

# A revision of *Cladonia* sect. *Cocciferae* in the Venezuelan Andes

TEUVO AHTI and SOILI STENROOS

Ahti, T. & Stenroos, S. 1986: A revision of *Cladonia* sect. *Cocciferae* in the Venezuelan Andes. — Ann. Bot. Fennici 23:229-238. Helsinki. ISSN 0003-3847

Nine species of lichens of the genus *Cladonia* (Ascomycotina: Lecanorales) sect. *Cocciferae* are reported from the Venezuelan Andes, mainly from the páramos. Three species are described as new, viz. *Cladonia leprocephala* Ahti & Stenr. (Venezuela, Colombia, Ecuador, Peru), *C. meridensis* Ahti & Stenr. (Venezuela, Colombia, Peru, Bolivia), and *C. microscypha* Ahti & Stenr. (Venezuela, Colombia). *C. symphoriza* Nyl. and *C. erythromelaena* Müll. Arg. are included in *C. miniata* G. Meyer, and *C. jamaicensis* G. K. Merrill ex Vareschi (nom. nud.) in *C. bacillaris*. The taxonomic problems posed by *C. coccifera* (L.) Willd. s. lat., *C. didyma* (Fée) Vainio s. lat., and *C. macilenta* Hoffm. s. lat. are discussed. The major phenolic constituents of each species are reported.

Key words: Lichens, *Cladonia*, taxonomy, phenols, páramo, Venezuela

*Teuvo Ahti and Soili Stenroos, Department of Botany, University of Helsinki, Unioninkatu 44, SF-00170 Helsinki, Finland*

## INTRODUCTION

The present contribution is part of a long-term project of the author Ahti for studying the neotropical species of the Cladoniaceae. The author Stenroos is primarily working on the Melanesian and S.E. Asian members of the family, with special reference to *Cladonia* section *Cocciferae*. We have examined a few thousand collections of Cladoniaceae from the Venezuelan Andes alone, i.e. the states Táchira, Mérida, Trujillo, Lara and Falcón. The extensive materials from these areas have mainly been collected by Prof. Manuel López-Figueiras in 1976-1985. Ahti also briefly collected in Mérida in 1979, and in Táchira in 1985. In addition, he has examined numerous Andean specimens in other herbaria, notably Washington (US), New York (NY), Caracas (VEN, Herb. V. Vareschi) and Utrecht (U). The main purpose of the present paper is to provide valid names for some species to be treated in a forthcoming continuation of the census of the lichens in the Venezuelan Andes by López (cf. López-Figueiras 1978).

Vareschi (1973) reported the following six taxa of *Cladonia* sect. *Cocciferae* from the Venezuelan Andes: *C. coccifera* (L.) Willd. var. *stemmatina* (Ach.) Vainio, *C. esorediata* (Asah.) Yoshim., *C. hypoxantha* Tuck., *C. hypoxanthoides* Vainio, *C. miniata* G. Meyer, and *C. vul-*

*canica* Zoll & Moritzi. Only two of these are recognized as correct here, while nine additional taxa are reported for the area.

Thin-layer chromatography (TLC) was applied in the identification of the secondary lichen substances in each species, using the standard techniques presented by Culberson (1972).

## Key to the species of *Cladonia* sect. *Cocciferae* in the Venezuelan Andes

- 1. Podetia ascyphose, subulate when immature ..... 2
- 1. Podetia scyphose, at least when mature (i.e. when with hymenial discs) ..... 9
- 2. Podetia, even very young, almost always tipped with hymenial discs, up to 1 cm in diam; generally stout, often broadly clavate, with continuous, glossy cortex; medulla conspicuously orange-red to white; basal squamules often forming large, thick, sterile tufts, the lobe margins sometimes granulose; chemistry highly variable but didymic acid common ..... 1. *C. miniata*
- 2. Podetia often without hymenia, slender, 0.3-1 mm thick; medulla white (to orange-yellow in necrotic tissues) ..... 3
- 3. Podetia esorediate and corticate, or microsquamulose or verruculose-granulose; stereome often largely exposed, pellucid or blackening ..... 4
- 3. Podetia distinctly farinose to granulose-sorediate, completely ecorticate or cortex present only at the base or right below the hymenial discs; stereome not usually extensively denuded ..... 5

4. PD-, containing barbatic and often didymic acids .... 4 a. *C. didyma* var. *didyma*
4. PD+ yellow, containing thamnolic and often didymic and/or barbatic acids ... 4b. *C. didyma* var. *vulcanica*
5. PD-, containing barbatic and often didymic acids .... 6
5. PD+ yellow, containing thamnolic and often didymic and/or barbatic acids ..... 7
6. Podetia pale grey to greenish, farinose-soresiate throughout (soredia less than 0.1 mm in diam.), or sometimes corticate below the hymenia or at base, rarely also granulose or squamulose, with thin, cottony medulla, stereome opaque, whitish ... 3. *C. bacillaris*
6. Podetia grey to green or in part embrowned to blackening, granulose to microsquamulose, granules immixed with soredia (mostly more than 0.1 mm in diam.), or in part sorediate; cottony medulla almost absent; stereome translucent, brownish ..... 4a. *C. didyma* var. *didyma*
7. Podetia very finely sorediate, ecorticate throughout, most podetia without hymenia ..... 2. *C. macilenta*
7. Podetia coarsely sorediate or esorediate, squamulose, in part corticate, often with hymenia ..... 8
8. Podetia never truly scyphose, usually 1–2.5 cm tall, slender, microsquamulose to granulose, scarcely corticate at base; cottony medulla almost absent ..... 4b. *C. didyma* var. *vulcanica*
8. Podetia subulate when young, soon producing narrow (0.2–0.4 mm) scyphi, at least before forming hymenia, usually 2–4 cm tall, stout, verruculose and squamulose, corticate at base, cottony medulla well developed .... 5. *C. microscypha*
9. Scyphi always very narrow, 0.2–0.4 mm wide, young tips subulate ..... 5. *C. microscypha*
9. Scyphi wider, 0.3–12 mm, without subulate tips ..... 10
10. Ashy to whitish-grey, without usnic acid ..... 11
10. Yellow to yellowish-grey, with usnic acid ..... 12
11. Podetia up to 1.5 cm tall, usually simple; scyphi 0.2–0.5 mm wide, gradually flaring, granulose-soresiate, granules mainly less than 0.1 mm in diam. .... 7. *C. leprocephala*
11. Podetia up to 4 cm tall, often proliferating from the margins of the scyphi, which are 0.3–0.8 mm wide, rather abruptly flaring, densely microsquamulose to granulose, esorediate, surface easily becoming denuded; granules 0.1–0.3 mm in diam. .... 6. *C. meridensis*
12. PD+ yellow, containing thamnolic acid, podetia verrucose-corticate at base, becoming granulose to microsquamulose higher up ..... 8. *C. corallifera*
12. PD-, containing zeorin, podetia corticate below the scyphi; in the herbarium with very fine needle-like crystals produced on the surface ..... 9. *C. coccifera*

## 1. *Cladonia miniata* G. Meyer

*Cladonia miniata* G. Meyer, *Entwickel. Flecht.* 149. 1825. – Type: “Südamerika” (not seen).

*Cladonia symphoriza* Nyl. in Triana & Planchon, *Ann. Sci. Nat.*, sér. 5 (Bot.), 7:303. 1867. — Type: Colombia. Boyacá: Muzo, 1 600 m, supra saxa schistosa, 1863 *A. Lindig 2553* (H-NYL p.m. 1 162, lectotype, designated here; BM, M, PC, isolectotypes). Contains barbatic, 4-O-demethylbarbatic and didymic acids.

*Cladonia erythromelaena* Müll. Arg., *Flora* (Regensburg)

65:298 (= *Lichen. Beitr.* no. 386). 1882. — Type: Brazil. “Prov. Rio de Janeiro”, 1881 *A. Glaziou 12327* (G, lectotype, designated here; G, H, M, isolectotypes). Contains barbatic acid and an unknown compound.

This species was comprehensively described by Vainio (1887), who emphasized its unusual variability in morphology and colour. It is showy and conspicuous when its medulla and the undersides of the squamules are strongly orange-red, but when they are white, it is less easily identified. However, it is commonly richly fertile, and the podetia are robust. When the podetia are slender and squamulose, or when it is sterile so that it forms thick clumps of vegetative squamules, the thick, glossy cortex serves as a diagnostic character. In the Andes the species is never sorediate, though in Brazil this state is fairly common.

The orange-red colouring is mainly due to rhodocladonic acid, a naphthoquinone, which is also responsible for the red colour of the hymenia of sect. *Cocciferae*. In addition, Huneck (in Kalb 1981) reported barbatic acid or usnic acid in *C. miniata* from Brazil. Vasconcelos and Xavier Filho (1982) also reported usnic acid. In our TLC analyses this species turned out to be extremely variable, producing more than 20 different substances. Most of these have not yet been identified, but the major substance is frequently didymic acid. The presence of barbatic, usnic, thamnolic, merochlorophaeic and porphyritic acids has also been confirmed, either as the only major substance or in combination with the others. It is still uncertain whether the chemistry can be correlated with the morphology so as to allow a reasonable taxonomic division of *C. miniata* s. lat.

*C. symphoriza*, described from the Colombian Andes, and *C. erythromelaena* are here regarded as new synonyms of *C. miniata*, though Vainio (1887) recognized them as distinct species. Vainio correctly united *C. sanguinea* Flörke and *C. secundana* Nyl. with *C. miniata* at species level (*C. secundana* was described from San Carlos de Río Negro, T. F. Amazonas, Venezuela, not from Brazil, as is often incorrectly reported).

Vainio (1887) reported *C. miniata* from Trujillo (“Truxillo”) and Mérida (given under “Colombia”), and Vareschi (1973) from Mérida. The species is widespread in Táchira, Mérida and Trujillo at elevations of 1 800–3 750 m, growing on humous or rocky soils from the upper Andean cloud forests to the lower páramos.

## Representative specimens:

Mérida: Páramo de Los Conejos, 3 750 m, 1980 *López-Figueiras* 24168 (H, MERF); La Carbonera, 2 300 m, 1978 *López-Figueiras* 17525 (H, MERF). — Táchira: Páramo de Tamá, 2 500–3 200 m, 1978 *Luteyn et al.* 7900 (H, NY); Páramo de El Zumbador, 3 400 m, 1985 *Ahti & López-Figueiras* 43840 (H, MERF, VEN). — Trujillo: Páramo de Cendé, 3 100–3 400 m, 1976 *López-Figueiras* 13093 (H, MERF); Páramo El Jabón, 2 900–3 000 m, 1976 *López-Figueiras* 13358 (H, MERF).

2. *Cladonia macilenta* Hoffm.

*Lichen macilentus* Ehrh., Pl. Crypt. 267. 1793, nom. nudum. — *Cladonia macilenta* Hoffm. Deutschl. Fl. 2:126. 1796. — Type: not typified.

The specimens included here are extremely similar to those of *C. bacillaris*, but they contain thamnolic acid, either as the sole major substance, or together with barbatic and didymic acids. The existence of morphological differences between *C. macilenta* and *C. bacillaris* is not clear in Eurasia and North America, although the species are traditionally kept apart in those regions. In the Andean material, however, the podetia of *C. macilenta* tend to be taller (3–4 cm), more branchy, acuminate, less fertile and almost completely ecorticate when compared with those of the local populations of *C. bacillaris*.

*C. macilenta* grows on decaying logs, tree bases and soil. It occurs primarily in the Andean forest, but ascends up to the subpáramo. The altitude records range from 1 225 to 2 750 m. It is known only from the states of Lara, Mérida and Trujillo.

## Representative specimens:

Lara: Sierra Portuguesa, Parque Nacional Yacambú, 1 400–1 900 m, 1978 *López-Figueiras* 15855 (H, MERF). — Mérida: near Mérida, between Finca San Eusebio and La Azulita, 1 800–1 900 m, 1976 *López-Figueiras* 13643 (H, MERF). — Trujillo: between Boconó and Las Negritas, 1 225–2 500 m, 1976 *López-Figueiras & Keogh* 11544 (H, MERF).

3. *Cladonia bacillaris* Nyl.

Not. Sällsk. Fauna Fl. Fennica Förhandl. 8:179. 1866 (preprint). — Type: not typified (see Ahti 1980:130).

*Cladonia floerkeana* subsp. *bacillaris* var. *clavata* subvar. *elegantior* Vainio, Acta Soc. Fauna Fl. Fennica 4:97. 1887. — Type: Venezuela. Caracas, 1 200 m, 1846 *Funck & Schlim* 388 p.p. (BM, isosynotype). Contains barbatic and 4-O-demethylbarbatic acids.

*Cladonia jamaicensis* G. K. Merrill ex Vareschi, Acta Bot. Venez. 8:198. 1973, nomen nudum. — Coll. orig.: (1) Jamaica. Vicinity of Cinchona, 1 500 m, 1920 *Maxon & Killip* 860 (NY). Contains didymic and barbatic acids. (2) Venezuela. Aragua: Tovar, 1 900 m, *Pittier* (VEN).

This is a widespread species in temperate and boreal zones, being well described in numerous floras, e.g. by Vainio (1887, as *C. floerkeana* subsp. *bacillaris*) and Thomson (1968). The Andean material matches with the northern material very well, except that it is more frequently fertile and often has better developed corticate areas at the base of the podetia and at the top below the hymenial discs. *C. bacillaris* contains barbatic acid and often didymic acid as well.

The correct name of *C. bacillaris* is somewhat uncertain (Ahti 1980) and it should perhaps be included in *C. macilenta* as a strain lacking thamnolic acid. *C. jamaicensis*, which has never been validly published but was reported for Venezuela by Vareschi (1973), also belongs here.

In Venezuela *C. bacillaris* commonly grows on rotten wood, or tree boles, besides humous soil, as it does elsewhere in its range. The altitude records range from 1 450 m to 3 600 m, but most specimens come from elevations of 2 000–2 600 m, i.e. from the Andean cloud forests.

## Representative specimens:

Lara: Sierra de Barbacoas, 1 450–1 800 m, 1980 *López-Figueiras* 22111 (H, MERF). — Mérida: La Carbonera, 2 400 m, 1979 *Ahti et al.* 37338a (H, MERF). — Táchira: Pregonero, Laguna García, 1 900 m, 1981 *López-Figueiras & Rodriguez* (H, MERF). — Trujillo: Páramo de La Cristalina, 2 000–2 300 m, 1976 *López-Figueiras & Keogh* 11373 (H, MERF).

4a. *Cladonia didyma* (Fée) Vainio var. *didyma*

*Cladonia didyma* (Fée) Vainio, Acta Soc. Fauna Fl. Fennica 4:137. 1887. — *Scyphophorus didymus* Fée, Essai Crypt. Ecorc. CI. 1824. — Type: Dominican Republic. "S.-Domingo, supra truncos et cortices vestustas, *D. Poiteau*" (protologue); "St. Domingue, com. cl. Fée" (PC-Montagne, probably syntype), reaction PD–.

*C. didyma* var. *didyma* may be called a sister taxon of *C. bacillaris*, having a similar chemistry (didymic and barbatic acids), but different dispersal strategy. *C. bacillaris* produces farinose soredia in abundance, whereas *C. didyma* produces microsquamules and granules, and also some soredia, in addition to fairly frequently developing hymenia. Var. *didyma* is infrequent

in the study area, being recorded from the state of Mérida only (at elevations of 1 800–2 400 m). It grows on rotten wood or humous soil.

**Representative specimens:**

Mérida: La Carbonera, 2 400 m, 1979 *Ahti et al.* 37338c (H); road to Páramo de Aricagua, Mocombo, 1 900 m, 1975 *López-Figueiras* 12778 (H, MERF).

**4b. *Cladonia didyma* var. *vulcanica* (Zoll. & Moritzi) Vainio**

*Cladonia vulcanica* Zoll. & Moritzi in Hasskarl, Natur- en Geneesk. Arch. Néerl.-Indië 1:396. 1847. — Type: Indonesia (not typified).

This is the thamnolic acid strain of *C. didyma*. It is customarily treated as a distinct species (e.g., Thomson 1968), because it is easily identified by its reaction, PD+ yellow. However, there are positively no morphological differences between var. *didyma* and the specimens with thamnolic acid (which usually also contain didymic and barbatic acids). Here the strain is tentatively regarded as a variety, but it could be considered a chemotype without a formal taxonomic rank.

Var. *vulcanica* is common in the Andes. There are numerous collections from the states of Mérida, Lara and Trujillo, but very few from Táchira. The altitude range is 1 225–3 600 m, and the habitats are on trees, wood, soil and rocks, in both forested zones and open páramos.

*C. didyma* s. lat. is a widespread tropical to warm temperate species, but also extends to cool temperate areas, at least in Patagonia and in eastern North America (up to Massachusetts).

**Representative specimens:**

Lara: Sierra de Barbacoas, Páramo de Los Nepes, 2 200 m, 1978 *López-Figueiras & Smith* 16518 (H, MERF); road Humocaro Alto to Guaitó, 2 100 m, 1978 *López-Figueiras & Smith* 16637 (H, MERF). — Mérida: La Carbonera, 2 400 m, 1979 *Ahti et al.* 37338b (H); Pico de Horma, Morro Negro, 2 400 m, 1980 *López-Figueiras & Rodríguez* 23049 (H, MERF). — Táchira: Páramo El Batallón, 3 500 m, 1975 *López-Figueiras & Keogh* 9314 (H, MERF). — Trujillo: Bococonó, Santa Rita, 1975 *López-Figueiras* 10462 (H, MERF); Carache, Mesa Arriba, 2 000–2 500 m, 1978 *López-Figueiras* 16885 (H, MERF).

**5. *Cladonia microscypha* Ahti & Stenr., sp. nova (Fig. 1)**

Thallus primarius persistens, squamulosus, lobis elongatis, crassiusculis. Podetia 1.5–2 cm alta,

glauescentia vel albo-cinerascentia, basi aurantiaca, apicibus primo subulatis, deinde scyphosis; scyphis angustissimis (0.8–2 mm); superficie areolato-corticata, esorediosa, vulgo dense microsquamulosa; squamulis retrorsis; hymenia abundantia, coccinea; acidum thamnolicum et acidum didymicum continens.

Type: Venezuela. Estado Mérida. Sierra Nevada de Santo Domingo, Páramo de Mucuchies, sector Mucubají, along trail between Laguna Negra and Mucubají, 3 500 m, open rocky páramo with wooded ravines, 1975 *M. E. Hale & M. López-Figueiras* 44447 (US, holotype; H, MERF, isotypes). Contains thamnolic and didymic acids (TLC).

Vegetative thallus consisting of persistent, well-developed squamules, born on richly branching, orange-yellow strands of subterranean prothallus; squamules elongate, lobate, c. 2–3 × 0.3–1 mm in size, fairly thick, glaucescent above, white below, becoming orange-yellow in emorient parts. Podetia 1.5–2 cm tall, 1.2–1.8 mm thick, glaucescent to whitish grey, embrowned in part, unbranched or little branched in apical parts or branching by scyphus formation; tips subulate and ascyphose at first, but soon becoming bluntish and producing narrow (0.8–2 mm wide) scyphi, at least before the production of hymenia. Surface of the podetia areolate-corticate up to c. 0.3–0.8 mm above the base, higher up ecorticate, with bare, embrowned or blackened, matt, fibrillose medulla at surface; also microsquamulose, often densely so; squamulae generally projecting downwards, c. (0.1)0.5–1.3 mm long, 0.1–0.4 mm wide, at first granular, then subterete to flattened.

Podetial wall c. 400 μm thick; cortex 30–35 μm; medulla 175–200 μm; stereome not distinctly delimited, c. 150–175 μm; surface of central canal somewhat glossy, minutely verruculose.

Hymenial discs commonly produced, usually at tips of short proliferations from scyphal margins, the separate discs finally fusing to form 1.5–3 mm wide, convex agglomerations; hymenium c. 50 μm, with 25 μm thick, red epihymenium; subhymenium indistinct, pale brown, c. 50 μm; spores 7–15 × 2.5–5 μm, oblong to fusiform. Conidiomata common, dolioliform, 0.2–0.3 × 0.1 mm, black to red at apex and inside, borne at branch tips or scyphal margins; conidia 6–8 μm, slightly arcuate to almost straight.

Chemistry: PD+ strongly yellow, K+ yellow, UV+ whitish-grey; contains thamnolic, decar-

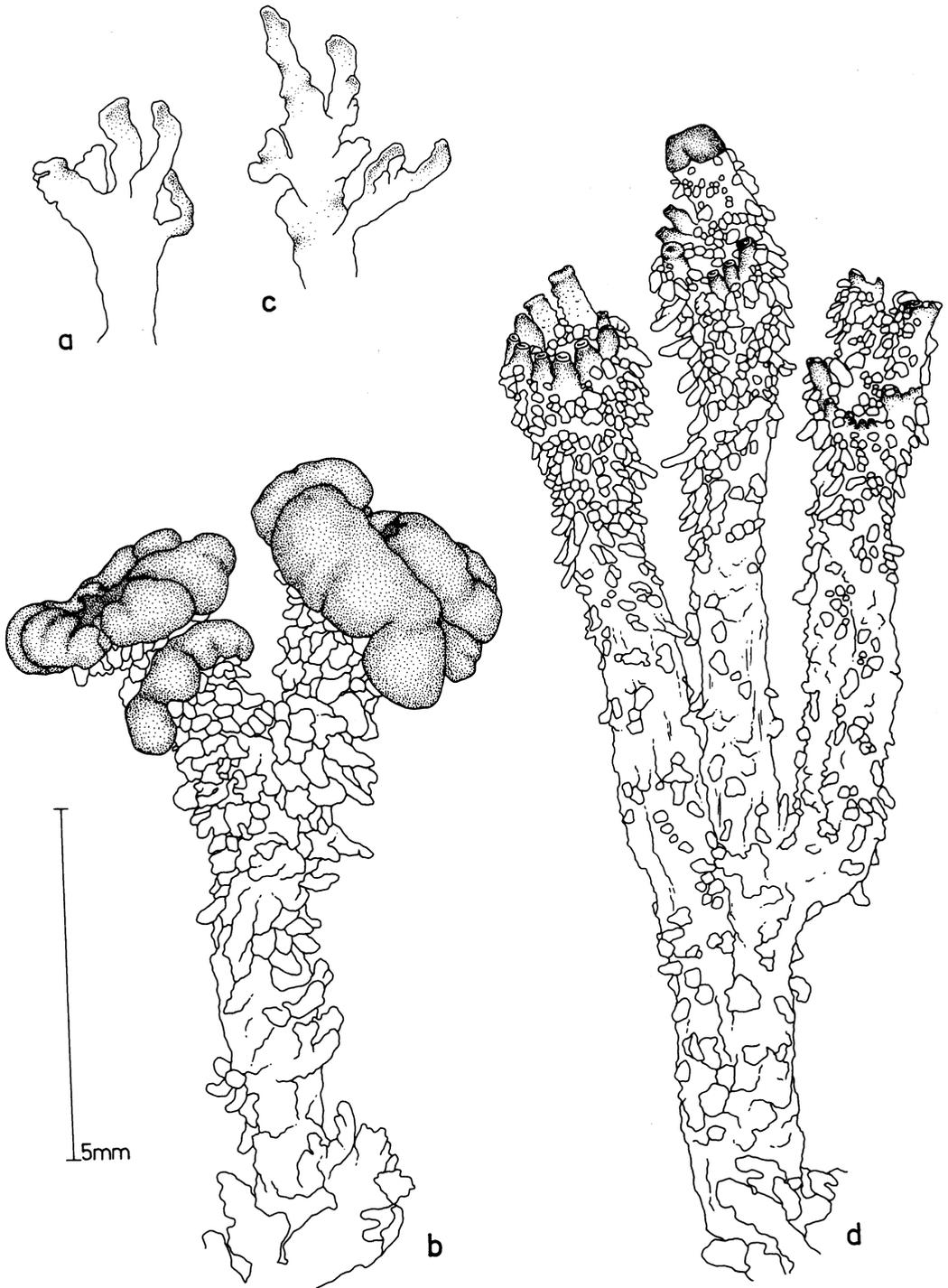


Fig. 1a-d. *Cladonia microscypha* Ahti & Stenr. (a-b Hale & López-Figueiras 44447, c-d Hale 44526, US). a, c: Squamules of the vegetative thallus. b, d: General habit showing podetia with narrow scyphi (d) and hymenia (b).

boxythamnolic (trace), didymic, condidymic (trace), subdidymic (trace) and rhodocladonic (in hymenia and conidiomata) acids, a yellow pigment, skyrin (K+ purple) in emorient parts, and other minor unknown accessory substances.

This is a very distinct species, which is primarily characterized by the production of very narrow scyphi at the ends of glaucescent, heavily squamulose podetia. The scyphi have often been overlooked and the species has been included in the chemically similar *C. didyma* var. *vulcanica*, its frequent associate. Field studies finally confirmed the distinctness of the two taxa.

*C. microscopha* is widespread in the páramos and subpáramos, sparser in the upper Andean forests at altitudes of 2300 to 3600 m, mainly growing on humous soils, including peat bogs and rock outcrops, but also on rotten wood and tree bases.

#### Representative specimens:

Venezuela. Mérida: Páramo de Mucuchies, E end of Laguna Negra, 3500–3600 m, 1975 Hale & López-Figueiras 44526 (US); Páramo de Los Conejos, 3300 m, 1980 López-Figueiras 23832 (H, MERF). — Táchira: Páramo de El Zumbador, 3400 m, 1985 Ahti & López-Figueiras 43822 (H, MERF), 43826 (H, MERF, VEN); Páramo de Tamá, 2750–3100 m, 1980 López-Figueiras 24484 (H, MERF). — Trujillo: Páramo de Guirigay, 3300 m, 1975 López-Figueiras & Ruiz-Teran 10826 (H, MERF); Páramo de Cendé, 3100–3400 m, 1976 López-Figueiras 13160 (H, MERF).

Colombia. Magdalena: Sierra Nevada de Santa Marta, Filo La Cumbre, 3800 m, 1977 Rangel *et al.* 1048 (U).

#### 6. *Cladonia meridensis* Ahti & Stenr., sp. nova (Fig. 2)

Thallus primarius squamulosus, lobis rotundatis. Podetia 1–3(4.5) cm alta, albo-cinerascentia, partim rufescentia, basi emorienti ochraceo-aurantiaca, simplicia vel ramosa, semper scyphosa; scyphis 5–12 mm latis; superficie esorediosa, ecorticata vel passim areolato-corticata, phyllidiis (diametro 0.1–0.5 mm) microsquamulisque abundanter obiecta; hymenia coccinea; conidiomata terminalia; acidum thamnolicum, vulgo autem acidum didymicum, rarius acidum barbaticum continens.

Type: Venezuela. Estado Táchira. Distrito Jáuregui: Municipio Vargas, Páramo de El Zumbador, c. 5 km S of El Cobre, 7°59'N, 72°04'W, alt. c. 3600 m, low páramo zone, wet mound by bog, 1985 T. Ahti & M. López-Figueiras 43828 (MERF, holotype; H, US, VEN, isotypes); contains thamnolic and didymic acids (TLC).

Vegetative thallus consisting of fairly erect, incurved squamules, with rounded lobes 0.5–0.7 mm wide, pale to glaucous grey, orange-yellow in dying parts, with orange streaks and dots also extending higher up on the lower sides of the squamules, usually poorly developed and evanescent when podetia mature, attached to orange-yellow subterranean prothallus strands. Podetia 1–3(4.5) cm tall, stalk 1.5–5 mm thick, whitish to glaucous grey, becoming brown at tips (especially inside the scyphi) and turning orange-yellow at bases and in other dying parts, simple or branching 2–3 times by scyphus formation, always scyphose, without subulate tips; scyphi 5–12 mm wide, 3–6 mm high, rather abruptly flaring. Surface of the podetia usually without continuous cortex but sometimes almost continuously areolate-corticate along podetial stalk or below hymenia, abundantly phyllidiose to microsquamulose; phyllidia 0.1–0.5 mm wide, flattened to spherical or somewhat elongate, centrally or distally attached, sometimes largely disintegrating so that the fibrose medulla is left bare, inside the embrowned scyphi the phyllidia particularly conspicuous against the dark background; true soredia absent.

Podetial wall 320–420  $\mu\text{m}$  thick, cortex 40  $\mu\text{m}$ ; medulla 240–280  $\mu\text{m}$  (incl. algal layer 160–200  $\mu\text{m}$ ); stereome not distinctly delimited, c. 120–160  $\mu\text{m}$ ; surface of central canal glossy, minutely uneven.

Hymenial discs fairly commonly produced, at tips of proliferations from scyphal margins, the separate discs fusing together to form 3–4.5 mm wide hymenia; hymenium 45–50  $\mu\text{m}$  thick, with 32–37  $\mu\text{m}$  thick red epihymenium; subhymenium 12–17  $\mu\text{m}$ , pale brown; spores 10  $\times$  2.5  $\mu\text{m}$ , oblong to fusiform. Conidiomata 0.2–0.3  $\times$  0.1–0.2 mm, borne at scyphal margins, black to brown outside, red inside and at apex; conidia 6–8  $\mu\text{m}$ , slightly arcuate.

Chemistry: PD+ yellow, K+ yellow, UV+ whitish to UV–; contains thamnolic acid, usually with didymic acid and sometimes barbatic acid; trace amounts of the satellite substances decarboxythamnolic, condidymic, subdidymic and 4-O-demethylbarbatic acids may also be present; rhodocladonic acid in hymenia and conidiomata and skyrin in emorient parts.

*C. meridensis* is very similar to *C. hypoxanthoides* Vainio, which was described from Serra do Caraça, Brazilian Highlands. We have seen material of the latter species from the type

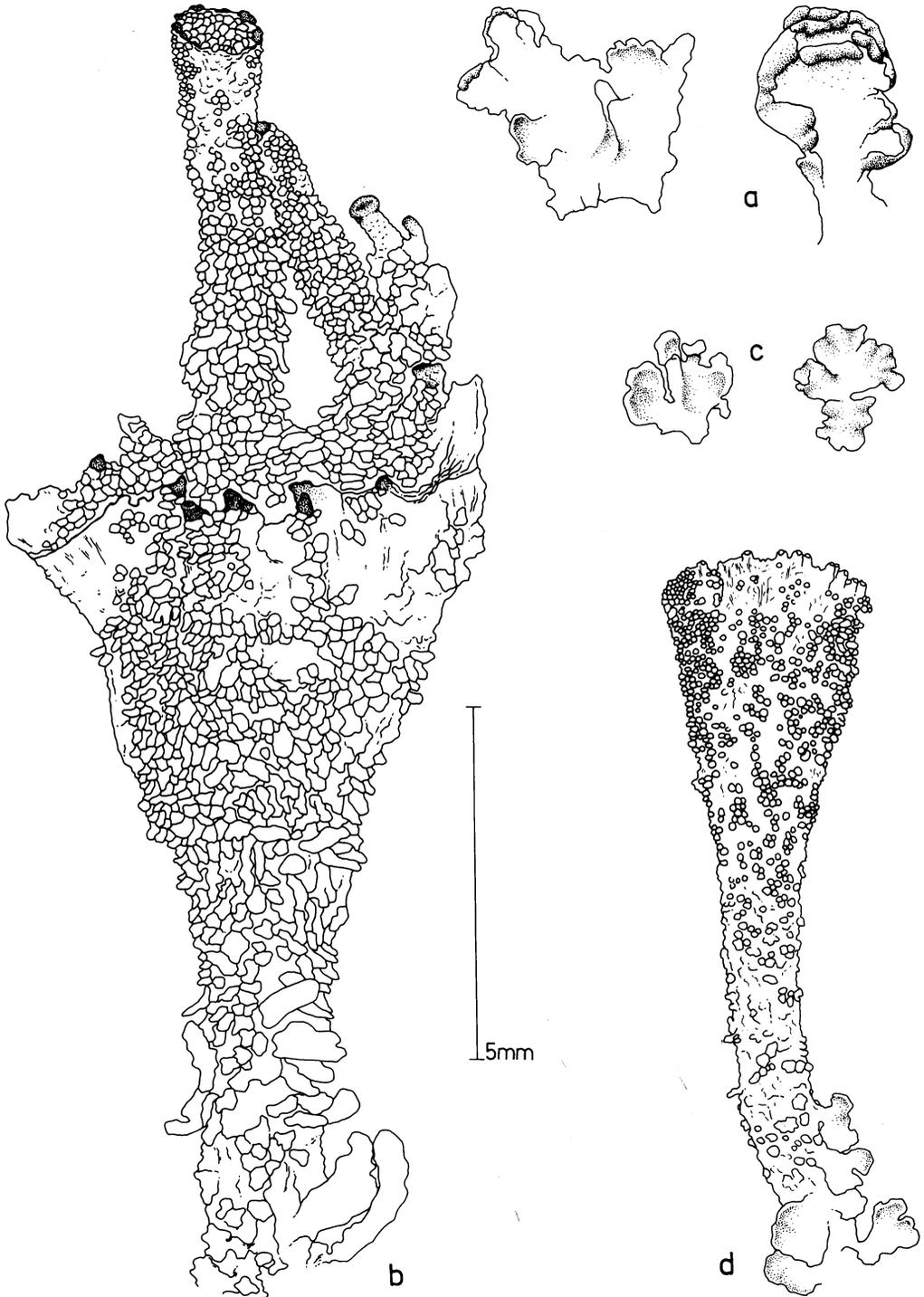


Fig. 2a-d. — a-b: *Cladonia meridensis* Ahti & Stenr. (López-Figueiras & Griffin III 31745, H). a: Squamules of the vegetative thallus. b: General habit showing branching by scyphus formation. — c-d: *Cladonia leprocephala* Ahti & Stenr. (Hale 42481, US). c: Squamules of the vegetative thallus. d: General habit.

locality only. It is exceedingly poor so that it is impossible to decide definitely whether it is different from *C. meridensis*. However, *C. hypoxanthoides* contains only thamnolic acid as its major constituent and in addition an unknown substance which gives a reddish spot in TLC ( $R_f$  values 2 in solvent A and 2 in solvent B). *C. meridensis* almost always contains didymic acid and/or barbatic acid besides thamnolic acid. Morphologically, *C. hypoxanthoides* seems to differ in developing a fairly smooth, continuous cortex on the basal parts of the podetia; in *C. meridensis* the cortex is almost absent or less well developed. Both species produce phyllidia and granules on the scyphi, but those in *C. hypoxanthoides* appear smaller and more spherical than in *C. meridensis*. The soredioid phyllidia of *C. leprocephala* are much smaller than those of *C. meridensis* and the podetia are more gradually flaring.

*C. meridensis* is a species of the páramos of the northern Andes, ranging from Venezuela through Colombia, Ecuador and Peru to Bolivia at elevations of 2 600–4 000 m. It is common in the páramos of the Venezuelan states Mérida, Táchira and Trujillo. The specimens have mostly been growing on soil, especially on thin soil over rocks, but also on dead trees.

#### Representative specimens:

Venezuela. Mérida: Páramo de San José de Acequias, 3 100 m, 1983 *López-Figueiras & Morales 30167* (H, MERF); Páramo de los Granates, 3 000 m, 1985 *López-Figueiras & Griffin III 31745* (H, MERF). — Táchira: Páramo de Los Colorados, 3 100 m 1977 *López-Figueiras 14312* (H, MERF); Páramo de Tamá, 3 000–3 300 m, 1975 *Hale & López-Figueiras 45508* (US). — Trujillo: Páramo de Guaramacal, 3 000 m, 1978 *López-Figueiras 17246* (H, MERF); Páramo El Jabón, 1985 *López-Figueiras & Griffin III 32044* (H, MERF); El Pico El Gavilán, 4 000 m, 1976 *López-Figueiras & Keogh 11785* (H, MERF).

Colombia. Cundinamarca: Bogotá, Monserrate, 3 150 m, 1971 *Nee & Mori 4220* (US). — Santander: Páramo Rico, near Vetas, 3 750–3 850 m, 1927 *Killip & Smith 17687* (NY).

Peru. Junín: Prov. Tarma, Huacapistana, 2 600–3 000 m, *Weberbauer 2105 p.p.* (WRS�).

Bolivia. La Paz: Prov. Larecaja, Sorata, 1858 *Mandon, Pl. And. Boliv. 1731* (PC).

#### 7. *Cladonia leprocephala* Ahti & Stenr., sp. nova (Fig. 2)

Thallus primarius squamulosus, inconspicuus, evanescent. Podetia 0.8–2.3 cm alta, viride-vel albo-cinerascentia, basi emorienti ochraceo-aurantiaca, simplicia, scyphosa; scyphis valde

angustis, diametro 2–2.5(3) mm; superficie areolato-corticata, parte superiore granulis vel phyllidiis (diametro usque ad 0.1 mm) soredioides obiecta, in scyphis distincte granuloso-sorediosa; hymenia coccinea; conidiomata terminalia; acidum thamnolicum, vulgo etiam acidum barbaticum, rarius acidum didymicum contentia.

Type: Venezuela. Mérida. Páramo La Negra between Delgado and Portachuelo, rocky hillside, 2 900 m, 1974 *M. E. Hale 42481* (US, holotype; H, MERF, isotypes); contains barbatic, thamnolic and didymic acids (TLC).

Vegetative thallus inconspicuous, evanescent, consisting of up to 2.5 mm long squamules, which have c. 0.5–1 mm wide, somewhat elongated lobes; lower side often largely orange-coloured. Podetia 0.8–2.3 cm tall, stalk 0.8–1.5(2) mm thick, greenish to whitish-grey, turning orange-yellow in dying basal parts, simple, rarely branching, always scyphose, without subulate tips; scyphi narrow, 2–2.5(3) mm wide, c. 2 mm high, gradually flaring. Surface of the podetia usually continuously areolate-corticate in basal parts, higher up (especially on scyphi) more finely divided into soredioid granules or phyllidia, which are mainly less than 0.1 mm across, but with age largely disintegrating, revealing the fibrose dulla; inside the scyphi clearly granulose-sorediate; podetial squamules often present, but mainly confined to the basal parts.

Podetial wall 280–360  $\mu\text{m}$  thick, cortex 40  $\mu\text{m}$ ; medulla 120–200  $\mu\text{m}$ , stereome fairly distinctly delimited, c. 80–160  $\mu\text{m}$ , surface of central canal minutely verruculose.

Hymenial discs infrequently produced, at tips of proliferations from scyphal margins; epihymenium red; no mature hymenia or conidiomata examined.

Chemistry: PD+ yellow, K+ yellow, UV+ whitish, containing thamnolic acid, often also barbatic and 4-O-demethylbarbatic (trace) acids, more rarely didymic acid, rhodocladonic acid in hymenia and conidiomata, and skyrin in emorient parts.

*C. leprocephala* may be said to be a sorediate counterpart of *C. meridensis*, although the soredia are very coarse, being sometimes very similar to the just slightly coarser phyllidia and micro-squamules of *C. meridensis*. The chemistry is the same, though barbatic acid appears to be more frequent and didymic acid less frequent in *C.*

*leprocephala*. However, the shape of the podetia is slightly different, being gradually flaring in *C. leprocephala* and more abruptly flaring in *C. meridensis* and *C. hypoxanthoides*. The latter species also has a smooth cortex on the podetial stalks.

All the specimens of *C. leprocephala* come from the páramos. The altitudes of the Venezuelan-Colombian material are 2900–4250 m, while in Ecuador the records range from 3500 to 4200 m. The species is also present in Peru.

#### Representative specimens:

Venezuela. Mérida: Páramo de Mucubají, 3500–3600 m, 1977 *López-Figueiras 14246* (H, MERF); Páramo de los Granates, 3450 m, 1985 *López-Figueiras & Griffin III 31805, 31867* (H, MERF); Páramo de Los Conejos, 3300 m, 1980 *López-Figueiras 23892* (H, MERF); Páramo de Cañaveral, 3000 m, 1978 *López-Figueiras 15355* (H, MERF). — Táchira: Páramo La Negra, 1955 *Vareschi 4328* (VEN). — Trujillo: Páramo El Jabón, 3000–3400 m, 1985 *López-Figueiras & Griffin III 32190* (H, MERF).

Colombia. Caldas: Nevado del Ruiz, La Olleta, 4250 m, superpáramo, 1972 *Cleef & Florschütz 5989* (H, U).

Ecuador. Cotopaxi: Parque Nacional Cotopaxi, slope of Volcán Cotopaxi, 3900–4100 m, 1982 *Brako 4569B* (NY), 1983 *Harris 17398* (NY), 17437 (NY, QCA), *Balslev & Briones 3583, 3700* (QCA), *Balslev & de Vries 3897* (NY). — Napo: Quito-Baeza rd., mountain pass, 4000 m, 1983 *Harris 17321* (NY, QCA); km 10 on Quito-Papallacta rd., 3500 m, 1983 *L. & A. Arvidsson 3604, 3605* (GB). — Pichincha: Cerro Antisana, 4200 m, 1983 *Brako 5009* (NY).

Peru. Ayacucho: Prov. Huanta, pass Tapuna by Tambo-Ayna rd., 3800–3850 m, 1977 *P. & E. Hegewald P328* (H).

#### 8. *Cladonia corallifera* (Kunze) Nyl.

Flora (Regensburg) 57: 70. 1874. — *Cenomyce corallifera* Kunze, printed herbarium label with description. 1827(?). — Type: Surinam, 1827 *Weigelt* (TUR-V 14165, lectotype, designated here; UPS, WRSL, isolectotypes); contains usnic, thamnolic and didymic acids.

*Cladonia corallifera* var. *kunzeana* Vainio, Acta Soc. Fauna Flora Fennica 4:178. 1887. — Homotypic with *C. corallifera*.

The specimens here included in *C. corallifera* contain usnic and thamnolic acid, and their podetia are fairly continuously corticate in the basal parts, becoming granulose (-sorediate) and microsquamulose higher up. They thus resemble some morphotypes of *C. meridensis*, except for the yellowish colour caused by the presence of usnic acid. The material is meagre and its identity is therefore somewhat uncertain. The possibility could not be excluded that it represents a rare usnic acid strain of *C. meridensis*.

*C. corallifera* is primarily a lowland Amazonian species, extending to Venezuelan Guayana, but generally absent from western South America.

The type material of *C. corallifera* contains didymic acid, but a strain with usnic and thamnolic acids alone is known from the Amazonian area as well. Vainio (1887) erroneously reported that the type of *C. corallifera* is K<sup>-</sup>, and later (in Zahlbruckner 1908) described a K<sup>+</sup> yellow chemotype of apparently the same species as *C. subcorallifera* Vainio (the type has not been examined).

#### Specimen examined:

Táchira: Laguna García near Pregonero, 1900 m, 1981 *López-Figueiras & Rodríguez 25477* (H, MERF).

#### 9. *Cladonia coccifera* (L.) Willd.

Fl. Berol. 361. 1787. — *Lichen cocciferus* L., Spec. Pl. 1151. 1753. — Type: Sweden? Herb. Linnaeus (LINN 1273.215, syntype); contains zeorin, usnic, porphyritic and "conporphyritic" acids.

*Cladonia diversa* Asperges, De Cladonia's uit de sectie Cocciferae in België 2:364. 1983. — Type: Belgium. Kalmthout, Van Gauren Ven, 1974 *Asperges 2498* (H, isotype); contains zeorin, usnic and rhodocladonic acids.

The status of the Venezuelan material of *C. coccifera* is not entirely clear. The podetia produce coarse, soredioid granules, phyllidia and microsquamules on the scyphi in much the same way as the European type of *C. coccifera* mentioned above. However, the stalk of the podetium tends to be more continuously corticate in Venezuela (representative specimen: *López-Figueiras 14883*, see below), which indicates that the material might be referable to *C. esorediata* (Asah.) Yoshim. (see Yoshimura 1968, Ahti & Lai 1979), known from East Asia, if that species is really distinguishable from *C. coccifera*.

Traditionally, since Asahina (1939) and Evans (1944), *C. coccifera* is supposed to be recognized by its content of barbatic acid, while the zeorin-containing specimens have been referred to *C. pleurota* (Flörke) Schaerer (e.g., Thomson 1968). The former species was supposed to be esorediate, while the latter is sorediate. Recently, Asperges (1983, 1985) made an attempt to recognize four species in the group, adding *C. diversa* Asperges. All the species may contain usnic acid and zeorin, but in *C. coccife-*

ra barbatic acid is reported to be almost always the major substance. However, it is probable that *C. coccifera* should be lectotypified with the syntype mentioned above, which would mean that *C. diversa* becomes a synonym of *C. coccifera*, and the barbatic acid-containing taxon requires a new name. For this reason we have adopted the name *C. coccifera*, especially since the status of *C. esorediata* is not clear, either. In any case, there is no soreciate *C. pleurota* in Venezuela. A few specimens (e.g., *López-Figueiras 24202*) lack the red pigment in the hymenia and represent f. *ochrocarpia* (Flörke ex Sommerf.) Rabenh.

*C. coccifera* is a common member of the páramo flora. Most of the specimens come from altitudes above 3 000 m.

#### Representative specimens:

Lara: Páramo de Los Nepes, 2 200–2 500 m, 1978 *López-Figueiras 17087* (H, MERF). — Mérida: Páramo de los Gra-

nates, 2 400 m, 1977 *López-Figueiras 14883* (H, MERF); Páramo de Los Conejos, 3 750 m, 1980 *López-Figueiras 24202* (H, MERF), f. *ochrocarpia*. — Táchira: Páramo de Tamá, 2 750–3 100 m, 1980 *López-Figueiras 24555* (H, MERF). — Trujillo: Páramo de Tuñame, 2 700–3 000 m, 1983 *López-Figueiras 30143* (H, MERF).

#### ACKNOWLEDGEMENTS

We are most grateful to Prof. Manuel López-Figueiras, Mérida, Venezuela, for providing us with abundant material of *Cladonia* collected in the Andes and for his invaluable assistance in the field during the visits that the author Ahti made to Venezuela. The material sent by Dr. Mason E. Hale, Washington, is also particularly appreciated. Financial support was received from The New York Botanical Garden for a stay in New York. This study is part of a long-term project on the taxonomy of the family Cladoniaceae, with special reference to the neotropical flora, which is primarily funded by the Academy of Finland. Thanks for the linguistic revision are due to Ms. Anna A. Damström, M.A.

#### REFERENCES

- Ahti, T. 1980: Nomenclatural notes on *Cladonia* species. — *Lichenologist* 12:125–133.
- Ahti, T. & Lai, M.-J. 1979: The lichen genera *Cladonia*, *Cladina* and *Cladia* in Taiwan. — *Ann. Bot. Fennici* 16:228–236.
- Asahina, Y. 1939: Über den Chemismus der Flechten der Cocciferæ (*Cladonia* subg. *Cenomyce*). — *J. Japanese Bot.* 15:22–36.
- Asperges, M. 1983: De *Cladonia*'s uit de sectie Cocciferæ in België. — 523 pp. Ph.D. thesis, Univ. Antwerpen, Wilrijk.
- Asperges, M. 1985: *Cladonia diversa* Asperges en Europe occidentale. — *Dumortiera* 32:24–31.
- Culberson, C.F. 1972: Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. — *J. Chromatogr.* 72:113–125.
- Evans, A.W. 1944: Supplementary report on the *Cladoniae* of Connecticut. — *Trans. Conn. Acad. Arts Sci.* 35:519–626.
- Kalb, K. 1981: *Lichenes Neotropici*. Fasc. 1 (no. 1–40). — 12 pp. Neumarkt.
- López-Figueiras, M. 1978: Censo de los macrolíquenes de los Andes Venezolanos. I. — 209 pp. Mérida.
- Thomson, J.W. 1968 ('1967'): The lichen genus *Cladonia* in North America. — 172 pp. Toronto.
- Vainio, E.A. 1887: *Monographia Cladoniarum universalis*. I. — *Acta Soc. Fauna Fl. Fenn.* 4:1–509.
- Vareschi, V. 1973: Resultados liquenológicos de excursiones efectuadas en Venezuela no. 3. *Catálogo de los líquenes de Venezuela*. — *Acta Bot. Venez.* 8:177–245.
- de Vasconcelos, I.A. & Xavier Filho, L. 1982: Estudo químico de *Cladonia miniata* var. *sanguinea* Flk. — *Cienc. Cult. Saúde* 2:22–26.
- Yoshimura, I. 1968: Lichenological notes. I. Some species of *Cladonia* with taxonomic problems. — *J. Hattori Bot. Lab.* 31:198–204.
- Zahlbruckner, A. 1908: *Lichenes amazonici*. Materialien zu einer Flechtenflora Brasiliens. — *Bol. Mus. Goeldi* 5:258–261.

Received 29.I.1986