: Serra do Ouro Preto, Brazil, *Damazio* 1090 (W, holotype; G, isotype).

Type collection: Caraça, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 400 (TUR, Vain. herb. no. 2410, lectotype; BM, FH, K, M, UPS, isotypes).

Thallus adnate to loosely attached to bark, 5–15 cm. in diameter, mineral gray; lobes rotund, 8–12 mm. wide, margins smooth or irregularly digitate-lobulate and crowded in older parts, ciliate, cilia 2–5 mm. long; upper surface plane, dull, continuous or becoming reticulately cracked with age, isidia and soredia lacking; medulla white, rarely turning orange red near the lower cortex; lower side black, sparsely rhizinate, dark brown and naked or mottled tan in a broad zone along the margins. Apothecia common, stipitate, to 10 mm. in diameter, exciple entire to short-dentate, ciliate, amphithecium rugose, white-maculate, disc imperforate; hymenium 75–90 μ high; spores 6–10$\times$17–22 μ, the episporium 1.5–2.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, pigmented medulla K+ purple, atranorine, alectoronic acid, and (if pigmented) rhodophyscin present.

A. L. Smith was familiar with *P. proboscidea* Tayl., a synonym of *P. crinita* Ach., because of her work in British lichens. When she saw Vainio's erroneous determinations of nonisidiate South American plants as *P. proboscidea*, she proposed a new name, *P. wainii*, for his misidentified material. *Parmelia wainii* is characterized by large rugose ciliate apothecia and conspicuously ciliate lobes. *Parmelia subrugata* Krempl. differs in having large spores, shorter cilia, and more richly branched, laciniate lobes. *Parmelia argentina* Krempl. differs in having a white rim below and more or less distinct maculae. *Parmelia wainii* is not common but has a characteristic South American-South African distribution pattern.

Additional specimens examined:

BRAZIL: MINAS GERAIS: Sitio, *Vainio, Lich. Bras. Exs.* 582b (TUR). NIGERIA: Basse, *Dusén, Almb. Lich. Afr.* 31 (H, LD, UPS, US). CONGO: Crete de Mvakala, *Devred* 1368 (BR). MOÇAMBIQUE: Lourenço Marques, *Junoa* 472 (PRE). UNION OF SOUTH AFRICA: NATAL: Ngoma, *Höeg* s.n. (TRH).

Subsection *Ornaticolae* Gyel. (1932, p. 225)

Thallus loosely adnate to suberect, 5–30 cm. in diameter; lobes broad, 5–20 mm. wide, the margins ciliate; upper cortex distinctly maculate; lower side brown or black with a brown or white marginal zone.

Type species: *Parmelia perforata* (Jacq.) Ach.

This subsection may be divided into two series: *Subpallidae*, the thallus with a pale entirely rhizinate lower side, and *Ornaticolae*, with a black center.

Series *Subpallidae*, ser. nov.

Thallus subtus ex toto pallidus, breve rhizinosus usque ad marginem, ceterum ut in subsectione *Ornaticolae*.

Type species: *P. subsumpta* Nyl.

This series of only three species seems to be unrelated to any other group in subgenus *Amphigymnia*. The species are closely related and appear to present a sorediate-isidiate-NIS series with a parallel development of chemical strains.

80. Parmelia subcaperata Krempih. Nat. For. Kjoeb. Vid. Medd. 1873: 10. 1873. PLATE 12

Parmelia erubescens Stirton, Scot. Nat. 4:201. 1877–78. Type collection: Near Brisbane, Australia, *Bailey* (BM, holotype).

Parmelia recipienda Nyl. Flora 68:609. 1885. Type collection: Brazil, s.c. (H, Nyl. herb. no. 35212, holotype).

Parmelia imperforata Nyl. Acta Soc. Sci. Fenn. 26, no. 10:7. 1899. Type collection: Brazil, *Glaziou* 1839 (H, Nyl. herb. no. 35425, holotype).

Parmelia annae Lynge, Ark. Bot. 13, no. 13:88, *pl. 2, fig. 6*. 1914. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2368B (S, lectotype).

P. ceracea Lynge, Ark. Bot. 13, no. 13:97. 1914. Type collection: Pilcomayo, Gran Chaco, Paraguay, *Malme*, Sept. 7, 1893 (S, lectotype).

Type collection: Lagoa Santa, Serra da Piedade, Brazil, *Warming* 297 (M, holotype).

Thallus loosely attached, 5–12 cm. in diameter, turning buff in the herbarium; lobes rotund, 7–15 mm. wide, margins crenate, ciliate, cilia 1.0–3.0 mm. long, often branched; upper surface plane, shiny, strongly white-maculate, becoming cracked with age; lower side uniformly pale tan or darkening toward the center, densely short rhizinate to the margins. Apothecia abundant, to 30 mm. in diameter, stalked, disc perforate; hymenium 55–65 μ high; spores 6–10$\times$12–19

μ, episporium 1.0–1.5 μ thick; pycnidia abundant, conidia 10–13 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present; or K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia subcaperata is characterized by the strongly maculate upper cortex, short rhizinate pale lower side, and the lack of soredia or isidia. It has the same chemical variation as *P. subsumpta* Nyl., a sorediate counterpart, but the distribution is more restricted. The types of *P. recipienda*, *P. annae*, and *P. ceracea* contain cryptochlorophaeic and protolichesteric acids, while the remaining types listed above all contain salacinic acid. Except for a single collection in Australia, the species is known only from South America.

Additional specimens examined:

Salacinic acid present:

BRAZIL: Minas Gerais: Sitio, *Vainio, Lich. Bras. Exs.* 737 (TUR, UPS); Retiro, Itatiaia, *Dusén, Lich. Austroamer.* 82, 86 (H, LD, MSC, S, US); Carangola, *Mexia* 4322 (MO, US); Lagoa Santa, *Warming* 313 (M); Serra dos Orgãnos, *Ainsworth & Gregory* 553 (BM); Rio de Janerio: Rio de Janeiro, *Glaziou* 1843, 2001 (M), *Malme* 372 (S), *Fry* s.n. (BM); São Paulo: Piquete, *Robert* s.n. (BM); Rio Grande do Sul: Pareci Nova, *Lima* 48 (MO).

Cryptochlorophaeic acid present:

BRAZIL: Minas Gerais: Caldas, *Henschen* s.n. (UPS); São Paulo: Piquete, *Robert* s.n. (BM). PARAGUAY: Asunción, *Malme* 1678 * * * (S); Pilcomayo, Gran Chaco, *Malme* s.n. (MO). ARGENTINA: Jujuy: Quinta, *Fries* 27 p.p. (S); Salta: Urundel, Orán, *Grassi* 594 (MO); Formosa: Las Lomitas, *Pierotti* 2896 (MO).

81. Parmelia subsumpta Nyl. Flora 52:117. 1869. Plate 12

Parmelia urceolata Eschw. var. *nuda* Müll. Arg. Flora 63:266. 1880. Type collection: Petropolis, Brazil, *Deventer* 33 (G, holotype).

P. hypotropa var. *imperialis* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:189. 1899. Type collection: Brazil, *S.M. Theresa Christina*, 1887 (P, holotype).

P. petropoliensis Zahlbr. Sitzungsber. Akad. Wiss. Wien Math. Naturw. 111:426. 1902. Type collection: Petropolis, Brazil, *Höhnel* 177 (W, holotype).

P. corrugis (Fr.) Müll. Arg. var. *imperialis* (Hue) Zahlbr. Cat. Lich. Univ. 6:236. 1929.

P. leucoxantha Müll. Arg. f. *firma* Ceng.-Samb. Annali Bot. 22, no. 1:18. 1939. Type collection: Serra dos Orgãos, Rio de Janeiro, Brazil, *Casaretti* 2444 (RO, holotype).

Type collection: Minas Gerais, Brazil, *Glaziou* s.n. (H, Nyl. herb. no. 35451, holotype).

Thallus loosely adnate to bark, up to 15 cm. broad, rather coriaceous, mineral gray turning buff in the herbarium; lobes rotund, 10–12 mm. wide, margins often ascending, subcrenate, sorediate, soralia elongate,

in older specimens becoming crescent-shaped, sorediate lobes involute, ciliate, cilia 1.0–1.5 mm. long; upper surface plane, shiny, strongly white-maculate, reticulately cracked with age; lower side uniformly pale to dark brown, rarely blackening, densely short rhizinate to the margin or with a narrow papillate zone along the margins. Apothecia rare, 10–13 mm. in diameter, stalked, amphithecium rugose, white-maculate, sorediate, disc imperforate; hymenium 65–75 μ high; spores 7–10×12–15 μ, episporium 1.0–1.5 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present; or medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present.

Parmelia subsumpta is a widespread corticolous species in tropical America and Africa. The distinguishing features are the strongly maculate upper cortex and short rhizinate, pale lower side. The soralia are linear and terminal but often enlarge and may become involute or even crescent-shaped, as in the holotype of *P. subsumpta*. The lower side may blacken somewhat so as to resemble *P. leucosemotheta* Hue, which has a broad naked zone below. There are at least two chemical strains in *P. subsumpta*. The most common by far (including all the types listed) contains salacinic acid, rarely with traces of usnic acid. The second strain with protolichesteric and cryptochlorophaeic acids occurs in Nebraska, Brazil, and Peru. Since there is similar chemical variation in other species in this series, we hesitate to recognize two separate species.

Additional specimens examined:

Salacinic acid present:

U.S.: GEORGIA: Vogel State Park, Union Co., *Hale* 7325 (US). MEXICO: PUEBLA: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19653 (US); OAXACA: 32 mi. northwest of Oaxaca, *Cain* 27566d (TRT, US); CHIAPAS: 14 km. west of San Cristóbal, *Hale* 20568 (TNS, US); south of Teopisca, *Hale* 20509 (DUKE, US); El Sumidero Canyon, Tuxtla Gutiérrez, *Hale* 21044 (US); 50 km. west of Tuxtla Gutiérrez, *Hale* 19957 (US). GUATEMALA: HUEHUETENANGO: Río Pucal, *Standley* 82404 (MO); BAJA VERAPAZ: Above Santa Rosa, *Standley* 91074 (MO). PANAMA: CHIRIQUÍ: Llano del Volcano, *Scholander* s.n. (MO, US).

VENEZUELA: Avila, *Vogl* s.n. (M). BRAZIL: MINAS GERAIS: Lagoa Santa, *Warming* 307 (M); SÃO PAULO: São Paulo, *Hoehne* s.n. (M); RIO GRANDE DO SUL: Near Cachoeira, Santo Angelo, *Malme* 908 (S). ARGENTINA: Without locality, *Lorentz & Hieronymus* (M).

CONGO: Biano, *Smitz* 3884 (BR). KENYA: Tinderet Forest Reserve, Kisumu-Londiani Distr., *Maas Geesteranus* 11120 (LD, L). UNION OF SOUTH AFRICA: TRANSVAAL: Northeast of Haenertsburg, *Kapp* 1773 (PRE); NATAL: Polela Forest, Polela, *Almborn* 9506 (LD); CAPE PROVINCE: 6 mi. from Knysna, *Almborn* 2618 (LD).

Cryptochlorophaeic and protolichesteric acids present:

U.S.: NEBRASKA: Sandhills, Nebraska National Forest, *Henzlik* s.n. (MSC). PERU: CUZCO: Urubamba, *Vargas* 7274 (MICH, US). BRAZIL: SANTA CATARINA: Rio dos Bugres, Caçador, *Reitz* 13215 (US).

82. Parmelia subtinctoria Zahlbr. Symb. Sin. 3:193. 1930. PLATES 2, 12

Parmelia proboscidea var. *aspera* Müll. Arg. Flora 69:258. 1886. Type collection: Caracas, Venezuela, *Ernst* 71 (G, lectotype).

P. virens f. *isidiosa* Müll. Arg. Ann. Nat. Hofmus. Wien 7:303. 1892. Type collection: Toowoomba, Qucensland, *Hartmann* 58 (G, holotype; W, isotype).

P. leucosemotheta Hue f. *isidiata* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:192. 1899. Type collection: Ohio, U.S.A., *Lesquereux* 262 (P, holotype).

P. velutina Zahlbr. Ann. Crypt. Exot. 1:206. 1928. Type collection: Mt. Tjibodas, Java, *van Overeem* 89 (W, holotype) [non P. *velutina* (Ach.) Wallr. Fl. Crypt. Germ. 3:552. 1831].

P. protovirens Gyel. Repert. Sp. Nov. Fedde 29:289. 1931. Based on *P. virens* f. *isidiosa* Müll. Arg.

P. haitiensis Hale, Bryol. 62:20, *fig. 2*. 1959. Type collection: Blue Mountains, Jamaica, *Orcutt* 2987 (US, holotype).

Type collection: Sanyingpan, north of Yunnanfu, Yunnan, China, *Handel-Mazzetti* 5645 (WU, holotype).

Thallus adnate to loosely attached, 5–10 cm. in diameter, mineral gray but soon turning buff in the herbarium; lobes rotund, 10–15 mm. wide, margins crenate, sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface plane, shiny, distinctly white-maculate, irregularly cracked with age, moderately to densely isidiate, isidia cylindrical, simple to branched, 0.04–0.07 mm. in diameter, to 1.0 mm. high, rarely ciliate apically; lower side uniformly pale brown, rarely darkening at the center, densely short rhizinate to the margin or with a narrow naked or papillate zone along the margins. Apothecia rare, 5–8 mm. in diameter, amphithecium isidiate, disc imperforate; hymenium 40–60 μ high; spores 5–8×8–11 μ, episporium 1 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C− KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present; or medulla K+ yellow turning red, P+ pale orange red, atranorine and salacinic acid sometimes mixed with protolichesteric acid.

Parmelia subtinctoria is a widespread pantropical species (fig. 24) usually found in herbaria under the names *P. crinita* Ach. or *P. subcrinita* Nyl. *Parmelia crinita* differs in lack of maculae, large spores, black lower side, and the presence of stictic acid. *Parmelia subcrinita* lacks distinct maculae and has a black lower side. The chemical variation presents an interesting pattern. All specimens from the Americas that have been tested (about 50) contain only

salacinic acid or cryptochlorophaeic acid and protolichesteric acid. Those from Asia, including the holotypes of *P. subtinctoria* and *P. velutina*, contain a mixture of salacinic, cryptochlorophaeic, and protolichesteric acids. *Parmelia haitiensis* (and *P. proboscidea* var. *aspera*) contains cryptochlorophaeic and protolichesteric acids and represents the type of the K−, KC+ strain. These variants can be considered as no more than chemical strains at this time.

Additional specimens examined:

Salacinic acid present (with or without protolichesteric):

U.S.: WEST VIRGINIA: 2 mi. north of Brandywine, Pendleton Co., *Hale* 18543 (US); 3 mi. northeast of Alvon, Greenbrier Co., *Hale* 16649 (US); near Huttonsville, Randolph Co., *Hale* 12493 (US); KENTUCKY: Near Oil Valley, Wayne Co., *Hale* 13360 (US); near Forest Cottage, Cumberland Co., *Hale* 13723 (US); Pennyrile State Forest, Christian Co., *Hale* 13217 (US); ILLINOIS: Cadiz, Hardin Co., *Hale* 13947 (US); IOWA: Fayette Co., *Fink* s.n. (US); MISSOURI: Near Radical, Stone Co., *Hale* 2549 (US); Aurora, Lawrence Co., *Hale* 2516 (US); Hartville, Wright Co., *Hale* 4290 (US); VIRGINIA: Mile 102, Blue Ridge Parkway, Bedford Co., *Hale* 19176 (US); Signal Knob Overlook, Warren Co., *Hale* 14844 (US); near Bane, Giles Co., *Hale* 12754 (US); NORTH CAROLINA: Near Bynum, Chatham Co., *Culberson, Vězda Lich. Sel. Exs.* 70 (H, LD, US); near Oxford, Granville Co., *Culberson* 6520 (DUKE, US); 11 mi. north of Burlington, Alamance Co., *Hale* 16364 (US); TENNESSEE: Cliff Springs, Overton Co., *Phillips* s.n. (US); Backbone Mountain Recreation Area, Johnson Co., *Hale* 18391a (US); GEORGIA: Near Cleveland, White Co., *Hale* 7457 (US); ALABAMA: Pell City, St. Clair Co., *Hale* 7235 (US); 15 mi. southwest of Rockford, Coosa Co., *McCullough* 1025 (US); FLORIDA: Sanford, Seminole Co., *Rapp* s.n. (FLAS, US); MISSISSIPPI: Holly Springs, Marshall Co., *Hale* 7841 (US); LOUISIANA: Near Shreveport, Caddo Parish, *Hale* 5620 (US); ARKANSAS: 8 mi. south of Hollis, Perry Co., *Hale* 3095 (US); Crystal Springs, Garland Co., *Hale* 3050 (US); Danville, Yell Co., *Hale* 3734 (US); Black Springs, Montgomery Co., *Hale* 3896 (US); OKLAHOMA: Beaver Bend State Park, McCurtain Co., *Hale* 4929 (US); north of Sallisaw, Sequoyah Co., *Hale* 5030 (US); TEXAS: Near Milano, Milam Co., *Hale* 5471 (US); near Avinger, Cass Co., *Hale* 5265 (US); KANSAS: Batesville, Woodson Co., *Hale* 4676 (US); near Coyville, Wilson Co., *Hale* 4728 (US); ARIZONA: Cave Creek, Chiricahua Mountains, Cochise Co., *Weber* 8787 (COLO, US). MEXICO: HIDALGO: Jacala, *Chase* 7431 (F, US); VERACRUZ: 15 km. south of Catemaco, *Hale* 19859 (US); PUEBLA: 3 km. west of Puebla-Veracruz state line, on highway 150, *Hale* 21043 (US); MEXICO: North of Acambay, *Cain* 27593 (TRT, US); MICHOACAN: 61 km. northwest of Zitácuaro, *Hale* 20862 (MSC, US); OAXACA: 132 km. northwest of Oaxaca on highway 190, *Hale* 20826 (DUKE, MSC, REN, S, TNS, US); CHIAPAS: El Sumidero, Tuxtla Gutiérrez, *Hale* 20013 (US), south of Teopisca, *Hale* 20503 (COLO, US). GUATEMALA: Ciudad Vieja, *Tejada* s.n. (FH, US). HONDURAS: COMAYAGUA: Siguatepeque, *Standley* 6355 (F).

CUBA: ORIENTE: Slope of El Gato, Loma del Gato, *Imshaug* 24746, 24798 (MSC). HAITI: Eastern end of Montagne Noire, *Imshaug* 22529 (MSC).

PARAGUAY: Río Apa, Colonia Risso, *Malme* s.n. (S).

KENYA: RIFT VALLEY PROV.: Cherangani, *Maas Geesteranus* 4711 (L); NYANZA PROV.: Londiani, Kisumu-Londiani, *Maas Geesteranus* 10935 (L); Tinderet Forest Reserve, *Maas Geesteranus* 11091 (LD, L). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH), *Sim* s.n. (BM). SWAZILAND:

Piggs Peak, *Almborn* 7902 (LD). UNION OF SOUTH AFRICA: TRANSVAAL: Punch Bowl Inn, north of Louis Trichardt, *Almborn* 6431 (LD, US); Houtbosch, Pietersburg, *Almborn* 6767 (LD); NATAL: Boschfontein Forest, Lions River Distr., *Almborn* 8712 (LD); Indumeni Forest, Cathedral Peak Area, *Almborn* 8874 (LD); Natal Table Mountain, *Almborn* 8577 (LD); Emmersdale, Estcourt, *Höeg* s.n. (TRH); CAPE PROVINCE: Matatiele, *Höeg* s.n. (TRH); northern part of Swellendam, *Almborn* 2155 (LD); Stormsrivier, Humansdorp, *Almborn* 4127 (LD, US); Keurboomsrivier, *Almborn* 2945 (LD); Parks Station, Knysna, *Arnell* 1500a (LD); 3 mi. east of Hermanus, Caledon, *Almborn* 5727 (LD).

INDIA: On way to Kasardeir, Almora Distr., *Awasthi* 3449 (AWAS). CHINA: Near Foochow, Kushan, Fukien, *Chung* F455 (FH). JAPAN: Honryu Temple, Nirayama, Prov. Idu, *Kurokawa* 58008 (TNS, US); Mt. Yatsugadake, Prov. Shinano, *Asahina* s.n. (TNS, US).

SUMATRA: Panprama Tabat Patah, *Groenhart* 9214 (BO). JAVA: Mt. Gedeh, *van Overeem* s.n. (MICH); Tjibodas, *van Woerden* 5493 (BO); Treanger, *Bakhuizen* 1518 (BO).

Cryptochlorophaeic and protolichesteric acids present (without salacinic acid):

U.S.: VIRGINIA: Brokenburg, Spotsylvania Co., *Hale* 15709 (US); NORTH CAROLINA: Darden, Martin Co., *Culberson* 6561 (DUKE); near Red Springs, Robeson Co., *Culberson* 7627 (DUKE); MISSISSIPPI: Near Aderman, Choctaw Co., *Hale* 7802a (US); ARKANSAS: Cove Lake, Logan Co., *Hale* 3452 (US); MEXICO: VERACRUZ: Northeast of Huatusco, *Hale* 19478 (US); PUEBLA: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19616 (US); CHIAPAS: 50 km. west of Tuxtla Gutiérrez, *Hale* 19921 (US).

HAITI: Summit of Montagne Noire, *Wetmore* 2722, (MSC), 2735 (MSC, US); near Boutillier, Morne Hospital, *Imshaug* 22514 (MSC). JAMAICA: Blue Mountains, *Orcutt* 2987 (US), *Imshaug* 14789 (MSC, US).

Additional records from the United States and the West Indies listed by Hale (1959a) as *P. haitiensis* are not repeated here.

Series *Ornaticolae*

Thallus black below in the center, the marginal rim commonly white or mottled, naked.

This is the most highly evolved group in subgenus *Amphigymnia*. Of the 23 species, only three, *P. hababiana*, *P. hypotropa*, and *P. subrugata*, may be considered pantropical. Sixteen of the species occur only in America or Africa or in both areas. There are two subgroups that may be recognized. One is characterized by a distinct white rim below along the margins and suberect lobes. It includes *P. abessinica*, *P. argentina*, *P. chiapensis*, *P. euneta*, *P. hababiana*, *P. hypotropa*, *P. melanothrix*, *P. paulensis*, *P. perforata*, *P. rigida*, *P. subrugata*, and *P. uruguensis*. Most of these species are centered in tropical America.

A second group has a dark marginal rim and more or less adnate lobes. It includes *P. cooperi*, *P. hanningtoniana*, *P. lobulascens*, *P. natalensis*, *P. nilgherrensis*, *P. pseudonilgherrensis*, *P. schimperi*, and *P. subcolorata*, all of which occur only in Africa or Asia.

The remaining species, *P. coralliformis*, *P. leucosemotheta*, and *P. reparata*, have very strong, almost effigurate maculae and occur chiefly in Mexico.

These three groups seem quite distinct, but relegating them to subseries would unnecessarily fragment the proposed subgeneric classification at this time.

83. Parmelia abessinica Krempelh. Linnaea 41: 140. 1877.

Parmelia glaucocarpa Müll. Arg. Flora 67: 615. 1884. Later homonym of *P. glacucocarpa* Ach. (=*Acarospora*). Type collection: Nossi-Bé, Madagascar, *Hildebrandt* 2150 (G, holotype; FH, FLAS, M, WU, isotypes).

P. abyssinica Nyl. Flora 68: 608. 1885. Superfluous name based on *P. abessinica* Krempelh.

P. hildebrandtii var. *ciliata* Müll. Arg. Bot. Jahrb. Engler 20: 255. 1894. Type collection: Marangu Station, Kilimanjaro, Tanganyika, *Volkens* 275 (G, lectotype; BM, isotype).

P. abyssenica [sic] var. *glabrior* Stein. & Zahlbr. Bot. Jahrb. Engler 60: 526. 1926. Type collection: Between Mazumbai and Mzinga, West Usambara, *Brunnthaler* s.n. (WU, holotype).

P. glaucocarpoides Zahlbr. Cat. Lich. Univ. 6:167. 1929. Based on *P. glaucocarpa* Müll. Arg., non Ach.

P. nigeriensis Dodge, Ann. Mo. Bot. Gard. 46: 156. 1959. Type collection: Mongu Forest Reserve, Panshin, Plateau Province, Nigeria, *Keay & King* 37096 (K, holotype).

Type collection: Ethiopia, *Hildebrandt* s.n. (M, holotype).

Thallus adnate to loosely attached, often ascending, to 10 cm. in diameter, mineral gray, turning olivaceous in the herbarium; lobes rotund, 6–10 mm. wide, margins subcrenate to more or less lobulate with age, sparsely to moderately ciliate, cilia 0.5–2.0 mm. long; upper surface smooth, more or less distinctly white-maculate, rugulose and cracked with age; lower side black and sparsely rhizinate, brown to ivory or mottled and naked in a broad zone along the margins. Apothecia common, stipitate, 5–13 mm. in diameter, amphithecium rugose, white-maculate, exciple variable, entire or dentate and ciliate, disc perforate; hymenium 70–80 μ high; spores variable, 9–12×18–23 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present; or medulla KC+ red, atranorine, protolichesteric acid, and cryptochlorophacic acid present.

Parmelia abessinica is the nonsorediate counterpart of *P. hababiana* Gyel. and has a similar geographical distribution and chemical variation, with two strains. The cryptochlorophaeic acid strain (including all types listed above except *P. glaucocarpa*) is less common but has a distribution similar to the protolichesteric acid strain. Spore size is intermediate and rather variable. The exciple is ciliate in less than half the specimens, and there is no apparent correlation of the

cilia with chemistry or distribution. *Parmelia abessinica* occurs on twigs and small branches of deciduous trees in open dry woods.

Additional specimens examined:

Cryptochlorophaeic and protolichesteric acids present:

MEXICO: Chiapas: El Zapotal, Tuxtla Gutiérrez, *Hale* 19990 (US). ETHIOPIA: North of Debra Marcos, Chokke Mountains, *Lythgoe* L46, L47 (K). CONGO: Southwest side of Lake Kivu, Mulungu, South Kivu, *Degelius* s.n. (DEGEL, US). ANGOLA: Bié: Chinguar, *Degelius* s.n. (DEGEL, US).

Protolichesteric acid alone present:

ETHIOPIA: Uoché, *Baldrati* s.n. (US). CONGO: Bangu, road to Thysville, *Compère* 1149 (BR, US); Mvakala Crater, *Devred* 1368 (BR); Lobito, *Quesyiere* 904 (BR); Lukuga Valley west of Albertville, *Höeg* s.n. (TRH). KENYA: Nyanza Prov.: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 4956 (L, LD). UGANDA: Mt. Eglon, *Small* J19 p.p. (K). ANGOLA: Huila: Quilengues, *Degelius* s.n. (DEGEL, US). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH). UNION OF SOUTH AFRICA: Transvaal: Mambelane, *Mogg* 2110 (PRE).

84. Parmelia aldabrensis Dodge, Ann. Mo. Bot. Gard. 46: 160. 1959.

Type collection: Aldabra Islands, *Fox* 220 (K, holotype).

Thallus adnate to bark, 4–8 cm. in diameter, buff mineral gray in herbarium; lobes rotund to irregular, 5–10 mm. wide, margins smooth to crenate and short dentate-laciniate, ciliate, cilia 0.5–2.5 mm. long; upper surface smooth, shiny, more or less coarsely white-maculate; lower side brown to dark brown, rarely blackening, coarsely rhizinate, pale brown and naked along the margins. Apothecia 2–10 mm. in diameter, short-stalked, amphithecium maculate, disc perforate; hymenium 50–70 μ high; spores 5–7×13–18 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning to red, C−, KC−, P+ orange yellow, atranorine and norstictic acid (sometimes mixed with stictic acid) present.

This is a peculiar species of somewhat doubtful status, although the three collections seen are rather uniform. It is very near *P. perforata* (Jacq.) Ach. in several respects: The strong maculation, perforate apothecia, small spores, and the presence of norstictic acid. It differs from *P. perforata* in size, being much smaller and more adnate, and in having a uniformly brown or darkening lower side, in contrast to the jet black center and white rim so characteristic of *P. perforata*. I believe these apparently consistent differences justify the recognition of *P. aldabrensis*.

Additional specimens examined:

TANGANYIKA: Wadiboma, *Fischer* 703 (BM, G). MADAGASCAR: Fort Dauphin, Vallée du Moyen Mandrare, *Decary*, Aug. 1, 1926 (LD).

85. Parmeli argentina Krempl h. Flora 61:476. 1878. PLATE 15

Parmelia urceolata var. *cladonioides* Müll. Arg. Flora 63:266. 1880. Type collection: Petropolis, Brazil, *Deventer* 35 (G, holotype).

P. melanothrix (Mont.) Vain. var. *argentina* (Krempl h.) Müll. Arg. Hedwigia 30:228. 1891.

P. macrocarpoides Vain. f. *phyllophora* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:177. 1899. Type collection: Brazil, *S. M. Theresa Christina,* 1889 (P, holotype).

P. laongii Lynge, Ark. Bot. 13, no. 13:68, *pl. 1, fig. 3.* 1914. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2392* (S, holotype).

P. melanothrix f. *microspora* Lynge, Ark. Bot. 13, no. 13:56. 1914. Type collection: Villa Morra, Asunción, Paraguay, *Malme* 1585C (S, lectotype).

P. subproboscidea Lynge, Ark. Bot. 13, no. 13:36. 1914. Type collection: Asunción, Paraguay, *Malme* 1678 (S, holotype).

P. subrugata var. *mexicana* Vain. Dansk Bot. Ark. 4, no. 11:5. 1926. Type collection: Consoquitla, Mexico, *Liebmann* 7562e (TUR, holotype).

Type collection: Argentina, *Lorentz & Hieronymus* (M, holotype; BM, H, S, W, isotypes).

Thallus to 10 cm. in diameter, loosely attached to suberect on bark, mineral gray, turning buff in the herbarium; lobes rotund, broad, 7–12 mm. wide, margins entire to crenate and dissected, ciliate, cilia 1.5–3.0 mm. long, K−, or K+ violet; upper surface plane, shiny, more or less distinctly white-maculate, soredia and isidia lacking; lower side black and sparsely rhizinate at the center, sharply delimited from a buff to ivory, naked, rugose zone along the margins. Apothecia common, stalked, 5–10 mm. in diameter, exciple short-dentate and ciliate, amphithecium maculate, disc imperforate; hymenium 50–70 μ high; spores 6–12×11–22 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia 5–7 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ orange red, P−, atranorine and alectoronic acid present.

Parmelia argentina is characterized by distinct maculae, imperforate, often ciliate apothecia, and a distinct pale or white zone below at the margin. The cilia may react K+ violet, as in the type specimens of *P. laongii* and *P. subproboscidea,* but this reaction is variable and apparently of no taxonomic significance. My preliminary key to the group (Hale, 1960) illustrates the futility of separating species on cilia reaction or minor variation in spore size. *Parmelia argentina* could be confused with *P. rigida* Lynge and *P. chiapensis* Hale, both of which have perforate apothecia, with *P. subrugata* Krempl h., which has large spores, or even with *P. melanothrix* (Mont.) Vain., which has protolichesteric acid and large spores.

Additional specimens examined:

MEXICO: CHIAPAS: El Zapotal, near Tuxtla Gutiérrez, *Hale* 19991, 20005 (US); El Sumidero, near Tuxtla Gutiérrez, *Hale* 20061 (US). HONDURAS: COMAYAGUA: Vicinity of Comayagua, *Standley & Chacón* 5925 (F, US); EL PARAÍSO: Vicinity of Galeras, *Standley et al.* 1969 (F, US).

VENEZUELA: Lara: Barquisimeto, *Saer* 44 (US). BRAZIL: Minas Gerais: Sitio, *Vainio, Lich. Bras. Exs.* 973 (TUR); Mato Grosso: Corumbá, *Malme* s.n. (S); no locality, *Theresa Christina,* 1899 (P). PARAGUAY: Asunción, *Malme,* Aug. 27, 1893 (UPS); Pilcomayo, Gran Chaco, *Malme,* Sept. 3 and 7, 1893 (S). ARGENTINA: Salta: Río Pescado, Orán, *Digilio-Grassi* 382 (MO).

86. Parmelia chiapensis Hale, sp. nov. Plate 15

Thallus laxe adnatus, 8–15 cm. latus, albido-glaucescens, lobis rotundatis, 7–12 mm. latis, apicem versus margine integris, centrum versus denticulato-laciniatis, ciliatis, ciliis 1–2 mm. longis, superne nitidus, levissime albomaculatus, aetate irregulariter rimosus, strato corticeo superiore 16–20 μ crasso, strato gonidiali 22–28 μ crasso, medulla superiore alba, medulla inferiore pro parte crocea, toto 110–130 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger sparse rhizinosus, ambitu castaneus, albovariegatus vel albicans, late nudus. Apothecia numerosa, pedicellata, ad 12 mm. diametro, amphithecio revolutente, rugoso, valde albomaculato, disco late perforato; hymenium 70–80 μ altum; sporae 9–12×18–22 μ, episporio 1.5–2.0 μ crasso; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla alba K−, C−, KC+ rubescens, P−, medulla crocea K+ atropurpurea, atranorinum, acidum alectoronicum et rhodophyscin continens.

Type in the National Science Museum, Tokyo, collected at Monte Ovando, Chiapas, Mexico, Jan. 1, 1925, by Eizi Matuda (no. 105; isotype in US).

Parmelia chiapensis is superficially very close to *P. argentina* Kremplh., especially in lobation and habit, but has perforate apothecia and lacks a distinct white zone below. *Parmelia subrugata* Kremplh. has a larger thallus, imperforate apothecia, and large spores. This species is known from the Chiapas highlands in Mexico and adjacent Guatemala.

Additional specimens examined:

MEXICO: Chiapas: Mt. Ovando, *Matuda,* December 1937 (MICH) and 45 (TNS). GUATEMALA: Quezaltenango: South of San Martín, *Standley* 83659 (MO).

87. Parmelia cooperi Stein. & Zahlbr. Bot. Jahrb. Engler 60:528. 1926. Plate 13

Parmelia segreganda des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:112. 1961. Type collection: Ambohitantely forest, near Ankazobe, Madagascar, *H. des Abbayes, Lich. Mad. Bor. Sel. Exs.* 17 (REN, lectotype; H, M, UPS, US, isotypes).

Type collection: Kapprana, Kapland, Africa, *Cooper* 1813 (W, holotype).

Thallus large, to 15 cm. in diameter, loosely attached, light mineral gray; lobes rotund, broad, 10–15 mm. wide, margins sorediate, soralia linear, rarely becoming submarginal, sorediate lobes sinuous,

margins ciliate, cilia 1.5–3 mm. long; upper surface plane, more or less distinctly white-maculate, reticulately cracked with age; lower side black, sparsely rhizinate, pale brown and naked in a broad zone at the margins. Apothecia poorly developed, adnate, 1–2 mm. in diameter, disc imperforate; hymenium 90–95 μ high; spores 7–10×18–20 μ, episporium 1–1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ blood red; P−, atranorine and lecanoric acid present.

Parmelia cooperi is a distinctive east African lichen (fig. 25) with an unusual combination of characters, lecanoric acid and cilia. Except for the presence of cilia and imperforate apothecia, it is very close to *P. austrosinensis* and occupies similar habitats in the dry forests of Africa. Dr. des Abbayes kindly showed me an isotype of his *P. segreganda*, which at the time seemed unique to me. Later examination of the type of *P. cooperi*, however, led me to regard them as the same species, although the cilia of *P. segreganda* are exceptionally long.

Additional specimens examined:

CONGO: Ibanda, Kabare, *Spirlet*, s.n. (BR); Kalongi, Albert National Park, *de Witte* 10307 (BR, US). KENYA: Rift Valley Prov.: Eastern Mau Forest Reserve, Nakuru distr., *Maas Geesteranus* 11313 (L); Nyanza: Londiani, Kisumu-Londiani, *Maas Geesternaus* 10932 (L, LD). TANGANYIKA: Livingstone Mountains, Milo, *Rae*, 1935 (BM). UGANDA: Kizezi, Naiziru, *Dale* L48 (K). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Feb. 2, 1930 (TRH). UNION OF SOUTH AFRICA: Transvaal: Houtboschberg, *Nelson* 1056 (TRH); Cape Prov.: 6 mi. west of Heidelberg, *Höeg*, June 12, 1929 (TRH). MADAGASCAR: La Mondraka, *Benoist*, 1879 (LD); between Tananarive and Majunga, km. 133, *des Abbayes*, Aug. 20, 1956 (REN, US).

88. Parmelia coralliformis Hale, sp. nov. Plate 14

Thallus laxe adnatus, expansus, rigidulus, usque ad 10 cm. latus, viridi-glaucescens, lobis rotundatis, parum ramosis, margine integris vel sinuato-incisis, centrum versus isidiatis, isidiis dense coralliformibus ramosis (ut in *P. fasciculata* Vain.), usque ad 5 mm. altis, apicibus nonnullis sparse sorediatis fatiscentibus, margine ciliatis, ciliis numerosis, 1.0–1.5 mm. longis, superne laevigatus, nitidus, valde albomaculatus, cortice continuo vel demum fisso, strato corticeo superiore 17–19 μ crasso, strato gonidiali 20–22 μ crasso, medulla alba, 90–95 crassa, strato corticeo inferiore 17–19 μ crasso, inferne niger, rhizinosus, ambitu castaneus, anguste nudus. Apothecia ignota. Thallus K+ flavida; medulla K+ rubra, C−, KC−, P+ aurantiaca, atranorinum et acidum salacinicum continens.

Type in the U.S. National Herbarium, collected in mature pine forests, elev. 2340 m., 18 km. southeast of San Cristóbal, Chiapas, Mexico, Mar. 24, 1960, by M. E. Hale (no. 20287; isotypes in REN, S).

Parmelia coralliformis has the large fatiscent coralloid isidioid growths typical of *P. fasciculata* Vain. and *P. ramuscula* Hale. It differs significantly from these two species in having a shiny, distinctly maculate upper surface. The rhizines are often produced to the margin below in a manner reminiscent of *P. subcaperata* Kremplh. but the center is jet black. It is known only from the type locality in Mexico, and may be related to *P. leucosemotheta* Hue, a common Mexican species with similar maculae and chemistry but differing in having soredia.

89. Parmelia euneta Stirton, Scot. Nat. 4:298. 1877–78.

Type collection: Victoria, Africa, *Thomson* (BM, holotype; GLAM, isotype).

Thallus loosely adnate, corticolous, often expanded, 10–25 cm. in diameter, coriaceous, mineral gray; lobes rotund, margins entire to crenate, ciliate, cilia 2–4 mm. long; upper surface plane, shiny, faintly to distinctly white-maculate, reticulately cracked with age, isidia and soredia lacking; lower side black, sparsely rhizinate, brown to white or mottled in a broad zone at the margins. Apothecia stalked, 5–15 mm. in diameter, amphithecium strongly maculate, exciple usually ciliate, disc perforate; hymenium 60–80 μ high; spores 7–12×18–26 μ, episporium 1.5–2.5 μ thick; pycnidia numerous, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ blood red, P−, atranorine and gyrophoric acid present.

Parmelia euneta appears to be a pantropical species, although it is very rare outside of Africa. It is unique in the presence of maculae, gyrophoric acid, and stalked perforate apothecia. The thallus is usually quite large and rather coriaceous. The maculae vary considerably in distinctness but will always be distinct near the base of apothecia. The spores are uniformly intermediate in size. It has no close relatives with gyrophoric acid, but it does resemble externally *P. abessinica* Kremplh., a smaller more membranous species with a similar variation in maculae and with intermediate-sized spores.
Additional specimens examined:

HAITI: Kenscoff, *Thomas* 101 (MO, NY, US).
SIERRA LEONE: Falaba, *Small* 450 (K). ANGOLA: Mayumbe, *Gossweiler* 7181 (BM); Vila Salazar, Cuanza-Norte, *Degelius*, Mar. 6, 1960 (DEGEL, US). CONGO: Isalowe Reserve, Yangambi, *Louis* 8675 (BR, US). TANGANYIKA: Milo, Livingstone Mtns., *Rae*, 1935 (BM).
CEYLON: No locality, *Tiwary*, s.d. (BM).

90. Parmelia hababiana Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. PLATE 15
Parmelia abessinica var. *sorediosa* Müll. Arg. Flora 68:501. 1885. Nomenclatural basis of *P. hababiana*.
P. nilgherrensis f. *subciliaris* Vainio, Hedwigia 37:40. 1898. Type collection: Ruwenzori, Uganda, Africa, *Scott Elliott* 218 (TUR, holotype).
P. subciliaris (Vain.) Dodge, Ann. Mo. Bot. Gard. 40:377. 1953.

P. allenii Dodge, Ann. Mo. Bot. Gard. 46:150. 1959. Type collection: Lake Ngunga, Kenya, *Allen* 1783 (FH-Howe, holotype) (not 1837).
(?) *P. hendrickxii* Dodge, Ann. Mo. Bot. Gard. 46:124. 1959. Type collection: Kahusi, Congo, *Hendrickx* 4307 p.p. (EA, holotype).

Type collection: Near Hababab, Ethiopia, *Hildebrandt* 310 p.p. (G, lectotype).

Thallus loosely adnate to bark, 6–10 cm. in diameter, mineral gray; lobes rotund, 7–12 mm. wide, margins often subascending, crenate, sorediate, soralia linear or in part capitate and submarginal, sorediate lobes becoming revolute with age, ciliate, cilia rather sparse, 0.5–2 mm. long; upper surface dull to quite shiny, faintly to strongly white-maculate, especially near the base of apothecia, rarely becoming white-pruinose; lower side black and sparsely rhizinate at the center, brown to ivory or mottled and naked in a broad zone at the margins. Apothecia rare, 2–3 mm. in diameter, amphithecium sorediate, disc perforate; hymenium 60–70 μ high; spores 8–10×15–81 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present; or medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

The name *P. hababiana* was probably proposed by Gyelnik as a nomenclatorial exercise, since he did not see the the type of the variety forming the basis of the species or, as far as we know, identify any material belonging to this species. It now appears that *P. hababiana* is much more common than had been thought. It is common not only in the savannas of Africa but also in the dry upland oak forests of Central America and in Asia. The outstanding morphological characters are the marginal soralia, cilia, faint to distinct maculae, and white or mottled zone below near the margin. Superficially it appears very similar to the nonciliate species *P. praesorediosa* Nyl. or *P. austrosinensis* Zahlbr. More than half of the specimens, including all the type specimens listed above, contain protolichesteric and cryptochlorophaeic acids (KC+ red) and the remainder contain only protolichesteric acid (KC−). These two chemical variants have nearly identical distributions (figs. 26, 27), although the typical strain with cryptochlorophaeic acid is much more common throughout the geographic range. *Parmelia abessinica* Kremplh., which has similar chemical variation, is the nonsorediate counterpart of *P. hababiana*.

Additional specimens examined:

Cryptochlorophaeic and protolichesteric acids present:

U.S.: Arizona: Stewart Creek Campground, Chiricahua Mountains, Cochise Co., *Weber* S28021 (COLO, US). MEXICO: Oaxaca: 53 km. northwest of Oaxaca, *Hale* 20796 (US); 132 km. northwest of Oaxaca, *Hale* 20835 (US); Chiapas: Just south of Teopisca, *Hale* 20499 (S, US); 2 km. north of highway

190 on road to Puebla Nueva, *Hale* 20164 (US). GUATEMALA: JUTIAPA: Vicinity of Jutiapa, *Standley* 75949 (F, MO). HONDURAS: COMAYAGUA: Siguatepeque, *Yuncker* 6505 (MO). NICARAGUA: JINOTEGA: Cerro Sialci, *Standley* 10591 (F). COSTA RICA: La Palma, *Valerio* 13 (S).

ARGENTINA: Santiago del Estero, Dept. Bando, *Vega* 20960 (SI).

ANGOLA: BIÉ: Chinguar, *Degelius* s.n. (DEGEL). KENYA: RIFT VALLEY PROV.: Lake Nakuru, *Maas Geesteranus* 4631 (L), Eastern Mau Forest Reserve, Nakuru Distr., *Maas Geesteranus* 11378 (L); Cherangani, *Maas Geesteranus* 4708 (L); CENTRAL PROV.: Nairobi, *Maas Geesteranus* 4438 (L); NYANZA PROV.: Tinderet Forest Camp, Kisumu-Londiani Distr., *Maas Geesteranus* 4955 (L, LD, US). SOUTHERN RHODESIA: Zimbabwe, *Hõeg* s.n. (TRH). UNION OF SOUTH AFRICA: TRANSVAAL: Louis Trichardt, Hanglip Forest, *Almborn* 12011 (LD); NATAL: Emmersdale, Estcourt, *Höeg* s.n. (TRH); Creighton Station, *Hõeg* s.n. (TRH). MADAGASCAR: Tananarive, *Bathie* s.n. (LD).

INDIA: Almora Distr.: Above village Naret, Askote, *Awasthi* 3297 p.p. (AWAS); Ranikhet, *Awasthi* 3548 (AWAS). CHINA: Schilungba, Yunnan, *Handel-Mazzetti* 255 (MICH).

Protolichesteric acid only present:

MEXICO: OAXACA: Cerro Zempoaltepetl, *Hallberg* 690 (MICH).

LIBERIA: WESTERN PROV.: Wohmen, Vonjama, *Baldwin* 12452 (US). ANGOLA: CUANZA-NORTE: Salazar, *Degelius* s.n. (DEGEL); BENGUELA: Between Benguela and Coporolo, *Degelius* s.n. (DEGEL). KENYA: RIFT VALLEY PROV.: Menengai, Nakuru Distr., *Maas Geesteranus* 10280 (L); NYANZA PROV.: Tinderet Forest Reserve, Kisumu-Londiani Distr., *Maas Geesteranus* 4949 (LD); CENTRAL PROV.: 4 mi. west of Nairobi, *Maas Geesteranus* 4394c (LD). SOUTHERN RHODESIA: Near Bulawayo, *Höeg*, s.n. (TRH). UNION OF SOUTH AFRICA: TRANSVAAL: 2 mi. north of Warmbad, Waterberg, *Almborn* 5889 p.p., 5896 (LD); NATAL: Boschfontein Forest, Lions River Distr., *Almborn* 8721, 8728 (LD); Natal Table Mountain, *Almborn* 8555 (LD); Weenen, *Höeg* s.n. (TRH); Emmersdale, Estcourt, *Höeg* s.n. (TRH); CAPE PROV.: Near Port Elizabeth, *Höeg* s.n. (TRH).

91. Parmelia hanningtoniana Müll. Arg. Flora 73:339. 1890. PLATE 2

Parmelia sinensis Hue f. *isidiata* Ceng. Samb. Nuov. Giorn. Bot. Ital. 40:283. 1933. Type collection: Limbolo, Angola, *Fenaroli* II (FI, holotype).

Type collection: South Africa, *Hannington* (G, holotype; K, isotype).

Thallus adnate to loosely attached, 5–8 cm. in diameter coriaceous, greenish mineral gray; lobes rotund, 15–20 mm. wide, margins crenate, ciliate, cilia 1.5–2.0 mm. long; upper surface distinctly white-maculate, plane to rugulose, isidia and soredia lacking; lower side black and sparcely rhizinate in the center, pale tan, rugose, and naked in a broad zone at the margins. Apothecia large, 4–10 mm. broad, stalked, amphithecium extremely wrinkled and lobulate, white-maculate, disc perforate; hymenium 50–60 μ high; spores 7–11×13–18 μ, episporium 1.5 μ thick, pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K—, C+ rose, KC+ red, P—, atranorine and gyrophoric acid present.

Parmelia hanningtoniana is apparently restricted to the savannas of west Africa. The unusual apothecia (cf. pl. 2) set it apart from all other Parmelias. They are large, stalked, and the amphithecium is coarsely sublobulate. In other respects it is close to *P. euneta* Stirt.

Additional specimens examined:

ANGOLA: Moxico: Between Luso and Cochipoque, *Degelius*, Feb. 16, 1960 (DEGEL, US); Koiembe, Quingenge-Benguela, *Damann, Tav. Lich. Lusit. Sel. Exs.* 168 (H, LD, US). CONGO: Biano, 26°3′ E., 10°16′ S., *Schmitz* 3884 (BR).

92. Parmelia hypotropa Nyl. Syn. Lich. 379. 1860.

Parmelia hypotropa var. *sorediata* Müll. Arg. Flora 60:77. 1877. Type collection: Near Dallas, Texas, *Boll* (G, holotype; US, isotype).

P. cetrata var. *hypotropoides* Nyl. ex Willey, Bot. Gaz. 21:203. 1896. Type collection: New Bedford, Massachusetts, *Willey* (US, holotype).

P. lividotessellata f. *ablephara* Hue, Nouv. Arch. Paris, ser. 4, 1:191. 1899. Type collection: Near Tonza, Algeria, Africa, *Maisonneuve*, November 1840 (P, holotype).

P. hypoleucina Stein. Oester. Bot. Zeitschr. 67:282. 1918. Type collection: Barro, Portugal, *Menyhart* 113 (WU, holotype).

P. trichotera var. *subincana* Mah. & Gil. Bull. Soc. Bot. Fr. 68:286. 1921 [1925]. Type collection: Forêt de Mamora, near Kenitra, Morocco, *Gillet* 105 bis (P, holotype).

P. subincana (Mah. & Gil.) Mah. & Gil. Bull. Soc. Bot. Fr. 72:862. 1925.

P. corrugis var. *sorediata* (Müll. Arg.) Zahlbr. Cat. Lich. Univ. 6:236. 1929.

Parmotrema gattefossei Choisy, Bull. Soc. Bot. Fr. 78:458. 1931. Type collection: Forêt Mamora, Morocco, *Gattefossé* (LY, herb. no. 1698, holotype).

P. werneri Choisy, Bull. Soc. Bot. Fr. 78:457. 1931. Type collection: Oued Cherrat, Morocco, *Gattefossé* (LY, herb. no. 1753, lectotype).

Parmelia mueller-argoviensis Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. Based on *P. hypotropa* var. *sorediata* Müll. Arg.

P. gattefossei (Choisy) Zahlbr. Cat. Lich. Univ. 8:559. 1932.

P. werneri (Choisy) Zahlbr. Cat. Lich. Univ. 8:569. 1932.

P. hypoleucina var. *subincana* (Mah. & Gil.) Werner, Bull. Soc. Sci. Nat. Maroc. 35:57. 1955.

Type collection: Comancharies, Texas [Mexico?], *Berlandier & Trécul* 2093 (P, holotype; H, isotype).

Thallus loosely adnate, 8–12 cm. in diameter, light mineral gray, sometimes turning pink below in the herbarium; lobes broad, ascending, 10–15 mm. wide, margins broadly crenate, ciliate, cilia 1–3 mm. long, sorediate, soralia linear, sorediate lobes sinuate; upper surface plane, shiny, strongly white-maculate, becoming rugose with age; lower side black and sparsely rhizinate in the center, outer margin white or rarely tan, rugulose, naked. Apothecia extremely rare, to 4 mm. in diameter, disc perforate; hymenium 40–50 μ high; spores 5–6×8–10 μ, episporium 1 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow or yellow

turning red, C−, KC−, P+ pale orange red, atranorine, norstictic and/or stictic acid present.

In his original description Nylander cites *Parmelia hypotropa* rather ambiguously as "*P. hypotropa" under *P. perforata*. It is possible to interpret *P. hypotropa* as having subspecific rank, but Nylander's brief notes also imply that it could be considered as a variety of *P. perforata*. I prefer to consider it as validly published at the species rank. In any event the first use of *Parmelia hypotropa* at a species rank (apparently Nylander in Flora 52: 291. 1869) still antedates any of the synonyms.

Parmelia hypotropa is easily recognized by the distinct maculae, marginal cilia and soredia, and the broad white marginal zone below. Apothecia are known only from a single collection. It is especially common in the southeastern United States (fig. 8) on the lower trunks of deciduous trees, and occurs also in southern California, in Mexico, in the Mediterranean region, and in one locality in Formosa. It is the sorediate counterpart of *P. perforata* (Jacq.) Ach., which has a similar but more southerly range in eastern United States (fig. 7) and is collected more frequently on the upper branches of deciduous trees.

All specimens from eastern North America and Mexico contain norstictic acid in abundance. Those from California and Europe (including the type specimens from Europe and Africa listed above) usually contain stictic acid, and norstictic acid cannot always be demonstrated with a G.A.o-T test, although a K_2CO_3 test is often successful. It is probable that the two acids always occur together but that our present chemical tests are not yet refined enough to detect them in mixtures.

Additional representative specimens examined:

U.S.: MASSACHUSETTS: New Bedford, Bristol Co., *Willey* s.n. (US); CONNECTICUT: 1 mi. south of Colebrook, Litchfield Co., *Hale* 15412 (US); NEW YORK: Near Sound, Suffolk Co., *Imshaug* 25770A (H); NEW JERSEY: Greenbank State Forest, Burlington Co., *Hale* 15331 (US); PENNSYLVANIA: 4 mi. northwest of Dingmans Ferry, Pike Co., *Hale* 16249 (US); DELAWARE: Laurel, Sussex Co., *Commons* s.n. (PH); MARYLAND: 2 mi. northwest of Bristol, Anne Arundel Co., *Hale* 14333 (US); WEST VIRGINIA: Near Pullman, Ritchie Co., *Hale* 10791 (US); 3 mi. northeast of Alvon, Greenbrier Co., *Hale* 18957; Glen Rogers, Wyoming Co., *Hale* 11643 (US); OHIO: Miami Whitewater Forest, Hamilton Co., *Taylor* 31 (US); Newstonville, Clermont Co., *Hale* 13225 (US); KENTUCKY: 4 mi. northeast of Whitly City, McCreary Co., *Hale* 13748 (US); 2 mi. east of Paducah, McCracken Co., *Hale* 13692 (US); INDIANA: Harrison County State Forest, Harrison Co., *Hale* 14038 (US); ILLINOIS: Grantsburg, Johnson Co., *Hale* 14013 (US); WISCONSIN: Near Dunnville, Dunn Co., *Culberson* 3725 (WIS); Wisconsin Dells, Juneau Co., *Thomson* 1825 (WIS); MISSOURI: Near Houston, Texas Co., *Hale* 4222 (US); VIRGINIA: Vint Hill Farms, Fauquier Co., *Cooke* (LD); Lee's Millpond, Isle of Wight Co., *Culberson* 7027 (DUKE); Prince William State Forest, Prince William Co., *Hale* 15223 (US); Millsboro Springs, Bath Co., *Hale* 12933 (US); NORTH

CAROLINA: 3 mi. southeast of Bertha, Currituck Co., *Culberson* 6968 (DUKE, US); 3 mi. north of Halifax, Halifax Co., *Hale* 16332 (US); 10 mi. south of Asheville, Buncombe Co., *Culberson* 7125 (DUKE); TENNESSEE: Sycamore, Cheatham Co., *Phillips* s.n. (US); Nashville, Davidson Co., *Gattinger* s.n. (fertile) (M); GEORGIA: Near Blue Ridge, Fannin Co., *Hale* 7321 (US); ALABAMA: De Soto State Park, De Kalb Co., *Hale* 7051 (US); FLORIDA: 3 mi. south of Sanford, Seminole Co., *Hale* 17679 (US); Eustis, Lake Co., *Nash* 1879 (US); MISSISSIPPI: 4 mi. south of Nettleton, Monroe Co., *Hubricht* B1533 (US); Holly Springs, Marshall Co., *Hale* 7850 (US); LOUISIANA: Plaquemines Parish, *Langlois* s.n. (PH, US); ARKANSAS: Near Briggsville, Yell Co., *Hale* 3747 (US); 0.5 mi. north of Francis, Boone Co., *Dodge et al.* s.n. (US); near Jasper, Newton Co., *Hale* 3081 (US); OKLAHOMA: Near Ardmore, Carter Co., *Hale* 4859 (US); TEXAS: Meridian, Bosque Co., *Hale* 5201 (US); Wisdom Ranch, Wilson Co., *Parks* 1098 (WIS); 20 mi. northwest of Fort Davis, Jeff Davis Co., *Parks* 1042 (WIS); Duffau, Erath Co., *Hale* 5496 (US); CALIFORNIA: San Diego, San Diego Co., *Palmer* 279 (US), *Alderson* 779 (US); Santa Catalina Island, *McGregor* 26 (US). MEXICO: TAMAULIPAS: South of Antigua Morelos, *Reeder* 1889 (US).

PORTUGAL: Near Magoito, Estremadura, *Tavares, Lich. Lusit. Sel. Exs.* 98 (H, US, WIS); near Azoia, Estremadura, *Tavares, Vezda Lich. Sel. Exs.* 68 (H, LD, US). ITALY: Pisa, Etruria, *Vivante, Gyel. Lichenoth.* 139 (H, LD); between Spezia and Pisa, *Hasselrot* s.n. (F).

MOROCCO: Near Rabat, *Gattefossé* s.n. (P); Oued Bouznika, Chaouia, *Gattefossé* s.n. (P).

FORMOSA: Keitau, *Asahina* 3411 (TNS, US).

93. Parmelia leucosemotheta Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:192. 1899.
PLATE 16

Type collection: Abrededores, San Luis Potosí, Mexico, *Maury* 7650 (P, holotype).

Thallus large, 10–20 cm. broad, loosely attached to bark, mineral gray; lobes rotund, 10–15 mm. wide, margins entire to dentate-laciniate with age, ciliate, cilia 1.5–2.5 mm. long, sorediate, soralia mostly on lateral margins, linear; upper surface shiny, strongly white-maculate, usually becoming conspicuously reticulately cracked with age; lower side black and sparsely rhizinate, dark brown to brown or mottled white in a broad zone along the margins. Apothecia rare, more or less adnate, to 6 mm. in diameter, amphithecium sorediate, disc imperforate or rarely perforate; hymenium 65–75 μ high; spores 7–10×12–16 μ, episporium 1.0–1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia leucosemotheta is characterized by strong maculation, marginal soredia, and a black lower side. It is very similar in many respects to *P. reparata* Stirt., which differs in being nonsorediate and in having perforate apothecia. It also closely resembles *P. subsumpta* Nyl., which differs principally in having a pale lower side with short dense rhizines and a narrow rhizinate or papillate zone at the margins. If specimens of *P. subsumpta* have an abnormally blackened lower

side, one must rely on the extent of papillae in the marginal zone to separate them from *P. leucosemotheta*, which typically has a broad, dark and shiny bare zone. These two species have similar distribution patterns, although *P. leucosemotheta* is much more common in Mexico.

Additional specimens examined:

MEXICO: Nuevo Leon: Monterrey, *Lacas* 521 (F); Hidalgo: La Placita, *Moore* 3900 (US); Veracruz: Northeast of Huatusco, *Hale* 19551 (COLO, DUKE, MSC, REN, S, TNS, US); 7 km. north of Fortín de las Flores, *Hale* 19709 (S, US), *Hale* 1690 (DUKE, US); 9 km. east of Jalapa, *Hale* 21233 (US); Puebla: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19614 (US); Michoacán: Morelia, *Arsène* 8238 (US); Oaxaca: Cerro del Machete, Pochutla Distr., *Reko* 6307a (F); Chiapas: 40 km. southeast of Comitan, *Hale* 20484 (US), 20483 (COLO, US); 14 km. west of San Cristóbal, *Hale* 20573 (LISU, US). GUATEMALA: Jalapa: Jalapa, *Standley* 76552 (MO). COSTA RICA: San José: Santa María de Dota, *Standley* 41727 (US); Cartago: North of Cartago, *Standley* 49616, 49635 (US).

HAITI: Summit of Montagne Noire, *Wetmore* 2730 (MSC).

BRAZIL: Minas Gerais: Caldas, *Mosén* 2313 (UPS), *Henschen* s.n. (UPS); São Paulo: Piquete, *Robert* s.n. (BM). ARGENTINA: Without locality, *Lorentz & Hieronymus* (M).

UNION OF SOUTH AFRICA: Boschfontein Forest, Lions River Distr., *Almborn* 8674 (LD).

94. Parmelia lobulascens Steiner, Verh. Zool. Bot. Gesell. Wien 53:234. 1903.

Type collection: Cameroons, *Bornmüller* (WU, holotype).

Thallus loosely attached, coriaceous, 5–10 cm. in diameter, mineral gray; lobes rotund, 8–14 mm. wide, margins entire, lobulate toward the center, central lobes often crowded, margins sorediate, soralia irregular to sublinear, ciliate, cilia rather sparse, 0.5–2.0 mm. long; upper surface shiny, moderately to strongly white-maculate, rugulose and cracked with age; lower side black and coarsely rhizinate, margins dark brown, naked, rugose. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ blood red, P−, atranorine and gyrophoric acid present.

The type of *P. lobulascens* is a very poor specimen. Laciniae or lobules are quite abundant and have irregularly sorediate margins, a fact overlooked by Steiner. Fortunately additional collections from Africa have clarified the range of variation in the species. The lobules may not be conspicuously developed and the soredia may be in elongate, more normal soralia. Maculae are always very distinct. It is extremely close to *P. pseudonilgherrensis* Asah., which contains alectoronic and α-collatolic acids and lacks lobules.

Additional specimens examined:

ETHIOPIA: North of Debra Marcos, Chokke Mtns., *Hiller* L85 (K); no locality, *Schimper*, s.d. (BM). KENYA: Nyanza: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 5532 (L).

95. Parmelia melanothrix (Mont.) Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:30. 1890.

Parmelia urceolata var. *melanothrix* Mont. Ann. Sci. Nat. Bot., ser. 2, 2:372. 1834.

Type collection: Brazil, *Gaudichaud* 89 bis (P, holotype).

Thallus 5–15 cm. in diameter, loosely attached to suberect on bark, mineral gray; lobes rotund, 6–12 mm. wide, margins crenate, short dentate-laciniate, especially toward the center, densely ciliate, cilia 2–3 mm. long; upper surface plane, shiny, white-maculate, isidia and soredia lacking; lower side black and rhizinate in the center, pale tan to white or mottled in a broad zone at the margins. Apothecia common, stalked, to 10 mm. in diameter, exciple minutely dentate or laciniate, ciliate, amphithecium rugose, maculate, disc imperforate; hymenium 80–100 μ high; spores 10–16×20–26 μ, episporium 2–3 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

Parmelia melanothrix is one of the few tropical Parmelias that is usually correctly identified in herbaria. The salient taxonomic features are the large spores, K−, P− reaction, maculae, and cilia. The only species with which it might be confused is *P. argentina* Krempih., which is KC+ red (alectoronic acid) and has intermediate-sized spores. *Parmelia melanothrix* has been commonly collected in southeastern Brazil; there is a disjunct locality in Réunion, in the Indian Ocean.

Additional specimens examined:

BRAZIL: Maranhao: São Bernardo, Serra de Cubatao, *Burchell* 3942 (K); Minas Gerais: Caldas, *Mosén* 2314, *Lich. Austro-Amer. Herb. Regnell.* 358 (BM, H, MSC, S, UPS, W); Sitio, *Vainio, Lich. Bras. Exs.* 950 (TUR, M, UPS); no locality, Warming 273 (M); Rio de Janeiro: Serra dos Orgãos, *Helmreichen*, s.d. (M), *Burchell* 2403 (K); Rio de Janeiro, *Glaziou* 1835 (M); São Paulo: Apiaí, *Puiggari*, s.d. (M); near Lapa, July 1901, *Schiffner* (M); Paraná: Fiarehy, September 1908, *Dusén* (M); Ypiranga, *Lüderwaldt, Zahlbr. Lich. Rar. Exs.* 222 (BM, BPI, MICH); Rio Grande do Sul: Elisenau, Württemberg, *Bornmüller* 796 (M).

RÉUNION ISLAND: Salazie, 1893, *Chauret* (P), 1889, *Rodriguez* (P).

96. Parmelia natalensis Stein. & Zahlbr. Bot. Jahrb. Engler 60:515. 1926.

Type collection: Van Reenens Pass, Drackensberge, Black Mountains, Natal, Africa, *Brunnthaler* (W, holotype).

Thallus expanded, coriaceous, 8–15 cm. in diameter, mineral gray; lobes rotund, 9–15 mm. wide, margins entire, ciliate, cilia 1–3 mm. long, sometimes sorediate; upper surface plane, shiny, strongly white-maculate, becoming sorediate in a broad zone along the margins, soralia orbicular, soon coalescing into extensive sorediate masses; lower side black and sparsely rhizinate, brown and naked in a broad

zone along the margins. Apothecia rare, 3–8 mm. in diameter, very short-stalked, amphithecium sorediate, disc imperforate, often radially split; hymenium about 50 μ high; spores 10–13 $\times$ 18–22 μ, the episporium to 2 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red or orange red, P−, atranorine and alectoronic acid present.

Parmelia natalensis, an African endemic, has a large coriaceous thallus with a broad submarginal zone of soralia. The maculae are usually very distinct. *Parmelia pseudonilgherrensis* Nyl., another maculate species with alectoronic acid, has strictly marginal soralia. *Parmelia rimulosa* Dodge, which occurs in South Africa, has a more membranous fragile thallus and extensive submarginal sorediate pustules.

Additional specimens examined:

CONGO: Volcan Karisimbi, Plaine de Lukumi, *Louis* 5411 (BR). KENYA: NYANZA: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 4956 (L, LD), 5017 (L, US), 5532 (L), 11100 (L); Londiani, Kisumu-Londiani, *Maas Geesteranus* 10933 (L, LD); RIFT VALLEY: Cherangani Mountains, Trans Nzoia Distr., *Maas Geesteranus* 4715 (L), 4829 (L, LD); Eastern Mau Forest Reserve, Nakuru Distr., *Maas Geesteranus* 11313 pr. p. (L). UNION OF SOUTH AFRICA: NATAL: Polela Forest, Polela, *Almborn* 9500 (LD).

97. Parmelia nilgherrensis Nyl. Flora 52:291. 1869.

Parmelia yunnana Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:186. 1899. Type collection: Lopin-chan, Yunnan, China, *Delavay*, July 31, 1888 (P, holotype).

P. siamensis Vain. Ann Soc. Zool. Bot. Fenn. 1, no. 3:37. 1921. Type collection: Doi Sutep, Thailand, *Hosseus* (TUR, holotype).

Type collection: Nilgherries Mountains, India, *Perrottet* (H, Nyl. herb. no. 35337, holotype).

Thallus loosely attached to bark, 8–15 cm. wide, mineral gray, turning buff in the herbarium; lobes rotund, 10–15 mm. wide, margins entire to crenate or dentate toward the center, ciliate, cilia 1–3 mm. long, rather coarse, often furcate; upper surface plane, shiny, strongly white-maculate, isidia and soredia lacking; lower side black and coarsely rhizinate, dark brown and naked in a broad zone at the margins. Apothecia large, numerous, 8–20 mm. in diameter, stalked, amphithecium strongly rugose and maculate, disc perforate; hymenium 100–130 μ high; spores 10–18 $\times$ 17–26 μ, episporium 2.0–2.5 μ; pycnidia abundant, conidia 14–16 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red or orange red, P−, atranorine, α-collatolic acid (predominantly), and alectoronic acid present; medulla, if pigmented, K+ purple, rhodophyscin present.

Parmelia nilgherrensis is a typical Asian species especially common in the foothills of the Himalayan Mountains (fig. 28). It is charac-

FIGURE 28.—Distribution of *Parmelia nilgherrensis* Nyl.

terized by strong maculae, perforate apothecia, and a dark lower side even at the margins. The predominant chemical is α-collatolic acid and the medulla does not fluoresce at all. The sorediate counterpart appears to be *P. pseudonilgherrensis* Asah.

Additional specimens examined:

SIKKIM: Lachen, *Hooker* 1994 (K). NEPAL: Lantang, Khola, *Polunin* M161 (BM); no locality, *Buchanan*, Feb. 3, 1803 (BM). INDIA: Wan, Gharwal Distr., *Pranavananda* A–119 (SESH, US); Ihageswar forests, en route to Ihagersen, *Sarma* A–114 (SESH, US); Ranikhet, *Senthna* 2 (US); Mussoorie, *Ali* 3 (BM), *Awasthi* 3815 (AWAS), *Mehra* 18 (MO); Mahasa, Simla, *Thomson* 1990 (K); Madras, *Gamble* 18048 (K); Jogeswar Ridge, Almora Distr., *Awasthi* 3505 (AWAS); Shola, near mile 9, Kodaikanal-Berijani Road, Madurai, *Foreau* 4238 (AWAS). CEYLON: Naini Jal, *Duvay*, May 1930 (BM). CHINA: YUNNAN: Eastern slopes of Likiang Snow Range, Likiang, *Rock* 11753 (US). THAILAND: Doi Sutep, *Hosseus* (TUR).

98. Parmelia paulensis Zahlbr. Denkschr. Akad. Wiss. Naturw. Wien 83:175, *pl. 1, fig. 6.* 1909.

Parmelia dolosa des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:115. 1961. Type collection: 30 km. northeast of Ankazobe, Forêt d'Ambohitantely, Centre Moyen, Madagascar, *des Abbayes* (REN, lectotype; US, isotype).

Type collection: Near Taipas, Mount Jaraguá, São Paulo, Brazil, *Schiffner* (W, holotype).

Thallus loosely attached, to 10 cm. broad, membranous, mineral gray; lobes rotund, to 15 mm. wide, subimbricate and dissected toward the center, margins and submarginal areas isidiate or sorediate-isidiate, densely ciliate, cilia 2–3 mm. long; upper surface smooth, dull to more or less distinctly white-maculate, becoming reticulately cracked with age; lower side black and sparsely rhizinate, dark to pale brown, ivory, or mottled and naked in a broad zone along the margins. Apothecia rare, 3–5 mm. in diameter, exciple short-dentate, ciliate, amphithecium rugose and maculate, disc imperforate;

hymenium 50–60 μ high; spores 13–15×26–28 μ, episporium 3 μ thick; pycnidia abundant, conidia to 10 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ faintly reddish or KC−, P−, atranorine, protolichesteric acid, and apparently an unknown substance present.

Parmelia paulensis has sorediate isidia very similar to those of *P. mellissii* Dodge, a pantropical species with alectoronic acid and intermediate spores. Unfortunately few specimens of *P. paulensis* have been available for study and the chemical constituents are uncertain. Protolichesteric acid is usually demonstrated but one syntype of *P. dolosa* (Forêt de Manjakatompo) appears to contain a fatty acid near caperatic acid. I was unable to prove gyrophoric acid reported by des Abbayes. The KC reaction is either negative or faintly reddish but no identifiable lichen substances have been demonstrated. *Parmelia paulensis* has an unusual Madagascar-Brazil distribution shared by *P. melanothrix* (Mont.) Vain., a related species.

Additional specimens examined:

MADAGASCAR: Forêt de Manjakatompo, Ankaratra, Centre Moyen, *des Abbayes*, July 30, 1956 (REN). RÉUNION: No locality, *Rodriguez*, 1890 (P).

99. Parmelia perforata (Jacq.) Ach. Meth. Lich. 217. 1803. PLATE 2

Lichen perforatus Jacq. Coll. Bot. III, 1:116, *pl. 3*. 1786.

Cetraria corrugis Fr. Syst. Orb. Veg. 1:283. 1825. Type collection: North America, *Schweinitz* (UPS, holotype).

Parmelia coriacea var. *perforata* (Jacq.) Eschw. *in* Mart. Fl. Bras. 1:206. 1833.

P. perforata var. *ciliata* Nyl. Syn. Lich. 377. 1860. Based on *Lichen perforatus* Jacq.

P. hypotropa f. *parmata* Nyl. *in* Cromb. Journ. Linn. Soc. London 17:568. 1880. Type collection: *pl. 20, fig. 44* in Dillenius, Hist. Musc. (OXF, holotype) (=*Parmelia perforata* (Jacq.) Ach.).

P. corrugis (Fr.) Müll. Arg. Flora 70:59. 1887. Based on *Cetraria corrugis* Fr.

P. hypotropoides Nyl. ex Willey, Bot. Gaz. 21:204. 1896. Type collection: New Bedford, Massachusetts, *Willey* (US, holotype).

P. corrugis f. *parmata* (Nyl. *in* Cromb.) Zahlbr. Cat. Lich. Univ. 6:236. 1929.

P. ciliata (Nyl.) Gyel. Report. Sp. Nov. Fedde 30:225. 1932. Based on *P. perforata* var. *ciliata* Nyl.

P. erecta Berry, Ann. Mo. Bot. Gard. 28:103. 1941. Type collection: Marble Falls, Newton Co., Arkansas, *Dodge, Berry,* and *Johnson* (MO, holotype).

Type collection: New England, *Tuckerman, Lich. Amer. Septentr. Exs.* 69 (UPS, neotype; isotypes in FH, L, M, MO).

Thallus loosely attached to suberect, corticolous, 8–12 cm. in diameter, light mineral gray or turning pinkish in the herbarium; lobes large, often monophyllous, 10–20 mm. wide, margins entire to lacerate or even laciniate, ciliate, cilia 2–4 mm. long; upper surface plane to

rugulose, shiny, strongly white-maculate, isidia and soredia lacking; lower side jet black and sparsely rhizinate at the center, pure white to ivory or rarely tan in a distinct broad zone along the margins. Apothecia numerous, stalked, 10–20 mm. in diameter, exciple rarely ciliate, amphithecium strongly rugose, maculate, disc perforate; hymenium 50–65 μ high; spores 7–9$\times$12–16 μ, episporium 1 μ; pycnidia numerous, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale yellow orange, atranorine and norstictic acid present.

A neotype is required for the typification of *P. perforata* since the holotype is probably destroyed, although represented by an excellent color plate. A logical choice of a neotype is the specimen in Tuckerman's exsiccate which is widely distributed in larger herbaria.

Parmelia perforata is a name which has in the past been applied to any large *Amphigymnia* species with perforate apothecia. Du Rietz (1924) did much to clear up the confusion and delimit the species more carefully. I had recognized the species as *P. hypotropoides* Nyl. (Hale, 1957) but later examination of Jacquin's plate left no doubt that *P. hypotropoides* is identical with *P. perforata*. The norstictic acid easily decomposes in improperly dried herbarium specimens and turns the white lower side pink or reddish. Other diagnostic characters are the distinct maculae, erect perforate apothecia, and the distinct white zone below (pl. 2). All of the specimens seen in the early part of this study were from eastern North America (see fig. 7), but several collections from Jamaica, Madagascar, and Ireland have extended the range considerably. In North America the species is most commonly found in the canopy of oak trees, whereas the sorediate counterpart, *P. hypotropa* Nyl., is more common on trunks near the base.

It is interesting to note that *Lichen cylindricus* L. (Sp. Pl. 1150. 1753), which antedates *Lichen perforatus*, is based primarily on "Lichenoides foliorum laciniis crinitis" Dill. Hist. Musc. 149, *pl. 20, fig. 42*. 1742. Dillenius' specimen (OXF) is typical *P. perforata* collected in Pennsylvania. Linnaeus cited a second syntype from Lapland; this specimen (LINN) is a small *Umbilicaria*. Linnaeus himself later realized that the American specimen did not fit his concept of *Lichen cylindricus* and put this name in the umbilicate series as a synonym of *L. proboscideus* L. without further explanation. All later authors have followed Linnaeus' concept without, however, realizing that *L. cylindricus* was based in large part on *Parmelia perforata*.

Additional specimens examined:

U.S.: Massachusetts: 1 mi. west of Tolland, Hampden Co., *Hale* 19092 (US); Connecticut: 1 mi. south of Colebrook, Litchfield Co., *Hale* s.n. (US);

NEW YORK: Chilson Lake, Essex Co., *Harris* s.n. (US); RHODE ISLAND: Bristol, *Howe, Lich. Nov. Angl.* 39 (M); DELAWARE: Laurel, Sussex Co., *Commons* s.n. (PH); OHIO: Near Cincinnati, Hamilton Co., *Lea* s.n. (PH); WISCONSIN: Fayette, Lafayette Co., *Cheney* 9220 (WIS); VIRGINIA: Skinquarter, Chesterfield Co., *Hale* 14574 (US); 5 mi. northeast of Wyllesburg, Charlotte Co., *Hale* 15814 (US); 3 mi. south of Laconia, Mecklenburg Co., *Hale* 15874 (US); NORTH CAROLINA: Shakelford Banks, Carteret Co., *Culberson* 6789 (DUKE, US); near Candler, Buncombe Co., *Green* s.n. (US); Florence, Pamlico Co., *Culberson* 5191 (DUKE); TENNESSEE: Between Del Rio and Newport, Cocke Co., *Sharp* TL5517 (WIS); Cross Roads, Overton Co., *Phillips* 336 (US); SOUTH CAROLINA: Northeast of Edgefield, Edgefield Co., *Standley* 92532 (F); FLORIDA: 5 mi. west of Clarksville, Calhoun Co., *Hale* 21865 (US); Gainesville, Alachua Co., *Nelson* s.n. (FLAS); 10 mi. east of Newport, Jefferson Co., *Hale* 21737 (US); 2 mi. west of Hosford, Liberty Co., *Hale* 21907 (US); Way Key, Levy Co., *Drouet* 11124 (F); LOUISIANA: Abita Springs, St. Tammany Parish, *Drouet* 9592a (F); southeast of New Iberia, Iberia Parish, *Drouet* 8937 (F); near Tunica, Feliciana Parish, *McFarland* 509 (WIS); TEXAS: Carrizo Sand Hills, Wilson Co., *Parks* 8 (US, WIS).

JAMAICA: *Greenwood* s.n. (K).

IRELAND: Without locality, *Taylor* s.n. (UPS).

MADAGASCAR: Near Ft. Dauphine, *Decary* s.n. (LD); near Berari, *Hildebrandt* s.n. (FH).

Additional records from the United States listed as "*Parmelia hypotropoides*" by Hale (1957) are not repeated here.

100. Parmelia pseudonilgherrensis Asahina, Journ. Jap. Bot. 29:370, *fig. 1.* 1954. PLATE 13

Parmelia nigrireagens Dodge, Ann. Mo. Bot. Gard. 46:145. 1959. Type collection: Kikandara, Toro Distr., Western Prov., Uganda, *Omaston* 3766c (K, holotype).

Type collection: Northern Korea, *Tsutani*, 1936 (TNS, holotype).

Thallus 5–10 cm. in diameter, loosely attached, mineral gray; lobes rotund, 8–15 mm. wide, margins sorediate, soralia linear, sorediate lobes sinuous; upper surface smooth, shiny, strongly white-maculate, submarginally sparsely sorediate; lower side black and moderately rhizinate, dark brown and naked in a broad zone along the margins. Apothecia unknown.

Reactions. Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, alectoronic and α-collatolic acids present.

Parmelia pseudonilgherrensis is apparently the sorediate phase of *P. nilgherrensis* Nyl. *Parmelia lobulascens* Stein. & Zahlbr. has similar maculae and soredia but contains gyrophoric acid. These species may prove to be chemical strains. Although only recently described from Korea, *P. pseudonilgherrensis* seems to be common on high mountains in Africa.

Additional specimens examined:

KENYA: Kinango, *Turner* 6388 p. p. (K); western slopes of Mount Kenya, elev. 3630 m., *Mearns* 1529 (US). UGANDA: Namwamba Valley, Ruwenzori, *Taylor* 3088 (BM); Mount Elgon, elev. 14,200 ft., *Dummer* 3397 (US); Kilimanjaro, *Höhnel*, 1890 (G).

NEPAL: Langtang Village, *Polunin* M179 (BM). KOREA: Kanchi-in, *Fujikawa*, Aug. 2, 1934 (TNS, US).

101. Parmelia reparata Stirton, Scot. Nat. 4: 201. 1877–78. PLATE 14
Parmelia virens Müll. Arg. Flora 69: 255. 1886. Type collection: Toowoomba, Queensland, Australia, *Hartmann* in 1882 (G, holotype).

Type collection: Cave Mountain, Brisbane, Australia, *Bailey* (BM, lectotype).

Thallus expanded, loosely adnate, up to 20 cm., coriaceous, mineral gray; lobes rotund, margins broadly crenate, ciliate, cilia abundant, 1.5–2.5 mm. long; upper surface plane, shiny, strongly effigurate white-maculate, becoming cracked with age, soredia and isidia lacking; lower side black and rhizinate, brown to mottled ivory and naked in a broad zone along the margins. Apothecia common, stalked, up to 20 mm. in diameter, amphithecium rugose, strongly white-maculate, disc perforate; hymenium 65–70 μ high; spores 6–7×13–16 μ, episporium 1 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ orange red, atranorine and salacinic acid present.

The type of *P. reparata* is unfortunately not in good condition. The lower side is dark and apparently sparsely rhizinate almost to the margins, exactly as in the type of *P. virens* Müll. Arg. The one collection from New Zealand and all collections from America cited below, however, have a broad distinct bare zone below. It is with some hesitation therefore that we identify the latter specimens with *P. reparata*, but the other morphological similarities, the strongly white-maculate upper cortex and perforate apothecia, are so great as to leave no other choice. The problem cannot be solved without field work or access to good recent collections from Australia. In Mexico, it seems that *P. reparata* is very closely related to and probably the nonsorediate counterpart of *P. leucosemotheta* Hue.

Additional specimens examined:

U.S.: ALABAMA: Mobile, Mobile Co., *Mohr* s.n. (US). MEXICO: VERACRUZ: 9 km. east of Jalapa, *Hale* 19406, 19394 (US); northeast of Huatusco, *Hale* 19529 (US); OAXACA: 32 mi. northwest of Oaxaca, *Cain* 27566a (TRT, US); CHIAPAS: El Sumidero, Tuxtla Gutiérrez, *Hale* 20078a (US).

AUSTRALIA: QUEENSLAND: Brisbane, *Bailey* s.n. (BM). NEW ZEALAND: North Island, *Gobby* s.n. (BM); Ashburton, *Allan* (BM).

102. Parmelia rigida Lynge, Ark. Bot. 13, no. 13:50, *pl. 2, fig. 2.* 1914.

Type collection: Piratiny, Rio Grande do Sul, Brazil, *Malme* 827B (S, holotype).

Thallus loosely attached, 6–12 cm. in diameter, mineral gray; lobes often suberect, rotund, 6–12 mm. wide, margins crenate to laciniate, ciliate, cilia 1–3 mm. long; upper surface shiny, minutely pitted, strongly white-maculate, rugose with age, soredia and isidia lacking; lower side black and sparsely rhizinate at the center, white

to ivory and naked in a broad zone along the margins. Apothecia common, pedicellate, to 20 mm. in diameter, exciple rarely ciliate, amphithecium rugose, white-maculate, disc perforate; hymenium 60–80 μ high; spores variable, 7–12×14–19 μ, episporium 1.0–1.5 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Parmelia rigida is virtually indistinguishable from *P. perforata* without chemical tests. There are two main differences which may be cited to justify recognizing two distinct species. First, *P. rigida* occurs in extreme southern United States (fig. 29), most commonly

FIGURE 29.—Distribution of *Parmelia rigida* Lynge in the United States.

near shorelines, as well as in South America, whereas *P. perforata* has not been collected in South America and has a much broader distribution in North America (fig. 7). Second, the spores of *P. rigida* are more variable and on the whole slightly larger than those of *P. perforata*. Both species occupy similar habitats in the canopy of deciduous trees. Field studies in Florida have shown that the two species rarely grow mixed at the same locality.

Additional specimens examined:

U.S.: NORTH CAROLINA: Shakleford Banks, Carteret Co., *Culberson* 4919 (DUKE); Smith Island, Brunswick Co., *Culberson* 8005 (DUKE, US); SOUTH CAROLINA: Myrtle Beach, Horry Co., *Culberson* 9085 (DUKE); Isle of Palms, Charleston Co., *Culberson* 9049 (DUKE); GEORGIA: 10 mi. south of Greensboro, Greene Co., *Culberson* 6599 (DUKE, US); ALABAMA: Gulf Beach, Baldwin Co., *Hale* 7263 (US); near Wilmer, Mobile Co., *Hale* 7167 (US); FLORIDA: 5 mi.

south of Lokosee, Osceola Co., *Hale* 16975 (US); Tomoka State Forest, Volusia Co., *Hale* 17059 (US); Fort Myers, Lee Co., *Standley* 12898 (US); 5 mi. south of Clermont, Lake Co., *Hale* 16585 (US); Orange Park, Clay Co., *Hale* 17740 (US); 5 mi. south of Panacea, Wakulla Co., *Hale* 21918 (US); 10 mi. east of Newport, Jefferson Co., *Hale* 21710 (US); Eastpoint, Franklin Co., *Hale* 21692 (US); St. Joe Beach, Gulf Co., *Hale* 21847 (US); east of Pensacola, Escambia Co., *Hale* 7997 (US); 2 mi. north of Jonathan Dickinson State Park, Martin Co., *Imshaug* 23975 (MSC); Sanford, Seminole Co., *Rapp* s.n. (FLAS); MISSISSIPPI: Near Hattiesburg, Forrest Co., *Hale* 7989 (US); 9 mi. south of Montrose, Jasper Co., *McDaniel* L–40 (US); TEXAS: Saratoga, Hardin Co., *Fisher* 50007 (DUKE); Barreda, Cameron Co., *Runyon* 1587 (MSC); Yturria Ranch, Willacy Co., *Runyon* 3821 (MSC); west of San Augustine, San Augustine Co., *Hale* 5234 (US); Pineland, Sabine Co., *Hale* 5159 (US); Corpus Christi, Nueces Co., *Palmer* 11212 (US); east of Franklin, Robertson Co., *Walker* 45 (US).

BRAZIL: RIO GRANDE DO SUL: Piratiny, *Malme* 827* (S). URUGUAY: Yazuarg, Dept. Tacuarembó, *Rosengurtt* 2861 (US). ARGENTINA: JUJUY: Near Quinta, *Fries* 27 (S).

103. Parmelia schimperi Müll. Arg. Hedwigia 31:276. 1892.

Type collection: Near Debra, Ethiopia, *Schimper* 13 (G, lectotype; H, UPS, isotypes).

Thallus 10–15 cm. in diameter, loosely adnate to bark, mineral gray; lobes rotund, 10–12 mm. wide, margins entire, sparsely ciliate, cilia 0.5–1.0 mm. long; upper surface plane, strongly white-maculate; lower side black and moderately rhizinate, brown and naked in a broad zone at the margins. Apothecia to 10 mm. in diameter, amphithecium rugose, maculate, disc usually perforate; hymenium 65–70 μ high; spores 10–12×17–22 μ, episporium 1.0–1.5 μ thick.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present.

This distinctive species is still known only from several collections of the lectotype by Schimper. Outside of the unusual chemistry, it is distinguished by the strongly maculate cortex and the black lower side. In the absence of more material, it is difficult to decide what relation it might have to other species with cryptochlorophaeic acid such as *P. abessinica* Krempelh. Additional syntypes cited by Müller (Geraz, *Schimper* 1396 and Mount Kubbi near Adoa) were not found at Geneva and their identity is unknown.

104. Parmelia subcolorata Hale, sp. nov.

Thallus late expansus, laxe adnatus, rigidus, 10–15 cm. latus, lobis rotundatis, usque ad 15 mm. latis, margine integris, ciliatis, ciliis 1.0–2.5 mm. longis, superne nitidus, plus minusve valde albomaculatus, strato corticeo superiore 14–18 μ crasso, strato gonidiali 13–16 μ crasso, medulla aurantiaco-flavida pro maxima parte, partim alba, 100–135 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus vel albovariegatus, late nudus. Apothecia usque ad 15 mm. lata, pedicellata, amphithecio

rugoso, albomaculato, disco imperforato; hymenium 50–60 μ altum; sporae 8–10×13–16 μ, episporio 1.0–1.5 μ crasso; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K+, C+, KC+ intensius lutea, P−, atranorinum, pigmentum K− ignotum continens.

Type in the Rijksherbarium, Leiden, collected in Tinderet Forest Reserve, Kisumu-Londiani, Nyanza, Kenya, Aug. 1, 1949, by R. A. Maas Geesteranus (no. 5359; isotype in US).

Parmelia subcolorata is a large conspicuous lichen known from only two localities in Africa. It differs significantly from similarly pigmented species (*P. myelochroa* Hale, *P. araucariarum* Zahlbr., etc.) in having distinct maculae, perforate apothecia, and long coarse cilia.

CONGO: Southwest side of Lake Kivu, Nulungu, *Degelius*, Mar. 19, 1960 (DEGEL).

105. Parmelia subrugata Krempl. Verh. Zool. Bot. Gesell. Wien 18:320. 1868.

PLATE 16

Parmelia latissima f. *subrugata* Nyl. *in* Fourn. Mex. Pl. 1:3. 1872. Type collection: Brazil (H, holotype).

Parmelia cyathina Stirton, Scot. Nat. 4:252. 1877–78. Type collection: Near Brisbane, Australia, *Bailey* 3 (GLAM, holotype).

Parmelia sinensis Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:187. 1899. Type collection: Near Yent-ze-Hay, Yunnan, *Delavay*, Aug. 8, 1888 (P, lectotype).

P. subrugata f. *integra* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:204. 1899. Type collection: Brazil, *S. M. Theresa Christina* (P, holotype).

P. subrugata f. *arcuata* Lynge, Ark. Bot. 13, no. 13:48. 1914. Type collection: Porto Alegre, Rio Grande do Sul, Brazil, *Malme* 440 (S, holotype).

P. amaniensis Stein. & Zahlbr. Bot. Jahrb. Engler 60:526. 1926. Type collection: Amani, East Usambara, *Brunnthaler* s.n. (W, holotype).

Type collection: Organ Mountains, Minas Gerais, Brazil, *Helmreichen* s.n. (M, holotype).

Thallus loosely attached, corticolous, 7–15 cm. broad, mineral gray, turning buff in the herbarium; lobes rotund, 7–15 mm. wide, often soon crowded, convoluted, and obscured by lobules, margins crenate to dissected-laciniate, laciniae usually becoming canaliculate, suberect, moderately ciliate, cilia 1–3 mm. long; upper surface plane to rugulose, shiny, opaque or very faintly white-maculate, distinctly maculate at the base of apothecia; medulla white, turning orange red frequently near the lower cortex; lower side black and sparsely rhizinate at the center, brown to ivory or mottled in a broad zone at the margins. Apothecia common, stalked, to 12 mm. in diameter, exciple often short dentate-laciniate, ciliate, amphithecium heavily rugose and white-maculate, disc imperforate; hymenium 100–140 μ high; spores 12–18× 26–34 μ, episporium 3–4 μ thick; pycnidia abundant, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present; medulla often pigmented, K+ purple, rhodophyscin present.

Des Abbayes (1962) was the first to place *P. sinensis* in synonymy under *P. subrugata*. These two species at first seem only distantly related. Typical *P. subrugata* has short laciniate, suberect lobes, rather distinct maculae, and a distinct pale zone below. *Parmelia sinensis*, known only from type collections, has more coriaceous lobes, less evident maculae, and darker zone below. However, both have alectoronic acid, large spores, and imperforate apothecia and must be considered as members of a single variable population. By applying these same criteria, we must also put *P. cyathina* Stirt., a coriaceous, strongly maculate species, and *P. amaniensis* Stein. & Zahlbr., a faintly maculate species, into synonymy. The amount of variation in *P. subugrata* is distressing, but separation of the plants seems to be artificial and unworkable.

Additional specimens examined:

MEXICO: Puebla: 5 km. west of Puebla-Veracruz State line on highway 150, *Hale* 19640 (DUKE, S, TNS, US); Chiapas: El Suspiro, 10 km. N. of Berriozábal, *Hale* 20207 (US). GUATEMALA: Guatemala: Volcan de Pacaya, *Standley* 58511 (MO).

HAITI: Summit of Montagne Noire, near Kenscoff, *Wetmore* 2747 (MSC).

BRAZIL: Minas Gerais: Caldas, *Regnell*, s.d. (S); Sitio, *Vain. Lich. Bras. Exs.* 994 (M, UPS); no locality, *Burchell* 1105:28 (K); Rio de Janeiro: Serra dos Orgãos, *Ainsworth & Gregory* 523 (BM). ARGENTINA: No locality, *Lorentz & Hieronymus*, 1872–74 (M).

MOÇAMBIQUE: Massangulo, *Sandrone* s.n. (F). UNION OF SOUTH AFRICA: Cape Prov.: Woodbury, Alexandria, *Hõeg*, July 20, 1929 (TRH); East London, *Höeg*, Dec. 20, 1929 (TRH).

CHINA: Yunnan: Sanyingpan, Yunnan-fu, *Handel-Mazzetti* 640 (W); Mekong-Salween, *Gebauer* s.n. (W).

AUSTRALIA: Queensland, *Bailey*, 1899 (BM).

106. Parmelia uruguensis Kremplh. Flora 61:461. 1878.

Parmelia dusenii Zahlbr. Ann. Mycol. 6:133. 1908. Type collection: Carmen de Patagones, Patagonia, Argentina, *Dusén* 158 (W, holotype; S, isotype).

P. hieronymi Lynge, Nyt Mag. Naturv. 62:88. 1925. Type collection: Abrededores, Pan de Azucar, Argentina, *Hieronymus* 34 (W, holotype).

P. perforata var. *ciliata* Ceng.-Samb. Contr. Sci. Miss. Sales. Don Bosco No. 6:45. 1930. Type collection: General Acha, Pampa, Patagonia, Argentina, *Macchi*, Apr. 25, 1910 (RO, holotype) [non *P. perforata* var. *ciliata* Nyl.].

Type collection: Córdova and Conceptión, Argentina, *Lorentz & Hieronymus* (M, holotype; isotypes in G, TUR).

Thallus loosely attached to twigs, 5–8 cm. broad, olivaceous in the herbarium; lobes rotund, often suberect, 8–15 mm. wide, margins crenate, short ciliate, cilia about 1 mm. long; upper surface plane, shiny, heavily white-maculate, reticulately cracked with age; lower side brown or blackening and short rhizinate at the center, white to

pale brown, rugose, short woolly rhizinate to the margins. Apothecia common, substipitate, to 10 mm. in diameter, exciple ciliate, disc perforate; hymenium 40–55 μ high; spores 5–7×9–13 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia uruguensis differs rather significantly from other members of series *Ornaticolae*. It is, for example, the only species with salacinic acid. It has peculiar fine, short rhizines to the margin, much as in *P. subcaperata* Krempelh. The stalked perforate apothecia, pale margin below, suberect lobes, and maculae, however, place it nearer to species in series *Ornaticolae* than to any in series *Subpallidae*. It is apparently endemic to Argentina.

Additional specimen examined:

ARGENTINA: Buenos Aires: Tandil, *Yussen* 20948 (SI).

Nomina Inquirenda

The following names are untypifiable because the type specimens are presumed lost, unavailable, or too fragmentary for study.

Omphalodium mazoense Dodge, Ann. Mo. Bot. Gard. 46:192. 1959. Type collection: Mazoe, Southern Rhodesia, *Eyles* 420 (K, holotype).

The type collection is too fragmentary for study. It is probably a *Parmelia* species in subsection *Ornaticolae*, series *Ornaticolae*, and may contain alectoronic acid.

Parmelia adspersa Vain. Hedwigia 46:168. 1907. Type collection: Lem Ngob, Thailand, *Schmidt* XV, XXXIV (TUR, syntypes; isosyntypes in C).

All of the collections seen are fragments. The chemical reaction in the medulla is K+ yellowish, C−, P+ orange red; the P+ reaction is caused by an unknown substance. Des Abbayes (1958) reported this species from Africa, but I have not seen the specimen he cited.

Parmelia arechavaletae Müll. Arg. Rev. Mycol. 10:1. 1888. Type collection: Montevideo, Uruguay, *Arechavaleta* (G, holotype).

The type collection is fragmentary and has been damaged by insects. Atranorine and stictic acid were proved, indicating that the species, if isidiate, is probably synonymous with *P. crinita* Ach.

Parmelia coriacea contexta Eschw. *in* Mart. Fl. Brasil. 1:209. 1833. Type collection: Amazon River, *Martius*.

The type has not been located and may be lost. Eschweiler's notation that it is near *P. conspersa* might mean that it is not an *Amphigymnia* species.

Parmelia coriacea rufa Eschw. *in* Mart. Fl. Brasil. 1:208. 1833; Icon. Sel. Crypt. p. 23, *pl. 13, fig. 2.* 1827. Type collection: Amazon River, *Martius.*

The type has not been located and the illustration does not help in further identifying this taxon.

Parmelia coriacea var. **urceolata** (Eschw.) Eschw. *in* Mart. Fl. Brasil. 1:207. 1833.

See entry under *Parmelia urceolata.*

Parmelia crinita Meyer, Entw. Metamor. Fortpfl. Fl. 23. 1825 (non Ach. 1814). Type collection: Rio de Janeiro, Brazil, *Beyrich.*

The type collection has not been located; the original description is extremely brief.

Parmelia crinita f. **variana** Merrill, Bryol. 11:95. 1908. Type collection: Carleton Place, Ontario, *Macoun* 3828.

The type collection was not found at Farlow Herbarium. It is probably synonymous with *P. crinita* Ach.

Parmelia flaveola Hillm. Repert. Sp. Nov. Fedde 49:197. 1940. Type collection: Na Pali-Kona Forest Reserve, Kauai, Hawaiian Islands, *Krajina* 425.

The type specimen was destroyed in World War II.

Parmelia hildebrandtii var. subcetraria Jatta, Malpighia 19:171. 1905. Type collection: Mt. Singalang, Sumatra, *Beccari* 285, 286.

The type collections have not been located.

Parmelia melanoleuca (Willd.) Zenk. Pharm. Waarenk. 1:156. 1827.
Lichen melanoleucus Willd. *in* Röm. & Usteri, Mag. für Bot. 4:9, *fig. 2.* 1788. Type collection: America meridionalis, s.c.

In Zahlbruckner's Catalogus this species is listed as a synonym of *P. perforata* (Jacq.) Ach., which does not occur in tropical America. A possible isotype (M) labeled "Auf Cort. Chin." contains stictic acid and apparently equals *P. crinita* Ach. The original collection is probably at Berlin, but I have not had an opportunity to examine it.

Parmelia melanothrix var. **lacinulata** Müll. Arg. Flora 74:376. 1891. Type collection: Andes, Bolivia, *Pearce* (K, holotype; G, isotype).

The type is a sterile species of the series *Ornaticolae* with alectoronic acid and without soredia or isidia. It is near *P. argentina* Krempih. but cannot be identified without spores.

Parmelia modesta Hue, Bull. Soc. Bot. Fr. Mém. 63 (28): 6. 1916. Type collection: British Africa, *Poncins.*

This species is missing from the collections at Paris.

Parmelia munda (Harm.) Gyel. Repert. Sp. Nov. Fedde, 30:225. 1932.

See the entry under *P. trichotera* f. *munda* Harm.

Parmelia novoguinensis Hillm. Repert. Sp. Nov. Fedde 50:334. 1941. Type collection: Station Felsspitze, New Guinea, *Ledermann* 12852.

The holotype specimen was destroyed in World War II and it is not known whether there were any isotypes.

Parmelia paxinoides Dodge, Ann. Mo. Bot. Gard. 46:119. 1959. Type collection: Andrangolaoka, Imerina, Madagascar, *Hildebrandt* (FH).

The holotype could not be found in the Farlow Herbarium. Dodge often failed to annotate his type specimens with the result that they are filed under the original determinations and effectively lost.

Parmelia pedicellata var. **isidiosa** Dodge, Ann. Mo. Bot. Gard. 46:144. 1959. Type collection: Bugishu, Bulambuli, Uganda, *Thomas* 549 p.p. (K)

The type collection was not found at Kew.

Parmelia perforata var. **denticulata** Lindsay, Trans. Roy. Soc. Edinburgh 22:212. 1859. Type collection: Singalelah, Sikkim, *Hooker* (K).

The type collection could not be found at Kew or the British Museum.

Parmelia perforata var. **digitata** Lindsay, Trans. Roy. Soc. Edinburgh 22:212. 1859. Type collection: Pedra Bonita, Brazil, *Gardner* in 1836 (K).

The type collection could not be found at Kew.

Parmelia perforata var. **incrassata** Wedd. Mém. Soc. Nat. Sci. Nat. Cherbourg 19:264. 1875. Type collection: Île d'Yeu.

The type specimen has not been located. The description suggests *Parmelia reticulata* Tayl.

Parmelia perlata var. **ceratophylla** Mont. & v.d. Bosch. *in* Jungh. Pl. Jungh. 4:442. 1855. Type collection: Mount. Ungarang, Java.

The type specimen has not been located.

Parmelia perlata var. **cinchonarum** Fée, Ess. Crypt., suppl. 119. 1837. Type collection: Peru.

The type has not been found at either Paris or Geneva.

Parmelia perlata f. **innocua** Wallr. Fl. Crypt. Germ. 3:521. 1831. Type collection: Germany?

The type collection has not been found. Wallroth lists *P. perlata* (Huds.) Ach. as a synonym.

Parmelia perlata var. **munda** Harm. Bull. Soc. Sci. Nancy, ser. 2, 14:221, 1897. Type collection: Épinal, Vosges, France, *Berher*.

The type collection could not be found in the Harmand herbarium at Duke University.

Parmelia perlata var. **munda** subvar. **innocua** Harm. Bull. Soc. Sci. Nancy, ser. 2, 14:221. 1897.

This taxon appears to be based on the same type as *P. perlata* var. *munda* cited above.

Parmelia perlata var. **opaca** Müll. Arg. Mém. Soc. Phys. Nat. Hist. Genève 16:372. 1862. Type collection: Geneva, *Müller* (G).

Müller's original specimen could not be found at Geneva.

Parmelia perlata f. **pilosa** Grognot, Pl. Crypt. Cell. 56. 1863. Type collection: Brisecou, near Autun.

The type collection has not been found.

Parmelia perlata subvar. **punctulata** Mont. *in* Sagra, Hist. Ile Cuba. Bot. 42. 1838. Type collection: Near Havana, Cuba, *Sagra*.

The location of the type specimen is unknown.

Parmelia perlata f. **soralifera** Woron & Pachun *in* Pakhunova, Trud. Tiflissk Bot. Inst. 1:312. 1934. Type collection: Crater of Mukhera, *Pakhunova*, 1925.

The type specimen has not been examined.

Parmelia perlata f. **sorediifera** Oxner, Bull. Jard. Bot. Kiev 1:33. 1924. Type collection: Minsk.

The type specimen has not been examined.

Parmelia platycarpa Stirt. Scot. Nat. 4:252. 1877–78. Type collection: Near Brisbane, Australia, *Bailey* (BM, holotype).

The type collection is in such poor condition that it could not be used as the basis for a description. The chemical constituents are atranorine and stictic acid, and the spores, as Stirton found, are large (30–37 μ long). This species differs from others with stictic acid in lacking cilia.

Parmelia proboscidea var. **sorediifera** f. **saxicola** Ceng.-Samb. Nuov. Giorn. Bot. Ital. 45:381. 1938. Type collection: Mohulo, Kipengere, Tanganyika, *Eusebio* 13 ter.

The type specimen has not been examined.

Parmelia pseudovirens Gyel. Repert. Sp. Nov. Fedde 29: 288, 1931.

See entry under *P. virens* β *sorediata* Müll. Arg.

Parmelia trichotera f. **dissecta** Oliv. Mem. Acad. Cienc. Art. Barcelona, ser. 3, 16:485. 1921 [not seen].

The type specimen has not been examined.

Parmelia trichotera f. **microphylla** B. de Lesd. ex Harm. Lich. France 4:582. 1909. Type collections: Petite Synthe, Dunkerque, *Lesdain*; La Massane, Pyrenees, *Weddell*.

The specimens in Bouly de Lesdain's herbarium were lost; no duplicates have been found in the Harmand herbarium at Duke University.

Parmelia trichotera f. **munda** Harm. Lich. France 4: 582. 1909.

The type collection could not be found in Harmand's herbarium at Duke University.

Parmelia trichotera var. **plombii** B. de Lesd. Rev. Bryol. Lichen. 19:235. 1950. Type collection: Cestas, Gironde, France, *Plomb*.

The type collection has not been available for study.

Parmelia uberrima Hue, Bull. Soc. Bot. Fr. Mém. 63:9. 1916. Type collection: British Africa, *Poncins*.

The type has not been found in Hue's herbarium at Paris.

Parmelia urceolata Eschw. Icon. Pl. Crypt. 23. 1827.

This species is illustrated by a color plate which unfortunately has so little detail that identification is impossible. It is obviously near *P. argentina* Kremplh. or *P. subrugata* Kremplh., and if the type is found (and typification is made), *P. urceolata* will be the earliest name for one of the species in this group.

Parmelia urceolata var. **sorediifera** Müll. Arg. Flora 63:266. 1880. Type collection: Petropolis, Brazil, *Deventer* (G, holotype).

The type specimen is an indeterminable scrap.

Parmelia virens β sorediata Müll. Arg. Flora 69:256. 1886. Type collection: Toowoomba, Queensland, Australia, *Hartmann* 49 (G, holotype).
Parmelia pseudovirens Gyel.

The type specimen is in poor condition. It is obviously close to *P. leucosemotheta* Hue since it is heavily maculate and contains salacinic acid. It could also be near *P. subsumpta* Nyl. No sound judgment can be made until additional material from Australia is seen.

Nomina Rejicienda

Parmelia glaberrima Kremplh. Flora 52:223. 1869. Type collections: Surinam, *Wuhlschlegel* (not seen); Assam, India, *Simons* 397 (M).

This name is a later homonym of *P. glaberrima* Fr. (Syst. Orb. Veg. 1:283. 1825), a *Lobaria* species. The Assam specimen at M is too poor for adequate study.

Parmelia latissima f. sorediata Kremplh. Journ. Mus. Godeffroy 41:100. 1873. Type collection: Ovalau, Fiji, *Gräffe* 26(?).

This name is a nomen nudum.

Parmelia neohollandica Nyl. Flora 69:324. 1886.

Although Nylander wrote a short Latin description, there is no indication of the locality, except as indicated by the specific name *neohollandica*, i.e. Australia. The only specimen so labeled at Helsinki is an unidentifiable scrap collected by Verreaux.

Parmelia perforata var. **isidioidea** Kremplh. Denkschr. Kgl. Bayer. Bot. Gesell. 4:130. 1861.

This is a nomen nudum.

Parmelia perforata f. sorediifera (Müll. Arg.) Merrill, Bryol. 30:87. 1927.

The basionym of this taxon is unknown.

Parmelia perlata var. **laciniata** Nyl. Mem. Soc. Imp. Sci. Nat. Cherbourg 5:301. 1857.

This is a nomen nudum; there is no specimen at Helsinki under this name.

Parmelia perlata var. **olivetorum** f. **isidiophora** Kremplh. Verh. Zool. Bot. Gesell. Wien 18:321. 1868. Type collection: Guatemala, 1841, *Friedrichsthal*.

This is a nomen nudum. The type specimen was not found at Munich.

Parmelia perlata var. platysmoides Nyl. ex Stizenb. Ber. St. Gall. Naturw. Gesell. 1888–89: 157. 1890. Cited collections: Teneriffe, *Perrandière*; Madeira, *Mandon*.

This is a nomen nudum. The first collection is at Helsinki; it is *P. crinita* Ach. The second could not be found.

Excluded Names

Many species placed in the subgenus (or section) *Amphigymnia* in catalogs and floristic lists actually belong to other subgenera in *Parmelia*. Names in the following lists, based on studies of type specimens, are drawn principally from Asahina (1952), Dodge (1959), Hillmann (1934), Lynge (1914), Magnusson (1955), Maas Geesteranus (1947), Tavares (1945), Vainio (1890), and Zahlbruckner (1909, 1929). These species are currently being investigated in the course of monographing other subgenera in *Parmelia*. They are listed here merely to justify their absence in lists of synonyms in this monograph.

The following species belong in subgenus *Parmelia*.

Parmelia albaniensis Dodge, Ann. Mo. Bot. Gard. 46:121. 1959.
P. antillensis Nyl. Bull. Soc. Linn. Norm., ser 2, 3:264. 1868.
P. aptata Kremplh. *in* Nyl. Flora 52:291. 1869.
P. badia Pers. *in* Gaud. Voy. Uranie 198. 1827.
P. balansae Müll. Arg. Rev. Mycol. 10:1. 1888.
P. balansae var. *sorediata* Müll. Arg. Rev. Mycol. 10:2. 1888.
P. biformis Vain. Phil. Journ. Sci. 4:660. 1909.
P. blastica Vain. Journ. Bot. Brit. For. 34:32. 1896.
P. canaliculata Lynge, Ark. Bot. 13, no. 13:28. 1914.
P. caperata (L.) Ach. Meth. Lich. 216. 1803.
P. caperatula (Nyl.) Nyl. Flora 68:606. 1885.
P. coralloidea (Mey. & Flot.) Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:33. 1890.
P. crozalsiana B. de Lesd. *in* Harm. Lich. Fr. 4:368. 1909.
P. cyliphora (Ach.) Vain. Acta Soc. Faun. Fl. Fenn. 13, no. 6:7. 1896.
P. ecaperata Müll. Arg. Flora 74:378. 1891.
P. euplecta Stirt. Scot. Nat. 4:299. 1877–78.
P. ghattensis Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:198. 1899.
P. hansfordii Dodge, Ann. Mo. Bot. Gard. 46:127. 1959.
P. hawaiiensis Magn. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:106. 1944.
P. herreana Zahlbr. Cat. Lich. Univ. 6:239. 1929.
P. hypomilta Fée, Ess. Crypt., suppl. 123. 1837.
P. immiscens Nyl. Flora 68:606. 1885.
P. inhaminensis Dodge, Ann. Mo. Bot. Gard. 46:130. 1959.
P. leucoxantha Müll. Arg. Flora 64:85. 1881.
P. livido-tessellata Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:191. 1899.
P. martinicana Nyl. Flora 68:609. 1885.
P. meiosperma (Hue) Dodge, Ann. Mo. Bot. Gard. 46:139. 1959.

P. michauxiana Zahlbr. Cat. Lich. Univ. 6:244. 1929.
P. microsticta Müll. Arg. Flora 62:164. 1879.
P. nairobiensis Stein. & Zahlbr. Bot. Jahrb. Engler 60:517. 1926
P. negata Nyl. Bull. Soc. Linn. Norm., ser. 2, 6:270. 1872.
P. nimandairana Zahlbr. Repert. Sp. Nov. Fedde 33:55. 1934.
P. nipponica Zahlbr. Bot. Mag. Tokyo 41:353. 1927.
P. nylanderi Lynge, Ark. Bot. 13, no. 13:82. 1914.
P. olivaria (Ach.) Fr. Lich. Scand. 1:112. 1871.
P. owaniana Stirt. Trans. Glas. Soc. Field Nat. 5:213. 1877.
P. perlata var. *subrevoluta* Müll. Arg. Flora 63:267. 1880.
P. praeperlata Nyl. Flora 69:319. 1886.
P. pseudoreticulata Tav. Acta Port. Biol. 1B:138. 1945.
P. ramulicola Dodge, Ann. Mo. Bot. Gard. 46:172. 1959.
P. raunkiaeri Vain. Ann. Acad. Sci. Fenn. 6, no. 7:19. 1915.
P. riograndensis Lynge, Ark. Bot. 13, no. 13:26. 1914.
P. rudecta Ach. Syn. Lich. 197. 1814.
P. ruminata Zahlbr. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:107. 1944.
P. somaliensis Müll. Arg. Flora 68:501. 1885.
P. soredians Nyl. Flora 55:421. 1872.
P. steineri Dodge, Ann. Mo. Bot. Gard. 46:125. 1959 [non *P. steineri* Gyel.].
P. subcaperatula Nyl. Flora 68:606. 1885.
P. subglauca Nyl. *in* Gasil. Journ. de Bot. 8:126. 1894.
P. subpluriformis Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:172. 1909.
P. subpraesignis Nyl. Lich. Environ. Paris 36. 1896.
P. tabacina Mont. & v.d. Bosch. *in* Mont. Syll. Gen. Sp. Crypt. 327. 1856.
P. wainioana Lynge, Ark. Bot. 13, no. 13:87. 1914.
P. wallichiana Tayl. London Journ. Bot. 6:176. 1847.

The following species should be classified in the subgenus *Xanthoparmelia* (Vain.) Hale.

Parmelia amphixantha Müll. Arg. Flora 71: 139. 1888.
P. dichotoma Müll. Arg. Flora 69: 257. 1886.
P. hypopsila Müll. Arg. Flora 70: 317. 1887.
P. implexa Stirt. Ann. Rep. Trans. Glasgow Soc. Field Nat. 1872–73: 20. 1873.
P. stramineonitens Zahlbr. Ann. Hist. Hofm. 11: 195. 1896.
P. subflabellata Stein. Bull. Herb. Boiss., ser. 2, 7: 639. 1907.
P. wrightii Dodge, Ann. Mo. Bot. Gard. 46: 128. 1959.
P. zeyheri Dodge, Ann. Mo. Bot. Gard. 46: 132. 1959.

The following species have pseudocyphellae and are related to *Parmelia cetrarioides* (Del.) Nyl. The exact position of this group in the genus *Parmelia* has not yet been determined.

Parmelia andreana Müll. Arg. Rev. Mycol. 1: 169. 1879.
P. cetrarioides (Del. *ex* Duby) Nyl. Flora 52: 289. 1869.
P. ethiopica Dodge, Ann. Mo. Bot. Gard. 46: 123. 1959.
P. kernstockii Lynge & Zahlbr. *in* Zahlbr. Ann. Nat. Hofm. Wien 27: 271. 1913.
P. lobarina Zahlbr. Ann. Mycol. 10: 381. 1912.
P. manshurica Asah. Journ. Jap. Bot. 17: 75. 1941.

P. nilescens Stirt. Scot. Nat. 4: 299. 1877–78.
P. praesignis Nyl. Bull. Soc. Linn. Norm., ser. 2, 6: 270. 1873.
P. pseudolivetorum Asah. Journ. Jap. Bot. 26: 16. 1951.
P. soredica Nyl. Flora 68: 605. 1885.

The following two species should be classified in the genus *Cetraria*.

Parmelia arisanii Zahlbr. Repert. Sp. Nov. Fedde 33: 57. 1934.
P. braunsiana Müll. Arg. Flora 64: 506. 1881.

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