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STUDIES IN BACIDIA SENSU LATO (LICHENIZED ASCOMYCETES: LECANORALES) I. THE GENUS BAPALMUIA

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Abstract: The lichen genus *Bapalmuia* is emended and monographed. Sixteen species are assigned to the genus, seven of which being new to science: *Bapalmuia cacaotica* Kalb & Lücking spec. nova, *Bapalmuia confusa* Kalb & Lücking spec. nova, *B. costaricensis* Lücking & Kalb spec. nova, *B. halleana* Sérus. spec. nova, *B. lineata* Lücking & Kalb spec. nova, *B. sorediata* Kalb & Lücking spec. nova, and *B. variratae* Sérus. spec. nova. *B. buchananii* (Stirt.) Kalb & Lücking comb. nova (= *Stereocaulon buchananii*), *B. callichroa* (Müll. Arg.) Kalb & Lücking comb. nova (= *Lopadium callichroum*), and *B. lafayetteana* (Vain.) Kalb & Lücking comb. nova (= *Bacidia lafayetteana*) are new combinations. *Bapalmuia kakouettae* Sérus. is excluded from the genus and *Byssoloma aptrootii* Sérus. is reduced into synonymy with it. *Bapalmuia* is characterized by biatorine apothecia with strongly convex disc and thin, usually evanescent margin, prosoplectenchymatous excipulum with radiating cell rows or with a labyrinthic structure, unbranched paraphyses, asci with an I+ darker tubular structure in the tholus, needle-shaped to narrowly cylindrical, multiseptate to submuriform ascospores, and small, unseptate, ellipsoid to fusiform conidia. 4,5-dichlorolichexanthone (= coronatone) is the major secundary product in all corticolous and muscicolous and in several foliicolous species. Because of apothecial anatomy and ascus structure, the genus is placed in the Pilocarpaceae. A key to all hitherto known species is provided.

Introduction

The genus *Bapalmuia* was established by SÉRUSIAUX (1993a) to accomodate the pantropical, foliicolous lichen *Bacidia palmularis* and a few supposedly related species. *Bapalmuia* was said to differ from *Bacidia* sensu stricto namely by the root-like mycelium at the apothe-

cium base, the ascus structure, and the small, simple conidia. The tholus of *Bapalmuia* was given as lacking any distinct structure, but SÉRUSIAUX (1993b) and EKMAN (1996a) demonstrated the presence of an I+ darker blue tubular structure similar to that found in *Byssoloma* (HAFELLNER 1984).

In an earlier study, KALB (1984) had proposed that the tropical corticolous *Bacidia multilocularis*, despite the different ascospore septation, was congeneric with *Bacidia callichroa*, and described the new genus *Lopacidia* for them. Apparently, this genus agreed in all important aspects with *Bapalmuia*, and we were ready to place the latter into synonymy when we discovered that the identity of the type species of *Lopacidia*, *Bacidia multilocularis*, was misinterpreted. While the material distributed in the exsiccata series, MALME & SANTESSON: Lich. Austro-am. Exs. 238 and KALB: Lich. Neotrop. 5, represents a typical *Bapalmuia*, the type specimen of *Bacidia multilocularis* is congeneric with *Bacidina phacodes* (Körb.) Vezda. Thus, *Lopacidia* does not replace *Bapalmuia*, but is the oldest available name for a genus which has been recently described several times under different names: *Lichingoldia*, *Woessia* (both in HAWKSWORTH & POELT 1986) and *Bacidina* (VEZDA 1991), of which the latter has been proposed for conservation against *Lichingoldia* and *Woessia* (EKMAN 1996b).

During our studies, a number of additional species belonging in *Bapalmuia* has been found. In this paper, we emend the genus on the basis of more anatomical and chemical characters, and provide a survey of and a key to all known species.

Material and methods

This study is based mainly on the collections of the authors and relevant type and other material housed in several major herbaria. Messurements of anatomical details were performed in water mounted slides. The chemistry was analysed by TLC or HPTLC, using the standardized method by CULBERSON & KRISTINSSON (1970), CULBERSON (1972) and CULBERSON & JOHNSON (1982).

The genus *Bapalmuia*

Bapalmuia Sérus., Nord. J. Bot. 13: 449 (1993). – Type species: *Bapalmuia palmularis* (Müll. Arg.) Sérus. – Basionym: *Patellaria palmularis* Müll. Arg., Lichenes Epiphylli Novi: 10 (1890).

Description: Thallus corticolous, muscicolous or foliicolous, crustose, smooth to granulose-effuse or provided with thin verrucae or radiate ridges, sometimes with soralia or isidioid outgrowths, pale grey to greenish grey, often with a whitish or rather dark prothallus. Photobiont a species of Chlorococcaceae (probably *Trebouxia* spp.).

Apothecia biatorine, sessile, base distinctly constricted and often with a root-like whitish mycelium. Disc (flat to) strongly convex, orange brown to dark brown or black. Margin thin, usually disappearing, rarely persistent, chamois-coloured or pale grey. Excipulum prosoplectenchymatous, with radiating cell rows (textura oblita) and then

externally sometimes with isodiametric cells, or rarely with a labyrinthic structure (textura epidermoidea) and then externally with short, free byssoid hyphae (Fig. 1). Hypothecium colourless to yellowish brown, rarely dark reddish brown or blackish brown. Epithecium indistinct or yellowish brown, sometimes encrusted with crystals, causing pruinose apothecial discs. Hymenium colourless, not inspersed. Paraphyses unbranched, apically not thickened. Asci cylindrical, tholus amyloid with an I+ darker blue tubular structure. Ascospores (4-) 8 per ascus, needle-shaped to narrowly cylindrical, transversely multiseptate to submuriform, uncoloured, not or slightly constricted at the septa, weakly halonate.

Pycnidia (found only in a few species) hemispherical to wart-shaped, often with a crater-like ostiolum. Conidia unseptate, ellipsoid to fusiform (*B. palmularis, B. nigrescens, B. halleana*), rarely bifusiform (a specimen tentatively assigned to *B. lafayetteana*). – Secondary chemistry homogenous, i. e. all corticolous and muscicolous (and some foliicolous) species contain 4,5-dichlorolichexanthone (= coronatone) (major) and lichexanthone (trace), but lichen acid deficient mutants do occur.

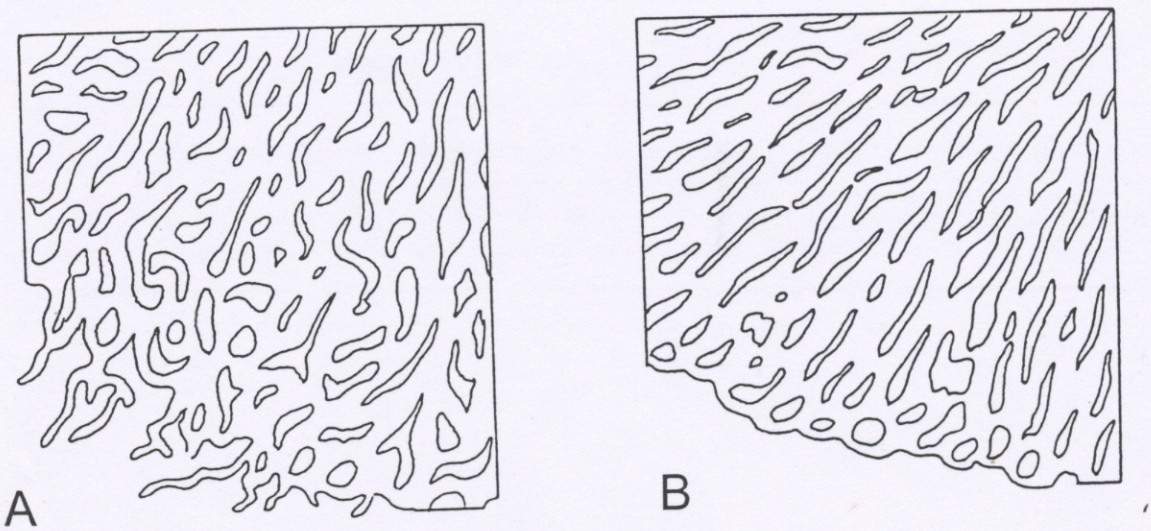

Figure 1: Excipulum structure in *Bapalmuia*. (A) *B. confusa* [Brazil, Malme 55 (S)], lateral excipulum with labyrinthic structure and free, byssoid outermost hyphae. (B). *B. lafayetteana* [TUR-Vainio 20800, lectotype], lateral excipulum with typically proso-plectenchymatous structure with radiating cell rows. Scale = 10 µm.

Notes: *Bapalmuia* is the most recent segregate of the collective genus *Bacidia* (SÉRUSIAUX 1993a). From *Bacidia* sensu stricto, it deviates mainly by its ascus type with an I+ darker tubular structure in the tholus (see HAFELLNER 1984). Additional differences are the mostly convex apothecia, the narrower ascospores and the presence of coronatone as major secundary substance, instead of atranorin in *Bacidia* (EKMAN 1996a). *Bapalmuia* is most similar to a number of mainly foliicolous species currently placed in *Bacidia* sensu lato, but belonging to a different genus (LÜCKING & KALB, in prep.). This genus has the same ascus and ascospore type as *Bapalmuia*, but differs in the paraplectenchymatous excipulum and the presence of zeorin as a major component.

The relationships between *Bapalmuia* and *Mycobilimbia* Rehm are also worth consideration. Indeed, both genera share the convex apothecia with a prosoplectenchymatous excipulum and the I+ darker blue tubular structure in the tholus. As circumscribed by HAFELLNER (1989), *Mycobilimbia* consists of two groups, the *M. hypnorum* group and the *M. sabuletorum* group. While the former is probably related to *Clauzadea* Hafellner & Bellem. (PURVIS et al. 1992), the *M. sabuletorum* group appears closer to *Bapalmuia*. However, its species have a different chemistry, typically short ellipsoid ascospores and asci with a tubular structure widening towards the ascus tip. Such asci are also found in the genus *Badimia* Vezda, which is placed in the Pilocarpaceae as well (SÉRUSIAUX 1986; LÜCKING et al. 1994). Thus, although there are certain relationships between *Mycobilimbia* p.p. and the Pilocarpaceae, we are confident about the generic separation between *Bapalmuia* and *Mycobilimbia* sensu HAFELLNER (1989).

Because of its ascus structure and other shared morpho-anatomical similarities with *Fellhanera* p.p. and *Byssoloma* p.p., we place *Bapalmuia* in the Pilocarpaceae, as suggested by SÉRUSIAUX (1993b) and EKMAN (1996a). *Bapalmuia* differs from the other genera in this family by the prosoplectenchymatous excipulum, the needle-shaped ascospores and the chemistry. Due to the presence of free hyphae in the outer part of the excipulum, a few species might be confused with *Byssoloma,* but can be distinguished by the compact, prosoplectenchymatous inner excipulum with labyrinthic structure and the needle-shaped ascospores.

So far, pycnidia are only known from the type species *Bapalmuia palmularis*, *B. nigrescens*, *B. halleana*, and a corticolous collection tentatively assigned to *B. lafayetteana*. In *B. palmularis*, *B. nigrescens*, and *B. halleana*, the conidia are ellipsoid to fusiform, while in the specimen assigned to *B. lafayetteana* they are bifusiform. Besides the excipular structure, conidia are an important feature to characterize genera within the Pilocarpaceae. Since pycnidia are only known from a few species within the genus, we cannot taxonomically evaluate the deviating conidia found in *B.* cf. *lafayetteana*. However, different types of conidia are also found within the genus *Fellhanera*, which otherwise is rather homogeneous (SÉRUSIAUX 1996; LÜCKING 1997).

Distribution and ecology: *Bapalmuia* is present in all (sub)tropical regions and extends with one species (*B. buchananii*) into cool-temperate rainforests of the southern hemisphere. While *B. palmularis* is pantropical, all other species are more or less restricted to either the Neotropics, tropical Africa or Australasia, the Neotropics showing the highest number of taxa.

The species are typical members of cryptogamic communities in the rainforest understory where they grow on bark, bryophytes or living leaves. As far as it can be stated from the material known at present, most species are rather substrate-specific, being either corticolous-muscicolous or foliicolous. While the foliicolous taxa are most common at lower altitudes, the corticolous and muscicolous representatives may occur higher up in the upper montane zone or in temperate rainforests.

Key to the known species of *Bapalmuia*

1a Spores submuriform ..... ***Bapalmuia callichroa***
1b Spores transversely septate only 2

2a Thallus sorediate 3
2b Thallus without soralia 6

3a Thallus verrucose or with radiating ridges 4
3b Thallus smooth 5

4a Thallus verrucose; ascospores 160-190 × 3.0-3.5 µm, 31-37-septate. – Tropical America ..... ***Bapalmuia verrucosa***
4b Thallus with radiating ridges; ascospores 90-130 × 1.5-2.5 µm, 25-35-septate. – Tropical America ..... ***Bapalmuia lineata***

5a Ascospores 40-55 × 3.0-3.5 µm, (8-) 12-16-septate – Tropical Australia .. .. ***Bapalmuia sorediata***
5b Ascospores 80-100 × 2.0-3.0 µm, 15-25-septate – Tropical Asia (Papua New Guinea) ..... ***Bapalmuia variratae***

6a Thallus corticolous or muscicolous 7
6b Thallus foliicolous 11

7a Apothecia light leather or cinnamon-coloured, pruinose; margin more or less the same colour as the disc, for a long time persistent and apothecial disc rather flat; ascospores 110-150 × 4.5-6 µm, 35-40-septate. – Tropical America ..... ***Bapalmuia confusa***
7b Apothecia ochraceous to blackish brown, naked; margin paler than the disc, soon disappearing and then apothecial disc strongly convex; ascospores not broader than 4.5 µm 8

8a Excipulum with labyrinthic structure and externally with short hairs; ascospores usually less than 3 µm broad 9
8b Excipulum with radiating cells rows and externally smooth; ascospores usually more than 3 µm broad 10

9a Ascospores 140-160 × 2.0-2.5 µm, 25-40-septate; thallus smooth. – Tropical Africa ..... ***Bapalmuia cacaotica***
9b Ascospores 70-105 × 2.5-3.0 µm, 20-28-septate; thallus smooth to very minutely squamulose and with isidioid outgrowths when old. – Tropical Africa ..... ***Bapalmuia halleana***

10a Ascospores 85-150 × 2.5-3.5 µm, 35-50-septate. – Tropical America .... ***Bapalmuia lafayetteana***
10b Ascospores 130-240 × 3.5-4.0 µm, 28-74-septate. – Australasia .... ***Bapalmuia buchananii***

11a Apothecia vertically elongated; ascospores very long (320-510 µm), with very numerous septa (70-100). – Tropical Asia .... ***Bapalmuia marginalis***
11b Apothecia not vertically elongated; ascospores shorter (up to 190 µm), with less septa (up to 39) 12

12a Ascospores longer than 70 µm and with more than 20 septa 13
12b Ascospores not exceeding 50 µm and with up to 11 septa 17

13a Ascospores 160-190 × 2.5-3.5 µm; thallus verrucose, sometimes additionally with soralia; apothecia mostly blackish brown, more rarely reddish brown. – Tropical America ..... ***Bapalmuia verrucosa***
13b Ascospores not exceeding 130 × 2.5 µm 14

14a Thallus with radiating ridges, often additionally with soralia; ascospores 90-130 × 1.5-2.5 µm, 25-35 septate ..... ***Bapalmua lineata***
14b Thallus smooth, without soralia **15**

15a Hypothecium light orange brown; excipulum with radiating cell rows and externally with smooth surface; ascospores 70-120 × 1.5-2.5 µm, 25-35 septate. – Pantropical ..... ***Bapalmuia palmularis***
15b Hypothecium orange brown to dark reddish brown; excipulum with labyrinthic structure and externally with short hyphae; ascospores 70-105 × 2.0-3.0 µm, 20-30-septate **16**

16a Hypothecium dark reddish brown, K+ purple. – Tropical America ..... ***Bapalmuia costaricensis***
16b Hypothecium orange brown, K–. – Tropical Africa ..... ***Bapalmuia halleana***

17a Apothecia dark grey to black. – Ascospores 7-9-septate. – Tropical America ..... ***Bapalmuia nigrescens***
17b Apothecia orange brown or ochraceous yellow to reddish brown **18**

18a Apothecia vividly orange brown, usually marginally hypophyllous; ascospores 7-11-septate. – Tropical Africa ..... ***Bapalmuia ivoriensis***
18b Apothecia ochraceous yellow to reddish brown, usually epiphyllous; ascospores 5-7-septate. – Tropical America ..... ***Bapalmuia consanguinea***

The species

Bapalmuia buchananii (Stirt.) Kalb & Lücking comb. nova

Basionym: *Stereocaulon buchananii* Stirt., Trans. Proc. New Zealand Inst. **7:** 367 (1875). – Type: NEW ZEALAND. prope Wellington, 18. IX. 1874, J. Buchanan s.n. (GLAM!, lectotype fide LAMB 1954: 121).

Bacidia pedicellata Knight, Trans. Proc. New Zealand Inst. **12:** 372 (1880). – Type: NEW ZEALAND. S. loc. (prope Wellington), s. dat., C. Knight (WELT, fide GALLOWAY 1985: 29).

Lecidea subglobosa Nyl., Lichenes Novae Zelandiae: 93 (1888). – Type: NEW ZEALAND, s. loc. (prope Wellington), s. dat., C. Knight (H-NYL).

Patellaria wilsonii Müll. Arg., Flora **71:** 541 (1888). – Type: AUSTRALIA.Victoria: Mt. Macedon, Black Spur, s. dat., F. R. M. Wilson (G).

Gomphillus baeomyceoides F. Wilson, J. Linn. Soc. London **28:** 370 (1891). – Type: AUSTRALIA. Victoria: Mt. Macedon, Black Spur, s. dat., F. R. M. Wilson 65 (BM, lectotype).

Bacidia exaltata A. Zahlbr., Denkschr. Akad. Wiss. Wien, Math.-Naturw. Kl. **104:** 319 (1941). – Type: NEW ZEALAND. Hawke's Bay, Mackinnen's Bush near Wairoa, on damp bank, s. dat., E. A. Hodgson (ZA 3550, lectotype; CHR 373615).

Description: Thallus corticolous or muscicolous, smooth to sometimes granular-effuse, grey to greenish grey. Apothecia scattered to rarely confluent, sessile, 0.5-2.0 mm in diam., obconical; disc strongly convex, pale brown to flesh coloured, non-pruinose; margin chamois-coloured, thin, soon disappearing. Excipulum prosoplectenchymatous, with radiating cell rows, c. 150 µm broad; hypothecium centrally 200-350 µm high, colourless to light yellowish brown; epithecium indistinct; hymenium c. 170-350 µm high. Asci cylindrical, 200-250 × 16-20 µm. Ascospores 8 per ascus, in a bundle, 25-75-septate, 130-240 × 3.5-4.0 µm, 40-60 times as long as broad. Pycnidia not observed. Chemistry: 4,5-dichlorolichexanthone (= coronatone).

Notes: This species is very similar to *Bapalmuia lafayetteana*, but differs in the larger ascospores with more numerous septa, and in the Australasian distribution.

Distribution and ecology: As already indicated from the rich synonymy, this lichen is widespread in Australia (Queensland, New South Wales, Australian Capital Territory, Victoria, Tasmania) and New Zealand (North Island, South Island and Stewart Island). It grows on humid bark, partly overgrowing mosses and hepatics in cool-temperate forests.

Additional specimen examined: AUSTRALIA. **AUSTRALIAN CAPITAL TERRITORY**: Tidbinbilla Nature Reserve, c. 40 km SW of Canberra, Cascades Trail, 35° 27' S, 148° 53' E, 1000 m, humid sclerophyll forest with *Eucalyptus fastigiata, Dicksonia antarctica, Acacia* spec., *Olearia* spec. and *Bedfordia* spec., corticolous and muscicolous, 2. VIII. 1992, K. & A. Kalb, J. Curnow, H. Lepp (hb. KALB 32618).

Bapalmuia cacaotica Kalb & Lücking spec. nova

Species nova similis *Bapalmuiae palmularis*, sed differt sporis longioribus et excipulo textura epidermoidea formato. – Type: TANZANIA. **MOROGORO DISTRICT**: Uluguru Mts. above Kiiji cha Tschenzema, muscicolous on mostly rain-protected bases of old tree trunks, 07° 07´ S, 37° 36´ E, 2200-2400 m, 26. IX. 1999, A. Frisch (hb. KALB 32842, holotype).

Description: Thallus muscicolous (and hepaticolous), smooth, greenish grey to greenish. Apothecia scattered, sessile, 0.6-1.0 mm in diam.; disc slightly convex, soon half-globose, chocolate brown to blackish brown, non-pruinose; margin chamois-coloured, distinct, soon disappearing. Excipulum prosoplectenchymatous with labyrinthic structure (textura epidermoidea) and externally with short, free hyphae, colourless, 150 µm broad; hypothecium centrally 100-120 µm high, reddish brown; epithecium indistinct; hymenium c. 220 µm high. Asci cylindrical, 180-220 × 8-10 µm. Ascospores 8 per ascus, in a bundle, 25-40-septate, 140-160 × 2.0-2.5 µm, 65-75 times as long as broad. Pycnidia not observed. Chemistry: 4,5-dichlorolichexanthone (= coronatone).

Notes: This species is easily recognized by its chocolate brown, half-globose apothecia and the long and relatively thin ascospores. From the other non-foliicolous taxa, it is well distinguished by its very narrow ascospores. Its ascospore dimensions make it intermediate between the foliicolous *Bapalmuia palmularis* and *B. verrucosa*; it differs from both by its labyrinthic excipulum and from *B. verrucosa* by its smooth thallus. Morphologically and anatomically very similar is *B. halleana*, but this species has distinctly shorter ascospores.

Distribution and ecology: *Bapalmuia cacaotica* is thus far only known from the type collection from Tanzania in tropical Africa. Its occurrence in a rainforest seems to correspond to the ecology of the other species of the genus, but compared to the bulk of the species, *B. cacaotica* was found at a rather high altitude.

Bapalmuia callichroa (Müll. Arg.) Kalb & Lücking comb. nova

Basionym: *Lopadium callichroum* Müll. Arg., Flora **64:** 532 (1881). – *Lopacidia callichroa* (Müll. Arg.) Kalb, Lich. Neotrop., Fasc. 8, Schedae: 3 (1984). – Type: BRAZIL. **SÃO PAULO:** Prope Apiahy in Brasilia meridionali, Puiggari 1392 (G).

Description: Thallus corticolous or muscicolous, smooth to slightly granulose, pale greenish grey. Apothecia scattered, sessile, 0.7-1.0 mm in diam., obconical; disc slightly convex, light orange brown to greyish brown, often slightly pruinose; margin pale grey to chamois-coloured, soon disappearing. Excipulum prosoplectenchymatous with radiating cell rows, c. 200 µm broad; hypothecium centrally 200-250 µm high, light yellowish brown to orange brown; epithecium indistinct to slightly yellowish brown; hymenium 250-300 µm. Asci cylindrical, 240-280 × 20-30 µm. Ascospores (2-) 4-8 per ascus, in a bundle or parallel arranged, submuriform, with 20-30 transverse and 1-2 longitudinal septa per segment, 100-140 × 7-9 µm, 14-16 times as long as broad. Pycnidia not observed. Chemistry: 4,5-dichlorolichexanthone (= coronatone).

Notes: At first glance, *Bapalmuia callichroa* might be confused with a *Calopadia*, in particular *C. foliicola* (Fée) Vezda. The latter has quite similar apothecia and ascospores, which are slightly broader and occur in a lower number per ascus. However, the anatomical structure of the apothecia (prosoplectenchymatous excipulum, non-aeruginous apothecial base, asci with tubular structure) and the secondary chemistry differ clearly from *Calopadia* and place the species in *Bapalmuia*.

Bapalmuia callichroa demonstrates that even in a group of species with extremely narrow ascospores such as *Bapalmuia*, a transition towards muriform septation is possible.

Distribution and ecology: Thus far, this rare species (neither VAINIO 1890 nor MALME 1937 do report on it) seems to be restricted to the southern, montane parts of the Atlantic rainforest of Brazil, where it overgrows tree bark in the forest understory. It has been found once invaded by the lichenicolous fungus *Dactylospora porphyrea* Hafellner.

Additional specimens examined: BRAZIL. **SÃO PAULO:** Morro Grande near Cotia, c. 25 km W of São Paulo, 23° 41' S, 46° 57' W, 850 m, rainforest, corticolous, 27. IX. 1980, K. Kalb (hb. KALB 14505). Serra do Mar, c. 20 km E of Cruzeiro, 22° 35' S, 44° 45' W, 3. XI. 1978, 1500 m, dark, humid rainforest, corticolous on *Podocarpus* spec., K. Kalb & G. Plöbst (hb. KALB 14507). **RIO DE JANEIRO:** Serra da Mantiqueira, Itatiaia, Parque National do Itatiaia, 22° 20' S, 44° 35' W, 1100 m, dark, humid rainforest, corticolous, 21. VII. 1978, K. Kalb & G. Plöbst (hb. KALB 14506). **MINAS GERAIS:** Serra da Mantiqueira, between Camanducaia and Vila Monte Verde, 22° 45' S, 46° 05' W, 1800 m, corticolous on *Podocarpus* spec., 29. XI. 1980, K. Kalb (KALB: Lich. Neotrop. 184); ibid., 0.5 km W of Vila Monte Verde, c. 30 km E of Camanducaia, 22° 50' S, 46° 00' W, 1500 m, corticolous, 2. VII. 1979, K. Kalb & G. Plöbst (hb. KALB 32821, with the lichenicolous fungus *Dactylospora porphyrea* Haf.).

Bapalmuia confusa Kalb & Lücking spec. nova

Similis *Bapalmuiae lafayetteanae*, sed differt ascosporis crassioribus. – Type: BRAZIL. **SÃO PAULO:** Serra da Cantareira, c. 30 km N of São Paulo, on a deciduous tree, in a dense montane rainforest, 23° 20' S, 46°, 45' W, 950 m, 5. VIII. 1978, K. Kalb & D. Hannack [hb. KALB, holotype; KALB: Lich. Neotrop. 5, isotypes, distributed as *Bacidia multilocularis* (Müll. Arg.) A. Zahlbr.].

Description: Thallus corticolous or muscicolous, smooth to granular-effuse, grey to greenish grey. Apothecia scattered, to rarely confluent, sessile, 0.5-2.0 mm in diam.; disc flat to slightly convex, pale brown to dark greyish brown, with a pale greyish pruina; margin chamois-coloured, distinct, for a long time persistent but in old apothecia disappearing. Excipulum prosoplectenchymatous with labyrinthic structure (textura epidermoidea) and externally with short, free hyphae, 100-120 µm broad; hypothecium centrally 120-130 µm high, light yellowish brown, epithecium light yellowish brown to brown, the outermost layer of the excipulum and the hymenium encrusted with tiny crystals not dissolving in K; hymenium surface with short, free hyphae; hymenium c. 175 µm high. Asci cylindrical, 140-160 × 12-16 µm. Ascospores 8 per ascus, in a bundle, 35-40-septate, 110-150 × 4.5-6.0 µm, 20-25 times as long as broad. Pycnidia not observed. Chemistry: 4,5-dichlorolichexanthone (= coronatone).

Notes: This species is well-characterized by its pruinose apothecia and the broad ascospores. The epithet *confusa* was chosen because this taxon caused quite a lot of confusion. Indeed, it was distributed in the exsiccata series MALME & SANTESSON: Lich. Austro-am. Exs. 238 and KALB: Lich. Neotrop. 5 as *Bacidia multilocularis* (Müll. Arg.) A. Zahlbr. but, as mentioned above, the type of this species belongs to another genus.

Distribution and ecology: *Bapalmuia confusa* exhibits a wide distribution in tropical America. It is a typically corticolous species and is mainly found in the understory of submontane to lower montane rainforests.

Additional specimens examined: VENEZUELA. **YARACUY:** Distr. Bolívar, Sierra de Aroa, Quebrada de Oro, c. 15 km SW of Aroa, 10° 18' N, 69° 00' W, 1500 m, rather original elfin forest, corticolous, 20. VIII. 1989, K. Kalb & R. Smith (hb. KALB 32819). — BRAZIL. **SÃO PAULO:** Serra do Mar, Serra de Boissocanga above Maresias, c. 30 km W of São Sebastião, 23° 45' S, 45° 40' W, 330 m, dark, primary coastal rainforest, corticolous, 18. II. 1980, K. Kalb & G. Plöbst (hb. KALB 14503). Serra do Mar, Serra de Paranapiacaba, c. 60 km SW of São Paulo, above Juquitiba, 23° 50' S, 47° 10' W, 550 m, corticolous on a deciduous tree at the edge of a lake, 27. IV. 1980, K. Kalb & G. Plöbst (hb. KALB 14502); ibid., 700 m, light, humid rainforest along the river Juquiá, corticolous on a deciduous tree, 13. V. 1978, K. Kalb & G. Plöbst (hb. KALB 32625). Morro Grande near Cotia, c. 25 km W of São Paulo, 23° 41' S, 46° 57' W, 850 m, rainforest, corticolous, 27. IX. 1980, K. Kalb (hb. KALB 28215, 32620). **RIO DE JANEIRO:** Corcovado, corticola in silva satis clara, 14.-15. VIII. 1892, G. O. Malme 55, 74 (S); ibid., corticolous, 4. IX. 1892, G. O. Malme (UPS, S; MALME & SANTESSON: Lich. Austro-am. Exs. 238, as *Bacidia multilocularis* (Müll. Arg.) A. Zahlbr.). Serra da Mantiqueira, Itatiaia, Parque National do Itatiaia, 22° 20' S, 44° 35' W, 1100 m, humid, dark primary rainforest, corticolous, 21. VII. 1978, K. Kalb & G. Plöbst (hb. KALB 32622).

Figure 2: General habit of *Bapalmuia* species. (A) *B. confusa* [Brazil, Malme 55 (S)], thallus with apothecia. Note the thin pruina and thin but persistent margin. (B) *B. confusa* [Brazil, Kalb & Plöbst (hb. KALB 32625)], thallus with isidioid outgrowths. Scale = 1 mm.

Bapalmuia consanguinea (Müll. Arg.) Kalb & Lücking

in LÜCKING & KALB, Bot. Jahrb. Syst. 122 (in press). – Basionym: *Patellaria consanguinea* Müll. Arg., Lichenes Epiphylli Novi: 11 (1890). – *Bacidia consanguinea* (Müll. Arg.) A. Zahlbr., Catal. Lich. Univ. **4:** 188 (1926). — Type: BRAZIL. **SÃO PAULO:** Apiahy, 1882, Puiggari 2288 (G, lectotype!).

Description: Thallus foliicolous, smooth, greenish grey. Apothecia scattered, sessile, 0.4-0.7 mm in diam.; disc strongly convex, ochraceous yellow to brownish red, non-pruinose; margin chamois, very thin, soon disappearing. Excipulum prosoplectenchymatous with radiating cell rows. Hypothecium centrally 60-80 µm high, yellowish brown; epithecium indistinct; hymenium c. 70-100 µm high. Asci narrowly clavate, 50-70 × 6-10 µm. Ascospores 8 per ascus, in a bundle, 5-7-septate, 30-50 × 1.5-2.5 µm, 18-23 times as long as broad. Pycnidia not observed. Chemistry: not studied.

Notes: The relatively short ascospores with few septa and the ochraceous yellow to brownish red apothecia are distinctive for this species. The likewise neotropical *Bapalmuia nigrescens* has similar ascospores, but differs by the blackish apothecia. *B. ivoriensis*, only known from Africa, is in many respects similar but differs in the more orange apothecia with a byssoid outer excipulum. In addition, its ascospores have more numerous septa.

Distribution and ecology: Neotropical, thus far only known from the southern part of the Atlantic rainforest in Brazil. The species is a typical member of the lichen community of the rainforest understory.

Additional specimens examined: BRAZIL. **MINAS GERAIS:** Serra do Espinhaço, Serra do Caraça, 1400 m, foliicolous, 1885, Vainio 1440b (TUR-Vainio 20782 as *Lecidea endoporphyrea*); ibid., Bocaina, c. 4 km E of the monastery, 20° 10' S, 43° 30' W, 1450 m, foliicolous, 25. V. 1978, K. Kalb & G. Plöbst (hb. KALB 32735). **RIO DE JANEIRO:** Rio de Janeiro, foliicolous, 1889, Glaziou 18012 (G). Serra da Mantiqueira, Itatiaia, Parque National do Itatiaia, 22° 20' S, 44° 35' W, 1100 m, humid, dark primary rainforest, foliicolous, 21. VII. 1978, K. Kalb & G. Plöbst (hb. KALB 32736). **SÃO PAULO:** Apiahy, foliicolous, 1882, Puiggari 2288 (G). Serra do Mar, Serra Bananal, c. 100 km SW of São Paulo, 24° 10' S, 47° 05' W, 200 m, dark, humid rainforest, foliicolous, 23. III. 1978, K. Kalb & G. Plöbst (hb. KALB 32715). Serra do Mar, Serra do Garrãozinho, between Mogi das Cruzes and Bertioga, 23° 45' S, 46° 10' W, 300-600 m, original rainforest, foliicolous, 6. IX. 1980, K. Kalb (hb. KALB 32716).

Bapalmuia costaricensis Lücking & Kalb spec. nova

Bacidia costaricensis nom. nud. in LÜCKING, Nova Hedwigia Beih. **104:** 130 (1992). – Haec species imprimis apotheciis usque ad 1.0 mm latis et margine persistente et hypothecio rubrofusco K+ purpureo ab speciebus aliis generis *Bapalmuia* differt. – Type: COSTA RICA. **PUNTARENAS:** Carara Biological Reserve, 55 km WSW of San José near the Pacific coast, 9° 47' N, 84° 35' W, 50-100 m, lowland evergreen moist forest, on leaves of *Erythrochiton gymnanthus* (Rutaceae), IX. 1991, Lücking 91-1835 (CR, holotype).

Description: Thallus foliicolous, sometimes covering the whole leaf surface, smooth but usually cracked when well-developed, pale greenish grey. Apothecia scattered, usually epiphyllous on the thallus sur-

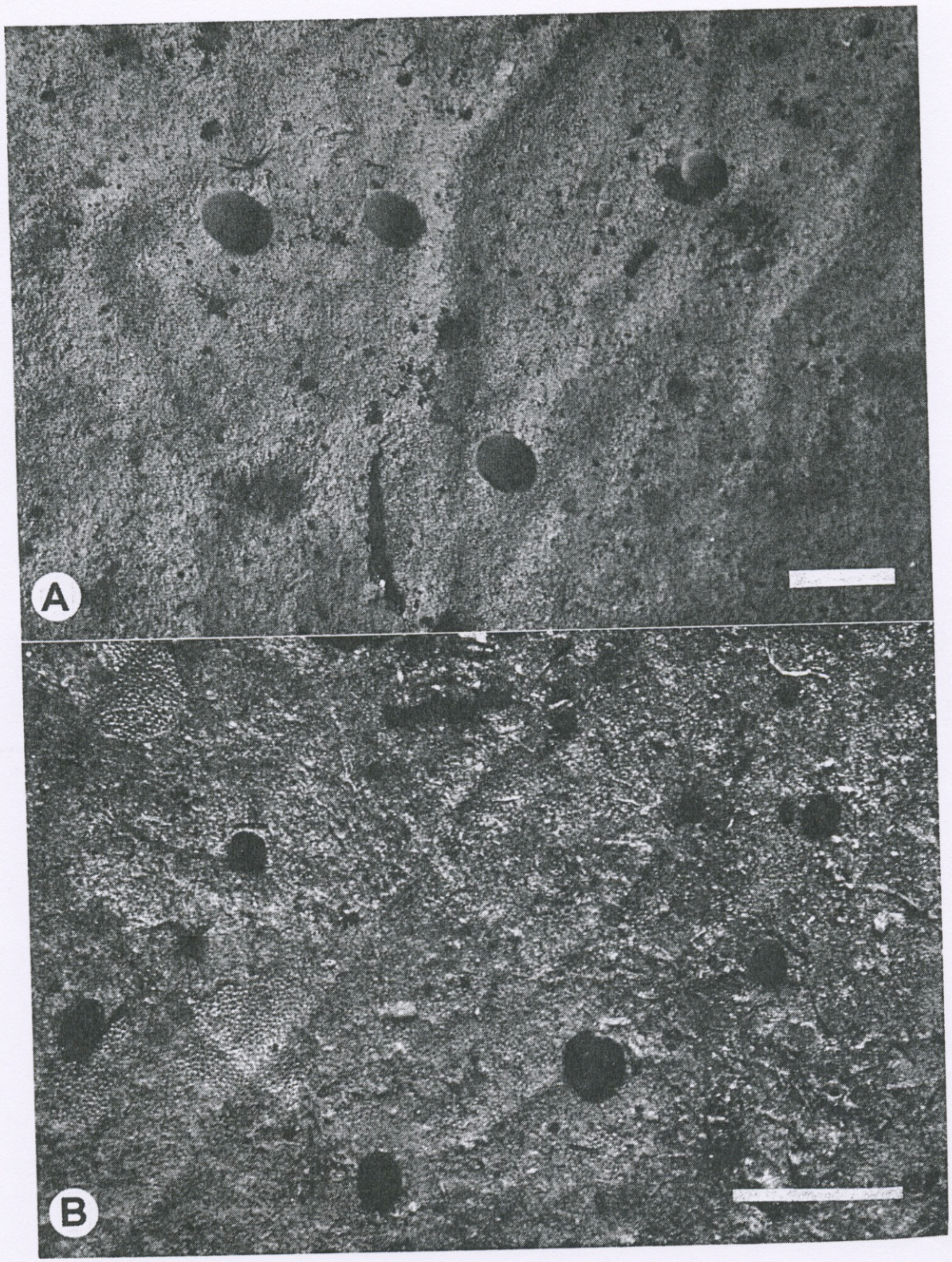

Figure 3: General habit of *Bapalmuia* species. (A) *B. consanguinea* [Brazil, Kalb & Plöbst (hb. KALB 32716], thallus with apothecia. (B) *B. nigrescens* [Brazil, holotype], thallus with apothecia. Scale = 1 mm.

face, rarely marginally hypophyllous on a mycelium free of algae, sessile, rounded to slightly irregular in outline when old, 0.7-1.0 mm in diam.; disc flat to slightly convex when old, blackish brown to almost black, non-pruinose; margin rather thick (0.05-0.15 mm), persistent even in mature apothecia, chamois-coloured to whitish, basally slightly byssoid and sometimes forming a root-like mycelium in young apothecia. Excipulum well-developed, prosoplectenchymatous with labyrinthic structure, up to 50 µm thick, pale yellowish brown, on the outer edge, especially in young apothecia, with a 30-50 µm thick tissue of loosely interwooven, byssoid hyphae, separated from the inner excipulum by a darker zone; hypothecium centrally up to 80 µm high, dark reddish brown, K+ purple; epithecium indistinct; hymenium 100-120 µm high. Asci narrowly cylindrical, 70-100 × 4-6 µm. Ascospores 8 per ascus, in a bundle, 20-30-septate, 70-90 × 2.5-3.5 µm, 20-30 times as long as broad. Pycnidia not observed. Chemistry: no substances dedected by TLC.

Notes: This new species is readily identified by its comparatively large apothecia with slightly convex disc and persistent, thick margin. In most other species of *Bapalmuia*, the apothecia usually are strongly convex and emarginate when mature. Anatomical details further characterize *B. costaricensis*: the small-celled excipulum with labyrinthic structure and byssoid outer part, and the dark, K+ purple hymenium. Based on these characters, the species seems to be related to *B. confusa*, which differs by the much larger and broader ascospores and the pruinose apothecia, and to *B. cacaotica* and *B. halleana*, which have lighter apothecia with paler, K– hypothecium and, in the case of the former, much longer ascospores.

Distribution and ecology: *Bapalmuia costaricensis* has been found on leaves in various parts of the Neotropics. Like *B. palmularis* and *B. lineata, B. costaricensis* seems to be a typical representative of foliicolous lichen communities in the shady understory of tropical lowland rainforests.

Additional specimens examined: COSTA RICA. **PUNTARENAS**: Carara Biological Reserve, 55 km WSW of San José near the Pacific coast, 9° 47' N, 84° 35' W, 50-100 m, lowland evergreen moist forest, foliicolous on *Erythrochiton gymnanthus* (Rutaceae), VIII. 1987, R. Lücking 87-353 (hb. LÜCKING). **HEREDIA**: La Selva Biological Station, 60 km N of San José, 10° 26' N, 84° 03' W, 50 m, lowland rainforest, foliicolous on undetermined dicotyledon, IX. 1991, R. Lücking 91-1955 (hb. LÜCKING). — ECUADOR. **NAPO**: Jatun Satcha Biological Station, 25 km E of Tena at Río Napo, 1° 04' S, 77° 35' W, 450 m, lowland to submontane rainforest, foliicolous, V. 1996, R. Lücking 96-576 (hb. LÜCKING).

Bapalmuia halleana Sérus. spec. nova

Similis *Bapalmuiae cacaoticae*, sed differt ascosporis minoribus. – Type: GABON. Forêt des Abeilles, Station Forestière de la Makande, 0° 49' S, 11° 54' W, 300 m, forêt ombrophile, foliicole, II. 1999, Sérusiaux s.n. (LG, holotype).

Description: Thallus corticolous or foliicolous, smooth to minutely very squamulose-araneous and with irregular isidioid outgrowths when old, pale green to greyish green. Apothecia scattered to abun-

dant, when foliicolous often marginally hypophyllous on a mycelium free of algae, sessile, rounded, 0.5-0.8 mm in diam.; disc strongly convex when old, chocolate brown to dark brown, non-pruinose; margin rather thick (0.05-0.1 mm), persistent but much thinner and not prominent in mature apothecia, chamois-coloured to whitish, basally slightly byssoid and sometimes forming a root-like mycelium in young apothecia. Excipulum well-developed, prosoplectenchymatous with labyrinthic structure, up to 80 µm thick, pale yellowish brown, on the outer edge, especially in young apothecia, with short, free hyphae; hypothecium centrally up to 180 µm high, orange brown; epithecium indistinct; hymenium 120-150 µm high. Asci narrowly cylindrical, 110-140 × 8-10 µm. Ascospores 8 per ascus, in a bundle, 20-30-septate, 70-105 × 2.5-3.0 µm, 25-35 times as long as broad. Pycnidia abundant in foliicolous specimens, pale flesh coloured, hemispherical to wart-shaped, often with a crater-like (sometimes black) ostiolum, conidia fusiform, 4-5 × 1-1.5 µm. Chemistry: not studied in material from Gabon, but 4,5-dichlorolichexanthone (= coronatone) confirmed by HPTLC in the specimens cited from Tanzania.

Notes: *Bapalmuia halleana* is dedicated to Prof. F. Hallé, the organizer and leader of the mission 'Le Radeau des cimes' organized in Gabon to explore the tree canopies in the African lowland rainforest.

This new species is most similar to *Bapalmuia cacaotica*, from which it differs by its shorter ascospores, and to *B. costaricensis*, which has darker apothecia with thicker margin and a darker, K+ purple hypothecium. In the corticolous collections from the type locality, the thallus is provided by dense, irregular isidioid outgrowths, a feature also observed in e.g. *B. confusa* and *B. lafayetteana*. The foliicolous specimens of *B. halleana* have a smooth thallus usually featuring abundant pycnidia, but the apothecial anatomy is essentially the same.

Distribution and ecology: *Bapalmuia halleana* is known from the type locality and from a number of foliicolous collections from Tanzania. In the lowland rainforest in Gabon, the species was quite abundant on bark in the shady understory, while it was absent from the canopy and marginal parts of the forest.

Additional specimens examined: TANZANIA. **IRINGA REGION:** Udzungwa Mts., rainforest near Itonya Village, 1500-1600 m, 08° 12' S, 36° 00' E, 12. IX. 1999, D. Schwenk (hb. KALB 32863, 32864, 32865, 32868) – **dto:** Udzungwa Mts., rainforest between Kiwalamo and Idunda Villages, 1700-1800 m, 08° 08' S, 26° 03' E, 13. IX. 1999, D. Schwenk (hb. KALB 32862, 32869); - **MOROGORO REGION:** Kilombero District, Udzungwa Mts., Luhega Forest Reserve, 1300-1400 m, 08° 24' S, 35° 59' E, 16. IX. 1999, D. Schwenk (hb. KALB 32866, 32867).

***Bapalmuia ivoriensis* R. Sant. & Lücking**
Nord. J. Bot. (in press). – Type: IVORY COAST. **MAN:** Forest of Kouin, 30 km E of Man, 300-400 m, tropical lowland moist forest, foliicolous, VIII. 1954, R. Santesson 10668:7 (UPS, holotype!).

Description: Thallus foliicolous, smooth, pale green, whitish prothallus usually present. Apothecia usually marginally hypophyllous on a mycelium free of algae, regularly rounded, 0.3-0.9 mm in diam.; disc

strongly convex, vividly orange brown, non-pruinose; margin thin, whitish, with byssoid outer parts, soon disappearing. Excipulum prosoplectenchymatous with radiating hyphae and byssoid outer parts; hypothecium centrally 70 µm high, light yellowish brown; epithecium indistinct; hymenium 50-60 µm high. Asci narrowly clavate, 45-55 × 6-9 µm. Ascospores 8 per ascus, in a bundle, 7-11-septate, 30-35 × 1.5-2.0 µm, 15-20 times as long as broad. Pycnidia not observed. Chemistry: no substances detected by TLC.

Notes: This recently discovered species is well-distinguished by its strongly convex, vividly orange brown apothecia with partly byssoid margin and comparatively short ascospores. *Bapalmuia nigrescens* is anatomically similar but differs by its grey to black apothecia. *B. ivoriensis* might be confused with the neotropical *B. consanguinea*, but that species has usually epiphyllous apothecia and larger ascospores with less numerous septa, and the apothecial margin is completely smooth. Also similar in apothecial colour is *Bacidia dimerelloides* Vezda which can be separated by the flat apothecial disc and the paraplectenchymatous excipulum.

With its partly byssoid excipulum and rather short ascospores, *Bapalmuia ivoriensis* takes a somewhat intermediate position between *Bapalmuia* and *Byssoloma*, thus indirectly confirming the placement of *Bapalmuia* in the Pilocarpaceae and the close relationship between both genera. We keep the species in *Bapalmuia* because of the prosoplectenchymatous inner exciple and the narrow ascospores.

Specimens resembling *Bapalmuia ivoriensis* have been distributed in VEZDA: Lich. Sel. Exs. 2031 from Tanzania, as *Bapalmuia palmularis*. They have somewhat shorter and broader ascospores (20-30 × 2.0-2.5 µm) with only 3-7 septa, but the material is too scanty to decide whether it represents a new species.

Distribution and ecology: *Bapalmuia ivoriensis* is thus far only known from two collections from the Ivory Coast and Tanzania in tropical Africa. Its ecology seems to correspond to that of the other foliicolous species of the genus.

Additional specimen examined: TANZANIA. **TANGA REGION:** SE corner of Mazumbai University Forest Reserve, submontane rainforest, foliicolous, 24. II. 1982, 1500 m, T. Pócs 6962 (hb. KALB 17196).

Bapalmuia lafayetteana (Vain.) Kalb & Lücking comb. nova

Basionym: *Bacidia lafayetteana* Vain., Acta Soc. Fauna Fl. Fenn. **7:** 14 (1890). – Type: BRAZIL. **MINAS GERAIS:** Lafayette, 1885, E. A. Vainio (TUR-Vain. 20800, lectotype!, selected here; VAINIO: Lich. Bras. Exs. 295).

Description: Thallus corticolous or muscicolous, smooth to granular-effuse, grey to greenish grey. Apothecia obconical, scattered, to rarely confluent, sessile, 0.6-1.4 mm in diam.; disc convex, light orange brown to dark brown, non-pruinose; margin chamois-coloured, thin, soon disappearing. Excipulum prosoplectenchymatous with radiating cell rows, 70-130 µm broad; hypothecium centrally 250 µm high, light yellowish brown; epithecium indistinct to light yellowish brown; hy-

menium c. 120-200 µm high. Asci narrowly cylindrical, 110-180 × 12-15 µm. Ascospores 8 per ascus, in a bundle, 35-50-septate, 85-130 × 2.5-3.5 µm, 30-40 times as long as broad. Pycnidia not observed (in genuine specimens; but see below!). Chemistry: 4,5-dichlorolichexanthone (= coronatone; e. g. in the type!) or no substances detected by TLC.

Notes: VAINIO (1890: 14) spelled the epithet "*lafayettiana*", but in the same paper corrected it (loc. cit.: 256) to "*lafayetteana*".

This species is distinguished from the likewise neotropical *Bapalmuia confusa* by the narrower ascospores and non-pruinose apothecia and from the australasian *B. buchananii* mainly by the smaller ascospores. *B. lafayetteana* is rather similar and perhaps closely related to the foliicolous type species, *B. palmularis*, which has smaller apothecia and narrower ascospores with more numerous septa.

As circumscribed here, the species seems to be heterogeneous with regard to secondary chemistry and anatomical details. The two collections marked with an asterix (*) below are identical with the type regarding the chemistry, but differ in the flat apothecia with persistent margin, while the other collections have typically emarginate apothecia but lack secondary substances. A further collection [hb. KALB 32621] was tentatively assigned to *B. lafayetteana*, however it carries pycnidia which produce bifusiform conidia and hence differs in this cha-racter from the type species of the genus.

Distribution and ecology: The species is thus far only known from the north- and south-eastern parts of Brazil (Atlantic rainforest).

Additional specimens examined: BRAZIL. **BAHIA:** Chapada Diamantina, Serra do Tombator, between Mundo Novo and Morro de Chapeú, 11° 50' S, 40° 45' W, 800 m, dark rainforest, corticolous, 20. VII. 1980, K. Kalb & M. Marcelli (hb. KALB 15118, 32621*); ibid., c. 10 km N of Rui Borbosa, 12° 10' S, 40° 25' W, 400 m, dark rainforest, corticolous, 18. VII. 1980, K. Kalb & M. Marcelli (hb. KALB 15117*). **SÃO PAULO:** Serra do Mar, Serra do Garrãozinho, between Mogi das Cruzes and Bertioga, 23° 45' S, 46° 10' W, 850 m, primary rainforest, corticolous, 29. III. 1980, K. Kalb (hb. KALB 32624); ibid., corticolous, 28. X. 1978 (hb. KALB 32619). Serra do Mar, between Taubaté and Ubatuba, c. 150 km E of São Paulo, 23° 15' S, 45° 15' W, 800 m, dense, humid rainforest, corticolous, 18. VI. 1978, K. Kalb & G. Plöbst (hb. KALB 32626).

Bapalmuia lineata Lücking & Kalb spec. nova

Species nova imprimis thallo verrucis elongatis radiantis instructis perspicua; apothecia apotheciorum *Bapalmuiae palmularis* similes; ascosporae 25-35-septatae usque ad 130 µm longae. – Type: COSTA RICA. **LIMÓN**: Hitoy Cerere Biological Reserve, 120 km ESE of San José near the Atlantic coast, 9° 41' N, 83° 02' W, 100-200 m, lowland rainforest, foliicolous on *Cryosophila warscewizcii* (Arecaceae), III. 1991, R. Lücking 91-1266 (CR, holotype).

Description: Thallus foliicolous, sometimes covering large areas of the leaf, provided with distinct elongate ridges which radiate from the basis of the apothecia or are irregularly arranged; ridges 0.05 mm thick, near apothecia thicker and root-like, chamois-coloured, thallus otherwise pale greenish grey. Rounded to irregular maculate soralia sometimes present, 0.3-1.0 mm broad, partly confluent, with pale

greenish contents. Apothecia scattered, usually marginally hypophyllous on a mycelium free of algae, rarely epiphyllous on the thallus surface, sessile, regularly rounded, 0.5-0.8 (-1.1) mm in diam.; disc orange to dark reddish brown, strongly convex when old, non-pruinose; margin thin, in mature apothecia disappearing, chamois-coloured to whitish, basally forming a root-like mycelium in young apothecia. Excipulum well-developed, prosoplectenchymatous with radiating cell rows, up to 100 µm thick, yellowish grey with darker grey marginal zone; hypothecium centrally up to 150 µm high, pale orange yellow; epithecium not developed; hymenium 140-170 µm high. Asci narrowly cylindrical, 110-150 × 4-6 µm. Ascospores 8 per ascus, in a bundle, 25-35-septate, 90-130 × 1.5-2.5 µm, 50-60 times as long as broad. Pycnidia not observed. Chemistry: 4,5-dichlorolichexanthone (= coronatone).

Notes: *Bapalmuia lineata* is easily recognized by the elongate, usually radiating ridges on the thallus which are somewhat reminescent of those of *Mazosia rotula* but less regular and of a different structure. The apothecia are morphologically and anatomically very similar to those of *B. palmularis*, indicating a close relationship with that species which differs, however, by the smooth thallus.

Bapalmuia lineata is sometimes attacked by the lichenicolous fungus *Pyrenidium santessonii* Lücking (LÜCKING 1998), which seems to be restricted to species hitherto assigned to *Bacidia* sensu lato but actually belonging to the Pilocarpaceae.

Distribution and ecology: *Bapalmuia lineata* is widely distributed in the Neotropics. It shares the same ecological preferences as *B. palmularis*, being abundant on leaves in the shady understory of tropical lowland rainforests. Both species are often found side by side on the same leaves and can be considered sympatrical taxa.

Additional specimens examined: COSTA RICA. **HEREDIA:** La Selva Biological Station, 60 km N of San José, 10° 26' N, 84° 03' W, 50 m, lowland rainforest, foliicolous, VII. 1997, R. Lücking 97-1561 (hb. LÜCKING). **LIMÓN:** Hitoy Cerere Biological Reserve, 120 km ESE of San José near the Atlantic coast, 9° 41' N, 83° 02' W, 100-200 m, lowland rainforest, foliicolous on undetermined dicotyledon, III. 1991, R. Lücking 91-1266 (hb. LÜCKING; with the lichenicolous fungus *Pyrenidium santessonii*). — GUYANA. **POTARO/SIPARUNI:** Paramakatoi village, 4° 42' N, 59° 43' W, 500-800 m, tropical submontane moist forest, foliicolous, II. 1996, R. Lücking 96-3760 (BRG). — ECUADOR. **NAPO:** Jatun Satcha Biological Station, 25 km E of Tena at Río Napo, 1° 04' S, 77° 35' W, 450 m, lowland to submontane rainforest, foliicolous, V. 1996, R. Lücking 96-505 (QCA), 96-800 (QCNE). — BRAZIL. **PARÁ:** Near Belém, 1° 00' S, 49° 00' W, 10 m, lowland rain forest, foliicolous, 19.-20. X. 1980, K. Kalb (hb. KALB 32724).

Bapalmuia marginalis (Vain.) Sérus.

Nord. J. Bot. **13:** 451 (1993). – Basionym: *Helotiopsis marginalis* Vain., Ann. Acad. Sci. Fenn., ser. A, 15: 151 (1921). – Type: PHILIPPINES. **POLILLO:** S. loc., foliicolous, 1909, Robinson s. n. (TUR-Vainio 26083, holotype!).

Description: Thallus foliicolous, smooth, pale greenish green. Apothecia marginally hypophyllous on a mycelium free of algae, rounded, 0.3-0.5 mm in diam., vertically strongly elongate and up to 1.1 mm

high; disc slightly convex, reddish brown, non-pruinose; margin thin, chamois-coloured to reddish white, basally forming a root-like mycelium in young apothecia. Excipulum prosoplectenchymatous with radiating cell rows, 50-70 µm broad; hypothecium centrally 30-70 µm high, brown; epithecium indistinct; hymenium 400-550 µm high. Asci narrowly cylindrical, 350-520 × 6-8 µm. Ascospores (6-)8 per ascus, in a bundle, 70-100-septate, 320-510 × 2.0-2.5 µm, 150-200 times as long as broad. Pycnidia not observed. Chemistry: not studied.

Notes: *Bapalmuia marginalis* is a very conspicuous species due to the vertically elongate apothecia with very long ascospores. The apothecia seem to be stipitate by superficial examination but are completely filled by the hymenium.

Distribution and ecology: The species is only known from a few collections from tropical Asia.

Additional specimens examined: INDONESIA. **SUMATRA:** Oostkust, near Besitang, 30 m, foliicolous, s. dat., Palm 61b (UPS). PAPUA NEW GUINEA. **MADANG:** Burbura logging site, 35 km NNW of Madang, 4° 48' S, 145° 38' E, 50 m, virgin rainforest on low hills, foliicolous, 28. VII. 1992, Sérusiaux 13500-4 (LG).

Bapalmuia nigrescens (Müll. Arg.) Cáceres & Lücking

Nova Hedwigia (in press). – Basionym: *Patellaria nigrescens* Müll. Arg., Lichenes Epiphylli Novi: 11 (1890). – *Bacidia nigrescens* (Müll. Arg.) Vain., Ann. Acad. Sci. Fenn., ser. A, **15:** 66 (1921). – Type: BRAZIL. **RIO DE JANEIRO:** Rio de Janeiro, foliicolous, 1889, Glaziou 18100 (G, lectotype!).

Description: Thallus foliicolous, smooth, greenish grey to olive grey. Apothecia scattered, either epiphyllous or marginally hypophyllous on a mycelium free of algae, sessile, 0.3-0.6 mm in diam.; disc strongly convex, in epiphyllous apothecia greyish black to black, in marginally hypophyllous apothecia greyish brown, non-pruinose; margin white to dark grey, very thin, soon disappearing. Excipulum prosoplectenchymatous with radiating cell rows and thinly byssoid outermost parts, 25-50 µm broad; hypothecium centrally 50-60 µm high, blackish brown; epithecium indistinct; hymenium 50-70 µm high. Asci narrowly clavate, 50-60 × 6-10 µm. Ascospores 8 per ascus, in a bundle, 7-9-septate, 25-40 × 2.0-2.5 µm, 12-16 times as long as broad. Pycnidia hemispherical to wart-shaped, 0.1 mm in diam. Conidia narrowly ellipsoid, unseptate, 5 × 1 µm. Chemistry: no substances detected by TLC.

Notes: *Bapalmuia nigrescens* is anatomically similar to *B. consanguinea* but differs clearly from this and other species of the genus by the greyish black to black apothecia with no brown tinge (CÁCERES & LÜCKING 2000).

Distribution and ecology: Widely neotropical but uncommon and thus far only known from a few scattered localities. The species usually grows together with other species of *Bapalmuia* and representatives of *Byssolecania* in the understory of lowland rain forests.

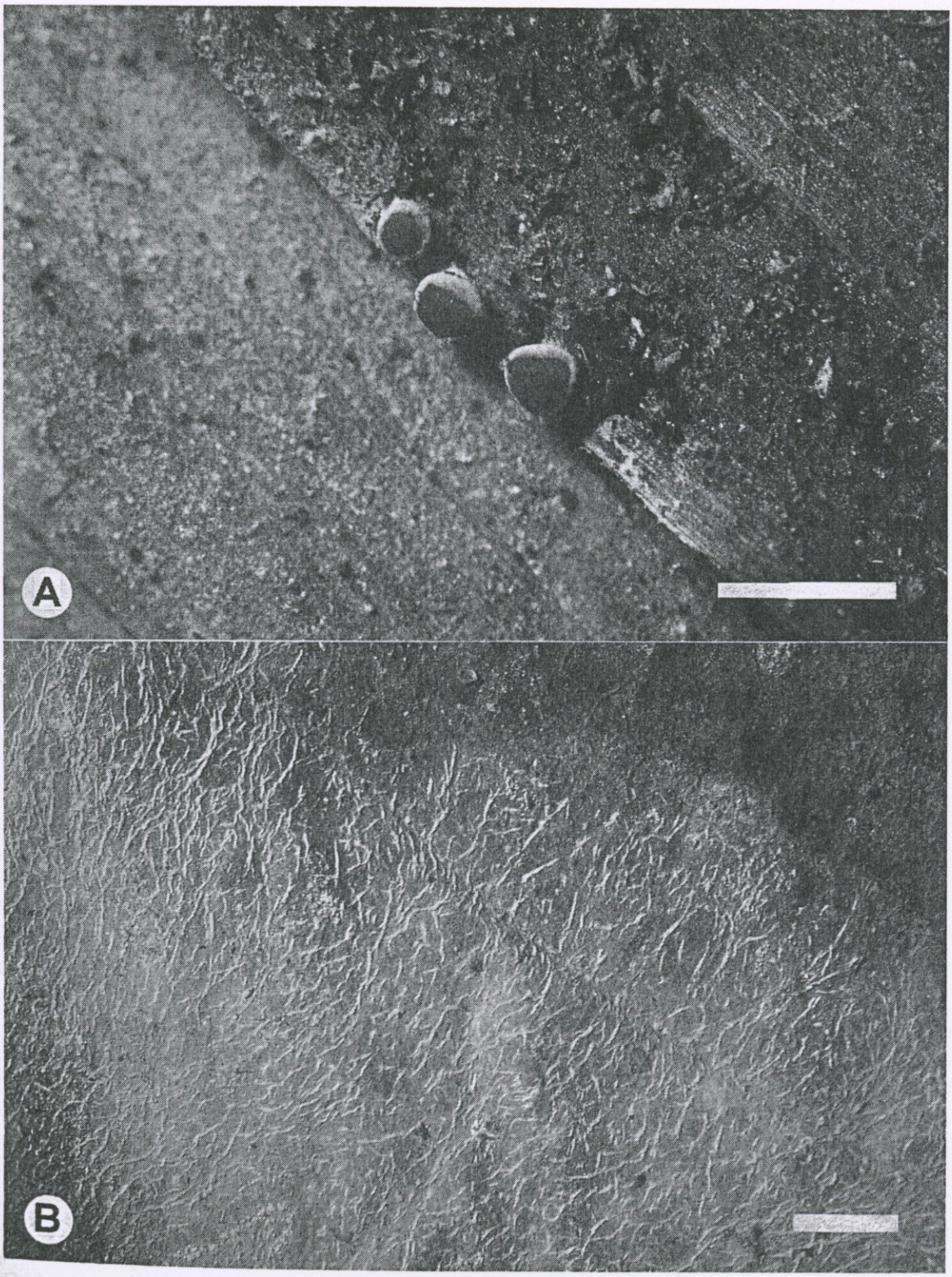

Figure 4: General habit of *Bapalmuia* species. (A) *B. lineata* [Costa Rica, Lücking 91-5629 (hb. LÜCKING)], marginally hypophyllous, young apothecia. Note the distinct margin. (B) *B. lineata* [Costa Rica, Lücking 91-1266a (hb. LÜCKING)], thallus with radiate ridges. Scale = 1 mm.

Additional specimens examined: COSTA RICA. **HEREDIA:** La Selva Biological Station, 60 km N of San José, 10° 26' N, 84° 03' W, 50 m, tropical lowland rainforest, foliicolous on undetermined dicotyledon, VII. 1997, R. Lücking 97-327, 97-1622, 97-1560 (hb. LÜCKING). BRAZIL. **PERNAMBUCO:** Gurjaú Ecological Reserve, near Cabo, 8° 16' S, 35° 02' W, 50-100 m, tropical evergreen dry forest, foliicolous, VIII-XI. 1997, M. Cáceres 97-41 (URM). Açude do Prata Forest Reserve (Dois Irmãos), 8° 00' S, 34° 57' W, 50-100 m, tropical evergreen dry forest, foliicolous, IV. 1989, W. A. Cavalcante & A. A. Silva 43205 (URM 75478); ibid., II. 1998, M. Cáceres & R. Lücking 98-138 (URM). **MINAS GERAIS:** Serra do Espinhaço, Serra do Caraça, 1400 m, foliicolous, IX. 1997, Cáceres s. n. (hb. CÁCERES). **SÃO PAULO:** Apiahy, foliicolous, s. dat., Puiggari 1086 (G).

Bapalmuia palmularis (Müll. Arg.) Sérus.

Nord. J. Bot. **13:** 451 (1993). – Basionym: *Patellaria palmularis* Müll. Arg., Lichenes Epiphylli Novi: 10 (1890). – *Bacidia palmularis* (Müll. Arg.) A. Zahlbr., Catal. Lich. Univ. **4:** 231 (1926). – Type: BRAZIL. **RIO DE JANEIRO:** Rio de Janeiro, 1889, Glaziou 18069 (G, holotype!).

Patellaria brasiliensis var. *laevis* Müll. Arg., Lichenes Epiphylli Novi: 10 (1890). – Type: BRAZIL. **SÃO PAULO:** Apiahy, s. dat., Puiggari 1086b (G, holotype!).

Patellaria rubicunda Müll. Arg., Lichenes Epiphylli Novi: 10 (1890). – *Bacidia rubicunda* (Müll. Arg.) A. Zahlbr., Catal. Lich. Univ. **4:** 239 (1926). – *Bapalmuia rubicunda* (Müll. Arg.) Sérus., Nord. J. Bot. **13:** 451 (1993). – Type: BRAZIL. **São Paulo:** Apiahy, s. dat., Puiggari 1086 (G, holotype!).

Bacidia lutea nom. nud. in LÜCKING, Nova Hedwigia Beih. **104:** 130 (1992).

Description: Thallus foliicolous, smooth, pale greenish green. Apothecia usually marginally hypophyllous, more rarely epiphyllous on a mycelium free of algae, regularly rounded, 0.4-1.0 mm in diam.; disc strongly convex, orange to reddish brown in young and epiphyllous apothecia and dark reddish to blackish brown in old and marginally hypophyllous apothecia; margin thin, chamois-coloured to whitish, soon disappearing, basally forming a root-like mycelium in young apothecia. Excipulum prosoplectenchymatous with radiating cell rows, 50-80 µm broad; hypothecium centrally 150 µm high, brown; epithecium indistinct; hymenium 120-150 µm high. Asci narrowly cylindrical, 100-140 × 6-10 µm. Ascospores (6-)8 per ascus, in a bundle, 25-35-septate, 70-120 × 1.5-2.5 µm, 45-50 times as long as broad. Pycnidia common on the thallus surface, hemispherical, 0.1-0.15 mm in diam. Conidia fusiform, unseptate, 4-6 × 1.0-1.5 µm. Chemistry: 4,5-dichlorolichexanthone (= coronatone).

Notes: *Bapalmuia palmularis* is characterized by the combination of smooth thallus, usually marginally hypophyllous apothecia and rather long, thin ascospores. The anatomically similar and also foliicolous *B. lineata* and *B. verrucosa* are easily separated by their different thallus structure. Among the non-foliicolous taxa, the most similar species is *B. lafayetteana*, which differs in the larger apothecia and the somewhat broader ascospores.

The colour of the apothecial disc in *Bapalmuia palmularis* varies from orange to blackish brown, depending on the age and position of the apothecia. Specimens with light apothecia are represented by the type material of *Patellaria rubicunda* (MÜLLER ARG. 1890) and by the invalidly published name *Bacidia lutea* (LÜCKING 1992).

Distribution and ecology: A common, pantropical species. *Bapalmuia palmularis* is a characteristic species of foliicolous lichen communities in the shady understory of tropical rainforests and usually accompanied by large species of the genera *Bapalmuia*, *Byssolecania* [*B. fumosonigricans* (Müll. Arg.) R. Sant., *B. hymenocarpa* (Vain.) Kalb, Vezda & Lücking), *B. deplanata* (Müll. Arg.) R. Sant. and *B. variabilis* Vezda, Kalb & Lücking], *Dimerella* (regarded a synonym of *Coenogonium*, see LÜCKING & KALB 2000) [*D. siquirrensis* Lücking] and *Porina* [*P. imitatrix* Müll. Arg., *P. distans* Vezda & Vivant coll.].

Selected specimens examined: COSTA RICA. **HEREDIA:** La Selva Biological Station, 60 km N of San José, 10° 26' N, 84° 03' W, 50 m, lowland rainforest, foliicolous, IX. 1991, R. Lücking 91-2459 (hb. KALB). **LIMÓN:** Hitoy Cerere Biological Reserve, 120 km ESE of San José near the Atlantic coast, 9° 41' N, 83° 02' W, 100-200 m, lowland rainforest, foliicolous on palm, III. 1991, R. Lücking 91-1265 (hb. KALB). — GUYANA. **POTARO/SIPARUNI:** Paramakatoi village, trail NW to Kato, 4° 42' N, 59° 43' W, 500-800 m, lowland to submontane moist forest, foliicolous, II. 1996, R. Lücking 96-3761 (BRG, US). — ECUADOR. Napo: Jatun Satcha Biological Station, 25 km E of Tena, 1° 04' S, 77° 35' W, 450 m, lowland to submontane rainforest, foliicolous, V. 1996, R. Lücking 96-574 (hb. LÜCKING). — BRAZIL. **AMAZONAS:** "Terra sujo" of Rio Preto, shortly before the mouth into the Amazon, c. 80 km E of Manaus, 03° 10' S, 59° 50' W, 40 m, foliicolous, VIII. 1993, K. & A. Kalb 27136 (hb. KALB). **SÃO PAULO:** Apiahy, s. dat., Puiggari 1086, 1086 b (G). Ilha de São Sebastião, c. 130 km SW of São Paulo, western slope of Morro das Tacas, 23° 50' S, 45° 20' W, 600 m, IV. 1978, very humid rainforest, foliicolous, K. Kalb & G. Plöbst 32720 (hb. KALB). Serra do Mar, Serra do Garrãozinho, between Mogi das Cruzes and Bertioga, 23° 45' S, 46° 10' W, 300-600 m, primary rainforest, foliicolous, IX. 1980, K. Kalb 32719, 32722 (hb. KALB). Morro Grande near Cotia, c. 25 km W of São Paulo, 23° 41' S, 46° 57' W, 850 m, rainforest, foliicolous, IX. 1980, K. Kalb 32725 (hb. KALB).

IVORY COAST. Taï National Park. 5° 52' N, 7° 27' W, 200 m, tropical lowland moist forest, foliicolous, 1992, U. Becker (KOELN). — GABON. Forêt des Abeilles, Station Forestière de la Makande, 0° 49' S, 11° 54' W, 300 m, forêt ombrophile, foliicole, II. 1999, Sérusiaux s.n. (LG). — DEMOCRATIC REPUBLIC OF CONGO (formerly Zaïre). **HAUT-ZAÏRE:** Prope staionem 87 km signatam viae a Kisangani ad Bafwasende ducentis, 300 m, foliicola in sylva primaria, S. Lisowski 43172 (hb. KALB; VEZDA: Lich. Sel. Exs. 1484). **KIVU:** Irangí, Réserve de l'IRSAC, 850 m, foliicole, I. 1972, Lambinon 72/18 (LG). **BAS-CONGO:** Leopoldville, Idiofa, Ipamu, foliicolous, 1921, Vanderyst 10554 (UPS). — TANZANIA. Usambara Mts., Amani, 800 m, foliicolous, 1909, Brunnthaler s. n. (UPS).

PAPUA NEW GUINEA. **MOROBE:** Boana, 1200 m, foliicolous, 1940, M. Clemens s. n. (UPS).

AUSTRALIA. **QUEENSLAND:** Eacham Shire, Souita Falls, 8 km SE of Millaa Millaa, 17° 35' S, 145° 40' E, tropical rainforest, foliicolous, VIII. 1987, A. Henssen 31250 (hb. HENSSEN).

Bapalmuia sorediata Kalb & Lücking spec. nova

Species nova similis *Bapalmuiae palmularis*, sed differt ascosporis minoribus (40-55 × 3.0-3.5 µm), (8-) 12-16-septatis et imprimis thallo soredioso. – Type: AUSTRALIA. **QUEENSLAND:** Daintree National Park, Mossman Gorge, 16° 29' S, 145° 23' E, 50 m, tropical rainforest, foliicolous, 2. IX. 1992, K. & A. Kalb 26820 (CANB, holotype; hb. KALB, isotype).

Description: Thallus foliicolous, 20-30 mm across or sometimes covering large areas of the leaf, smooth, pale greenish grey, 20-30 µm thick. Rounded to irregular soralia present, 0.2 mm broad, partly confluent, with pale greenish, finely granular soredia.

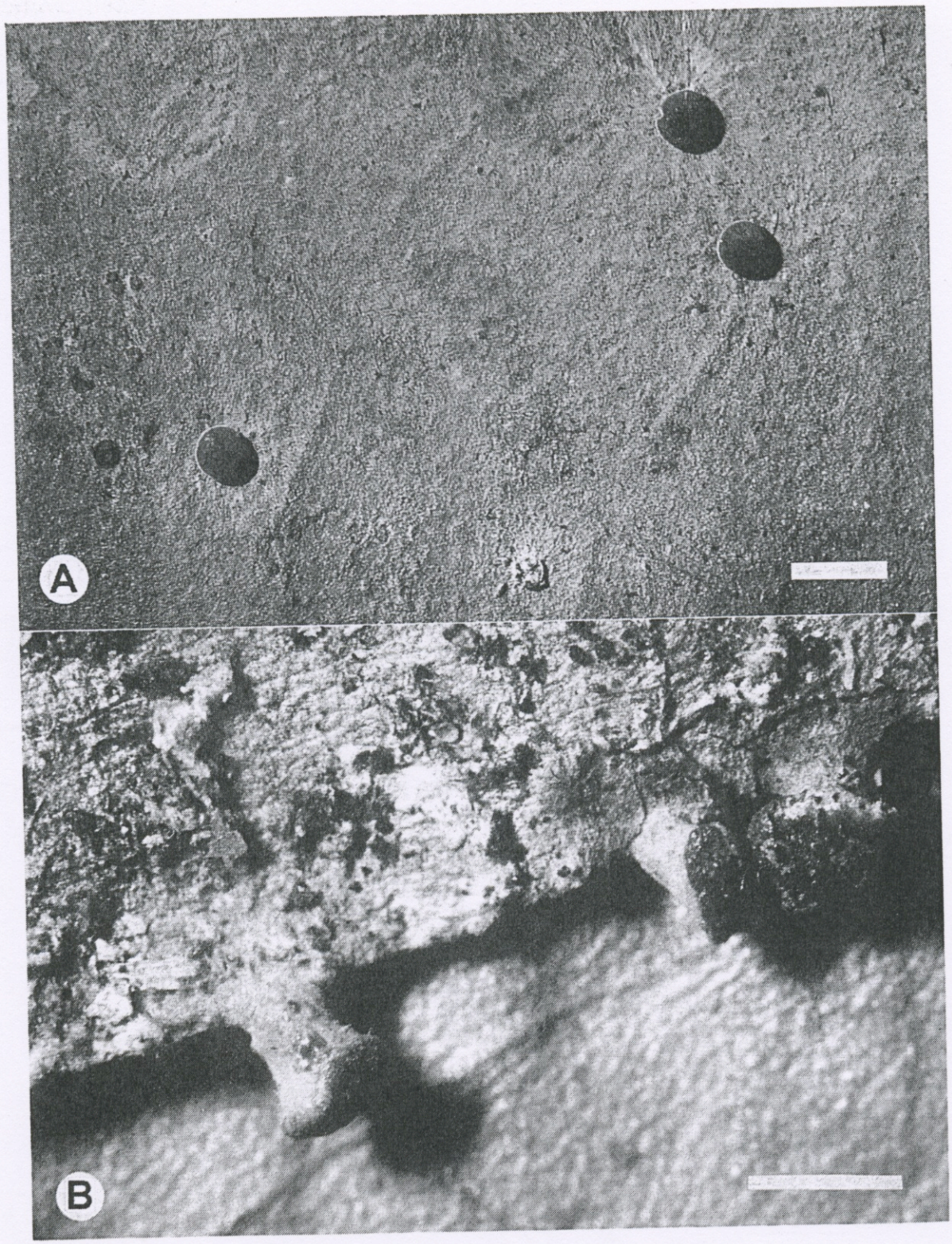

Figure 5: General habit of *Bapalmuia* species. (A) *B. palmularis* [Ecuador, Lücking 96-574 (hb. LÜCKING)], thallus with epiphyllous apothecia. Note the convex disc with evanescent margin. (B) *B. marginalis* [PHILIPPINES, holotype], marginally hypophyllous apothecia. Scale = 1 mm.

Apothecia scattered, usually marginally hypophyllous on a mycelium free of algae, rarely epiphyllous on the thallus surface, sessile, regularly rounded, 0.5-0.8 mm in diam.; disc orange to dark reddish brown, strongly convex when old, non-pruinose; margin thin, in mature apothecia disappearing, chamois-coloured to beige. Exciple well-developed, up to 100 µm thick, pale yellowish brown, laterally besides the hymenium prosoplectenchymatous with radiating cell rows but otherwise paraplectenchymatous with 4-10 µm broad cells; hypothecium centrally up to 150 µm high, pale yellowish brown; epithecium not developed; hymenium 140-170 µm high. Asci narrowly cylindrical, 70-85 × 6-10 µm. Ascospores 8 per ascus, in a regular bundle, (8-) 12-16-septate, 40-55 × 3.0-3.5 µm. Pycnidia not observed. Chemistry (HPTLC): 4,5-dichlorolichexanthone = coronatone.

Notes: *Bapalmuia sorediata* is easily recognized by its thallus provided with abundant, rounded to irregularly maculate soralia. A second species with similar thallus and apothecial morphology described below is *B. variratae*, which differs from *B. sorediata* only by the longer ascospores with more numerous septa. Soralia are otherwise known to occur occasionally in *B. lineata* and *B. verrucosa*, but the thallus of these species differs clearly in the presence of radiate ridges or verrucae.

Although the apothecia of *B. sorediata* are morphologically similar to those of *B. palmularis*, it cannot be regarded as a sorediate modification of the latter, since its ascospores are shorter and its excipular structure differs from all other species of the genus. Indeed, *B. sorediata* provides a transition towards *Bacidia brasiliensis* and other species currently included in *Bacidia* s. lat. with entirely paraplectenchymatous excipulum, and underlines the close relationship of this latter group with *Bapalmuia*. Its inclusion in *Bapalmuia* is justified, however, because of the general apothecial morphology (convex disc and evanescent margin) and the presence of coronatone instead of zeorin.

Distribution and ecology: *Bapalmuia sorediata* is so far only known from two collections, but it seems to have the same ecological preferences as the other foliicolous species of the genus.

Additional specimen examined: AUSTRALIA. **QUEENSLAND:** Maleny, Mary Cairncross Park, 40 km W of Caloundra, 26° 47' S, 152° 51' E, 440 m, dense, subtropical rainforest, foliicolous, 2. VIII. 1995, K. & A. Kalb (hb. KALB 32852).

Bapalmuia variratae Sérus. spec. nova

Species nova similis *Bapalmuiae sorediatae*, sed differt ascosporis maioribus (80-100 × 2-3 µm) 15-25-septatis. – Type: PAPUA NEW GUINEA. **CENTRAL PROVINCE:** Varirata National Park, 22 km E of Port Moresby, 9° 26' S, 147° 21' E, 800 m, tropical rainforest remnants along stream, foliicolous, 23. X. 1995, Sérusiaux s.n. (LG, holotype; hb. Lücking, isotype).

Description: Thallus epiphyllous, covering large areas of the leaf, smooth, pale greenish grey. Rounded to irregularly maculate soralia dispersed over the thallus surface, 0.3-1.8 mm broad, partly confluent,

Figure 6: General habit of *Bapalmuia* species. (A) *B. variratae* [hb. LÜCKING, isotype], thallus with young and premature apothecium. (B) *B. variratae* [hb. LÜCKING, isotype], thallus with maculate soralia. Scale = 1 mm.

with pale greenish, finely granular soredia. Apothecia scattered, epiphyllous or marginally hypophyllous on a mycelium free of algae, sessile, regularly rounded, 0.4-0.7 mm in diam.; disc orange brown, convex when old, non-pruinose; margin thin, chamois-coloured to beige. Exciple well-developed, 140-180 µm thick, colourless to pale yellowish, laterally besides the hymenium prosoplectenchymatous with radiating cell rows (cells 1-3 µm broad), otherwise paraplectenchymatous (cells 4-10 µm broad); hypothecium centrally up to 70 µm high, pale yellowish; epithecium not developed; hymenium 120-160 µm high. Asci narrowly cylindrical, 90-120 × 8-10 µm. Ascospores 8 per ascus, in a regular bundle, needle-shaped, 15-25-septate, 80-100 × 2-3 µm. Pycnidia not observed. Chemistry: 4,5-dichlorolichexanthone = coronatone.

Notes: *Bapalmuia variratae* is morphologically identical with *B. sorediata*, including its typical excipulum, and with some hesitation we describe this taxon as a separate species. The only difference between the two taxa are the ascospores, which are much longer in *B. variratae* and provided with more numerous septa. Considering ascospore variation in other species of the genus, it is unlikely that the same species can produce ascospores of such different size. On the other hand, the needle-shaped ascospores in *Bapalmuia* are often difficult to observe and easily break into parts outside the asci. However, broken ascospores are recognized by the presence of a very thin gelatinous sheath at their broken ends, and careful examination showed that even entire ascospores in *B. sorediata* do not exceed 55 µm in lenght.

Distribution and ecology: Although *Bapalmuia sorediata* is so far only known from the type collection, it seems to have the same ecological preferences as the other foliicolous species of the genus.

Bapalmuia verrucosa Sérus. & Lücking

in LÜCKING et al., Lichenologist **30:** 177 (1998). – Type: BRAZIL. **AMAZONAS:** Manaus, foliicolous, V. 1961, G. E. P. Peres 15486 (URM 22249, holotype!).

Description: Thallus foliicolous, verrucose, verrucae typically orange brown (thus far found only in the type material), in other specimens pale; irregular maculate soralia and dark prothallus sometimes present. Apothecia usually marginally hypophyllous on a mycelium free of algae, regularly rounded, 0.7-1.0 mm in diam.; disc strongly convex, reddish to blackish brown, non-pruinose; margin thin, chamois-coloured, soon disappearing. Excipulum prosoplectenchymatous with radiating cell rows, 70-150 µm broad; hypothecium centrally 150 µm high, reddish brown; epithecium indistinct; hymenium 250 µm high. Asci narrowly cylindrical, 180-200 × 9-12 µm. Ascospores 4 (-8) per ascus, in a bundle, 31-37-septate, 160-190 × 3.0-3.5 µm, 50-60 times as long as broad. Pycnidia not observed. Chemistry: not studied.

Notes: *Bapalmuia verrucosa* is easily recognized by the combination of verrucose thallus and large ascospores. The verrucae are not elongate as in *B. lineata* and, at least in the type collection, are of a different, very characteristic colour. The collections cited below differ from the type in having pale verrucae but are provisionally included here.

Distribution and ecology: A foliicolous species known from Brazil (type) and (with pale verrucae) from Guyana, Brazil and Ecuador. Probably restricted to South America (Amazon), where it exhibits the same ecological preferences as the other species of the genus.

Selected specimens examined (all with pale verrucae): GUYANA. **POTARO/SIPARUNI:** Paramakatoi village, 4° 42' N, 59° 43' W, 500-800 m, tropical submontane moist forest, foliicolous, II. 1996, R. Lücking 96-3790 (hb. Lücking). — ECUADOR. **NAPO:** Jatun Satcha Biological Station, 25 km E of Tena at Río Napo, 1° 04' S, 77° 35' W, 450 m, lowland to submontane rainforest, foliicolous, V. 1996, R. Lücking 96-984 (hb. Lücking). — BRAZIL. **PARÁ:** Near Belém, 1° 00' S, 49° 00' W, 10 m, lowland rainforest, foliicolous, X. 1980, K. Kalb 32717 (hb. Kalb).

Doubtful and excluded species

***Bapalmuia kakouettae* Sérus.**

Nord. J. Bot. **13:** 449 (1993). – Type: FRANCE. **PYRÉNÉES-ATLANTIQUES:** Gorges de Kakouetta (SE de Tardets-Sorholus), 400 m, sur *Buxus*, VII. 1985, Sérusiaux 7703 (LG, holotype!; hb. LÜCKING, isotype!).

Byssoloma aptrootii Sérus., Nord. J. Bot. **13:** 451 (1993). – Type: PORTUGAL. **MADEIRA:** Route Ribeira Brava-São Vicente, un peu au N du col de Boca de Encumeada, 800 m, laurisylve ± dégradée le long d'une rivière, sur feuilles de *Ocotea foetens*, II. 1988, Sérusiaux s. n. (LG, holotype!; BM, E, hb. LÜCKING, hb. VEZDA, isotypes).

Notes: In the original description of *Bapalmuia*, SÉRUSIAUX (1993a) *described B. kakouettae* as an additional species in the genus. However, our more detailed studies revealed that this western European taxon differs from *Bapalmuia* as circumscribed in this paper in the structure of the excipulum: the outer part is composed of more or less free hyphae, while the inner part can be described as paraplectenchymatous. In this character, together with the relatively broad ascospores and the pyriform conidia, *Bapalmuia kakouettae* agrees with *Byssoloma aptrootii* Sérus., which was described in the same paper (SÉRUSIAUX 1993a). The now available abundant material indicates that the latter is probably a neotenic form of *Bapalmuia kakouettae* and best regarded as a synonym. The species, whose generic position is unclear at the time, is now known from SW France, S Italy and throughout Macaronesia (PUNTILLO et al. 2000), and is found on living leaves, chlorophyllous twigs and bark.

Since the excipulum structure is an important feature for the distinction of genera in the Pilocarpaceae, *Bapalmuia kakouettae* (= *Byssoloma aptrootii*) cannot be retained in *Bapalmuia*, but rather takes an intermediate position between *Fellhanera* and *Byssoloma*. A similar excipulum, partly encrusted with crystals, is known from *Byssoloma syzygii* Vezda & Vivant (VEZDA 1994) and *Fellhanera pilomarginata* Lücking (LÜCKING 1997). At least two other European species currently placed in *Bacidia* sensu lato agree with *Byssoloma aptrootii* in the excipular structure, viz. *Bacidia carneoglauca* (Nyl.) A. L. Smith and *B. viridifarinosa* Coppins & James. (see PURVIS et al. 1992; BRICAUD & ROUX 1993). These species undoubtedly belong in the Pilocarpaceae, and further studies in a forthcoming paper will attempt to clarify their taxonomical status within the family.

More than 100 taxa are currently referred to the Pilocarpaceae. Most species are rather distinctive with regard to excipulum structure, paraphyses, ascospores and conidia; they thus can be easily assigned to either *Fellhanera*, *Fellhaneropsis*, *Byssoloma*, *Byssolecania*, *Bapalmuia*, or other genera yet to be established. Intermediate forms are relatively rare, and their taxonomic status should therefore not affect generic delimitation in the family but is rather a problem of individual placement, which can only be resolved when the phylogenetic relationships of the genera involved are better understood (LÜCKING 1997).

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