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New species and new records of *Menegazzia* (Parmeliaceae, lichenized ascomycetes) from Malaysia and Indonesia

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The genus *Menegazzia* (Parmeliaceae, lichenized ascomycetes) in Malaysia and Indonesia is studied. Some specimens from Papua New Guinea are also included. The great majority of available specimens are from Kinabalu Park, State of Sabah, Malaysia. Three species are described as new to science, namely the two sorediate species ***M. capitata*** (from Sabah and Pahang in Malaysia) and ***M. sabahensis*** (from Sabah), and the fertile, primary species ***M. monospora*** (from Sabah and Papua New Guinea). *M. asahinae*, *M. dissoluta*, and *M. efflorescens* are reported for the first time from Malaysia, and *M. subsimilis* is reported for the first time from Malaysia and Indonesia. The subgenus ***Megamenegazzia*** is newly described to accommodate the large, broad-lobed species with numerous perforations on the lower surface. *M. efflorescens* is selected as the type species for the new subgenus. Notes are also provided on the type specimens of *Hypogymnia pectinatula*, a species originally considered as belonging to *Menegazzia*. *Botanical Journal of the Linnean Society*, 2007, **153**, 489–499.

ADDITIONAL KEYWORDS: lichens – Mount Kinabalu – South-East Asia – subgenus – taxonomy.

INTRODUCTION

The lichen genus *Menegazzia* A. Massal. has its major centres of speciation in the Southern Hemisphere, with the highest species richness in the temperate zones of New Zealand, south-east Australia, Tasmania, and southern South America. The number of known species declines towards the equator. Nevertheless, at least nine species are known to occur in the montane forests and alpine belts of Papua New Guinea (James *et al*., 2001; Bjerke, 2003; Elix *et al*., 2005), and several taxa remain undescribed (cf. James *et al*., 2001). Although the mountainous islands of South-East Asia are physiognomically and floristically similar to Papua New Guinea, there are very few reports of species of *Menegazzia* from these areas. Zahlbruckner (1928) described *Parmelia* (*Menegazzia*) *pectinatula* from Java, but, as shown by Elix & Jenkins (1989), this taxon belongs to the genus *Hypogymnia*. Smith (1993) reported *M. subsimilis* (H. Magn.) R. Sant. from South-East Asia, but without giving any exact localities or citing any examined specimens. Sipman (1993) reported *Menegazzia* cf. *terebrata* (Hoffm.) A. Massal. from the Malaysian Mount Kinabalu, and gave a brief description of the variation of *Menegazzia* occurring there. Elix *et al*. (2005) reported the new species *M. malesiana* Elix, Bawingan & Schumm from Papua New Guinea and the Philippines. Elsewhere in Asia, recent revisions have been made for three regions: Taiwan (Aptroot, Lai & Sparrius, 2003), Japan (Bjerke, 2004), and Tibet (Bjerke & Obermayer, 2005).

The objective of this study was to investigate more thoroughly the second author's material of *Menegazzia* from Kinabalu Park, and supplement the investi-

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gation with material from other areas in South-East Asia and from other collectors. Kinabalu Park is established around Mount Kinabalu, the tallest mountain in South-East Asia, which reaches 4095 m in altitude. The vegetation on the slopes of the mountain can be divided roughly into four belts (Sipman, 1993): (1) below 1500 m, the original high forest was replaced long ago by cultivated fields and secondary vegetation; (2) montane forest between *c*. 1500 and 2500 m; (3) stunted forest on ultrabasic bedrock between *c*. 2500 and 3000 m; and (4) stunted forest and low shrub vegetation on granitic bedrock between *c*. 3000 and 4000 m. The highest lichen abundance occurs in this belt. The summit is almost bare.

On the basis of the material from Kinabalu Park and elsewhere, we describe three species as new to science, report four species as new to Malaysia, and one species as new to Indonesia.

MATERIAL AND METHODS

This study is largely based on specimens collected in 1989 by the second author and B. C. Tan in Kinabalu National Park, State of Sabah, Malaysia, at *c*. 06°05′N, 116°35′E. This material is held in B and in Kinabalu Park Headquarters. Specimens from Kinabalu collected by others and specimens from other areas in South-East Asia and Melanesia were also studied. Some of the examined specimens were on loan from various herbaria to P. W. James, and studied by the first author during two different research visits to BM. We also borrowed relevant material from ABL, US (M. E. Hale's collections from Kinabalu), W, BM, and CANB. All available South-East Asian and Melanesian specimens were compared morphologically, anatomically, and chemically with type specimens and other material from related species of *Menegazzia* housed in various herbaria, the most relevant collections being housed in B and BM (see Bjerke, 2004, 2005 for a full list of herbaria whose *Menegazzia* material has been studied). Although numerous specimens from Papua New Guinea were studied, these are not mentioned in this paper, except in relation to the treatment of a new species, because New Guinean species have been revised recently (James *et al*., 2001), and because our primary objective was to study material from Malaysia and Indonesia. Acetone extracts of the specimens were analysed by standardized thin-layer chromatographic (TLC) methods (Culberson, 1972; Orange, James & White, 2001), and a few specimens were also analysed by reverse-phase high-performance liquid chromatography (HPLC) according to Bjerke, Lerfall & Elvebakk (2002) and Bjerke & Elvebakk (2004).

RESULTS

SUBGENUS *DISPORA* R. SANT.

Menegazzia asahinae (Yasuda ex Asahina) R. Sant., *Ark. Bot.* **30A (11):** 13 (1942). = Parmelia asahinae Yasuda ex Asahina, *Bot. Mag. [Tokyo]* **41:** 374 (1927).

Holotype: Plate 12, fig. 6 in Asahina (1927)!; epitype: Japan, Prov. Idzu [Izu], Mt. Amagi, 4.ix.1922, *Y Asahina* (annotated 'Isotype!') (TNS!) designated by Bjerke (2004). = *M. anteforata* Aptroot, M.-J. Lai & Sparrius, *Bryologist* **106:** 160 (2003). *Type:* Taiwan, Miaoli Co., Shei-Pa National Park, 25 km east–north-

KEY TO THE SPECIES OF *MENEGAZZIA* IN SOUTH-EAST ASIA (EXCLUDING NEW GUINEA)

1A. Apothecia usually present; soralia absent 2
1B. Apothecia rarely present; soralia present 3
2A. Asci one-spored; spores very large, oblong; lateral toe-like, finger-like to narrowly obovate lobes numerous; laminal raised lobes not present ..... *Menegazzia monospora*
2B. Asci two-spored; spores of intermediate size, ellipsoid; lateral lobes very rare; laminal, raised, secondary lobes common ..... *Menegazzia asahinae*
3A. Thallus surface finely and densely pitted/wrinkled; cortex easily abrading and exposing coarsely sorediate patches ..... *Menegazzia dissoluta*
3B. Thallus surface smooth; cortex not easily abrading 4
4A. Soralia capitate at raised secondary lobes, maniciform at final stage, but never lacerate ..... *Menegazzia capitata*
4B. Soralia not capitate, on more or less lacerate rims around terminal perforations of secondary lobes 5
5A. Lobes 3–7 mm wide, inflated, loosely attached to substrate; perforations mostly confined to lower surface ..... *Menegazzia efflorescens*
5B. Lobes 0.5–2(–3) mm wide, flat to slightly convex; perforations only on upper surface 6
6A. Perforations scattered, not coalescing; lobes slightly convex, to 2 mm wide ..... *Menegazzia subsimilis*
6B. Perforations numerous, occasionally coalescing; lobes mostly plane, less than 0.9 mm wide ..... *Menegazzia sabahensis*

east of Tungshi, near Tahsuehshan, at km 48, 1600 m elevation, 51RTG996866, on *Picea morrisonicola*, 8.x.2001, *A. Aptroot* 51931A (holotype in BM!, isotype in ABL!).

For additional synonyms, see Bjerke (2004).

Notes: Previously, this species was known with certainty from Japan and Taiwan (Bjerke, 2004). Here, it is reported as new to Malaysia. In Kinabalu Park, it grows as an epiphyte in mossy montane cloud forest between 2000 and 2300 m, often in association with other species of *Menegazzia*, and mostly on thin twigs. *M. asahinae* is characterized by an ash-grey to greyish-blue, nonsorediate, convex upper surface, ellipsoid to oval perforations that are often conical, cupuliform, pedicellate apothecia, exciples with numerous minute perforations, and the presence of the stictic acid complex in the medulla (Bjerke, 2004). The specimens from Kinabalu Park conform well to Japanese material of *M. asahinae*, with regard to both morphology and anatomy.

Based on studies of isotype material, Bjerke (2004) discussed whether the Taiwanese taxon *M. anteforata* Aptroot, M.-J. Lai & Sparrius was conspecific with *M. asahinae*, but a conclusion was not reached. During the first author's last visit to BM, the holotype of *M. anteforata* was also studied. The holotype consists of two small fragments, which are 11×12 mm and 11×9 mm, respectively. Perforate lobe apices are a diagnostic character for this taxon according to Aptroot *et al*. (2003). As the illustration of the holotype in Aptroot *et al*. (2003) shows, these perforations are not formed at the tips of main lobes, but rather on small, raised, secondary lobes. This type of perforation is also seen in *M. asahinae* (Bjerke, 2004). These secondary lobes may have started as conical perforations. The exciple of the single apothecium in the holotype of *M. anteforata* is not smooth, as stated by Aptroot *et al*. (2003), but possesses some longitudinal cracks which may originate from minute perforations, and these cracks are actually visible in the illustration in Aptroot *et al*. (2003). This is another character that *M. anteforata* shares with *M. asahinae*. We could not find any significant differences between the two taxa, and therefore regard them as conspecific.

Additional material examined: MALAYSIA: State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, altitude *c*. 2300 m. Stunted mossy forest on ridge near Lowii shelter. 13.v.1989, *Sipman & Tan 31357b*, B; Kinabalu Park, sheltered woods just below Kambaranga radio tower, tourist trail, viii.1964, *Hale 28323*, US; Kinabalu Park, felled trees on new road to Kambaranga roadhead, viii.1964, *Hale 28808*, US; Kinabalu Park, Mesilau trail, West Mesilau River, viii.1964, *Hale 28268*, *29288*, *29186*, US.

Menegazzia capitata *Sipman & Bjerke,* ***sp. nov.***

Diagnosis: Thallus ut in *Menegazzia terebrata* sed soraliis capitatis stipitatis differt.

Holotype: MALAYSIA, State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, altitude *c*. 2900 m. Porphyric rock flats in stunted forest below Villosa shelter. Epiphytic in forest. 10.v.1989, *H. Sipman & B. Tan 31040* (B 60 0085795).

Illustration: Figure 1.

Description: THALLUS corticolous, closely attached, forming small rosettes, to 7 cm diameter, sometimes

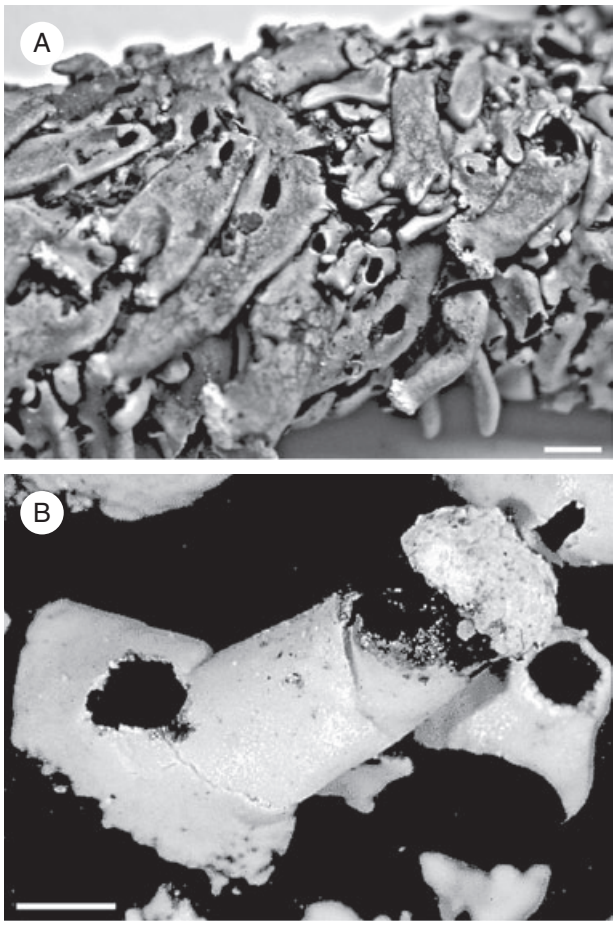

Figure 1. *Menegazzia capitata* Sipman & Bjerke A, Habit (*Degelius As-544a*), raised lobes compressed during storing. B, Capitate soralium produced terminally on patchily blackened, raised, secondary lobe (holotype). Scale bars: A, 1.0 mm; B, 0.5 mm.

coalescing. UPPER SURFACE probably greyish-green when fresh, straw yellow to pale brown in herbarium material, blackened along margins and towards centre, smooth, matt, faintly maculate, epruinose; apices shining, with brown tips. LOBES irregularly to sympodially branched, partly imbricate, slightly convex, inflated, narrow, 0.5–1.5 mm wide; lateral lobes short, toe-like. SECONDARY LOBES ascending in a 60–90° angle from main lobe, narrow, to 0.3 mm wide and to 2.5 mm tall, starting as wart-like dots, becoming elongate, tapering, later ± cylindrical, becoming sorediate. SORALIA terminal at secondary lobes, appearing stipitate, at first narrow, becoming capitate or slightly clavate, in the final stage becoming maniciform with a central opening. SOREDIA grey–white, granular. PERFORATIONS scattered, normally one or two on each main lobe, rounded to elliptical, small, 0.1–0.8 mm wide, lateral lobes often eperforate; rim flat to weakly raised. LOWER SURFACE dark brown to black, slightly shining at apices, striate, without perforations. CENTRAL CAVITY creamy white in the youngest part of the upper side, brown–black in older parts and on lower side. APOTHECIA rare, only found in one specimen (*G. Degelius As-544a*) containing one mature and three immature apothecia, to 2.3 mm wide at maturity, pedicellate. PEDICEL 0.9 mm tall, furrowed. DISC slightly concave, brown, epruinose. EXCIPLE smooth at first, becoming fluted with longitudinal cracks. ASCI 105–115 µm × 38–56 µm, two-spored. ASCOSPORES ellipsoid, 40–50 µm × 26–39 µm at maturity; wall 3.8–5.0 µm thick, thinnest at maturity. PYCNIDIA unknown.

Chemistry: Atranorin (minor) and chloroatranorin (trace) in the upper cortex. Stictic (major), constictic (minor), cryptostictic (minor), and menegazziaic (trace) acids, and additional satellite compounds in the medulla.

Etymology: The epithet of the new species refers to the predominant shape of the terminal soralia.

Taxonomic discussion: Menegazzia capitata is characterized by narrow, firmly attached lobes, a small rosette-forming thallus, and capitate, clavate to maniciform soralia arising from the tips of ascending, secondary, reduced lobes (often called protuberances). It belongs to the *Dispora* group of stictic acid-producing, sorediate species without yellow pigments in the medulla. Other species in this group are the two widespread (mostly in the Northern Hemisphere) species *M. subsimilis* and *M. terebrata*, the southern temperate species *M. subpertusa* P. James & D. J. Galloway and *M. neozelandica* (Zahlbr.) P. James, and the southern South American endemics *M. magellanica* R. Sant. and *M. kawesqarica* Bjerke & Elvebakk. None of these species has capitate soralia raised on tall, secondary lobes. Of these species, the first two mentioned are morphologically most similar to *M. capitata*, with shining, epruinose lobe apices, small perforations with flat rims, and more or less brown–black lobe margins and centres, but differ in the morphology and ontogeny of their soralia. These distinguishing characters appear to be constant and reliable. An additional distinguishing character is the numerous toe-like lateral lobes in *M. capitata*, a character not common in the other two species.

Menegazzia fumarprotocetrarica Calvelo & Adler, a southern South American endemic, is morphologically quite similar to *M. capitata*. Both species have more or less capitate soralia produced on tall, secondary lobes, as can be seen by comparing Figure 1B with the illustration of a soralium of *M. fumarprotocetrarica* in Bjerke & Elvebakk (2001). This is a character not seen in other sorediate species of the genus. *M. fumarprotocetrarica* differs clearly in chemistry, with the absence of stictic acid aggregate and the presence of fumarprotocetraric acid.

Additional material examined (paratypes): MALAYSIA: State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, 10–12.v.1989, *Sipman & Tan 31037*, B 60 0085803; Kinabalu Park, vicinity of Layang Layang, tourist trail, viii.1964, *Hale 29067*, US. State of Pahang: Fraser's Hill, Lady Maxwell road, 19.v.1989, *Sipman, Tan & Haji Mohamed 45008b*, B 60 0127109. Cameron highlands, above Tanah Rata, *c.* 2000 m, 29.iii.1964, *Degelius As-544a*, UPS.

Menegazzia dissoluta P. James, Aptroot, Sérus. & Diederich *Bibl. Lichenol.* 78: 98 (2001).

Holotype: Papua New Guinea, Eastern Highlands Province, Mount Gahavisuka Provincial Park, 11 km north of Goroka, altitude 2300 m, 5.xi.1995, *H. Sipman 39165* (B 60 0103505!).

Notes: Previously, this species was only known from Papua New Guinea, where it grows in montane forest at altitudes of 2300–2500 m (James *et al*., 2001). In Kinabalu Park, it grows as an epiphyte in mossy montane cloud forest at 2000–2300 m. *M. dissoluta* is characterized by a finely wrinkled upper surface that dissolves into soredia, and the occurrence of the stictic acid complex in the medulla. James *et al*. (2001) stated that barbatic acid was sporadic in this species. We detected it in all specimens examined. As it is not known fertile (cf. James *et al*., 2001), its affiliation in subgenus *Dispora* is provisional.

Additional material examined: MALAYSIA: State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, 9–13.v.1989, *Sipman & Tan 30934*, B 60 0085805, *30959*, B 60 0085806, *31346*, B 60 0085807; Kinabalu Park, vicinity of Layang Layang, tourist trail, viii.1964, *Hale 28351*, *29169*, US; Kinabalu Park, open ridge between East and West Mesilau Rivers, viii.1964, *Hale 29254*, US.

Menegazzia monospora *Bjerke & Sipman,* ***sp. nov.***

Diagnosis: Species haec a *Menegazziae asahinae* differt lobis non glauco-griseis, ascis monosporis, sporis oblongis majoribus.

Holotype: MALAYSIA, State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, altitude *c*. 2300 m. Stunted mossy forest on ridge near Lowii shelter. 13.v.1989, *H. J. M. Sipman & B. Tan 30955* (B 60 0085797).

Illustration: Figure 2.

Description: THALLUS corticolous, often encircling tiny twigs, firmly attached, forming small, partial rosettes, to 6 cm wide. UPPER SURFACE smooth, shining especially at apices, greyish-green in fresh material, straw-coloured in herbarium material, sparingly brown–black along margins, occasionally also towards centre, epruinose. LOBES elongate, convex, 1.5–3.0 mm wide; with numerous toe-like, finger-like, or narrowly obovate lateral lobes which are constricted at base and may become independent from main lobes. Without SORALIA or ISIDIA. PERFORATIONS frequent, 0.03–1.15 mm wide, at first minute, rounded, becoming larger, smallest at lateral lobes, oval, ±conical, and gaping; rim often undulating, raised either around the entire perforation or only around a section of the perforation, often blackened. LOWER SURFACE black, shining, pleated, without perforations. CENTRAL CAVITY creamy white on upper side in apical sections, brown–black in older parts and on lower side. APOTHECIA scattered to frequent, mostly on older lobes, to 3.0 mm wide, pedicellate. PEDICEL furrowed to wrinkled, often with a pale orange tinge. DISC plane at maturity, slightly concave before maturity, pale brown, epruinose. EXCIPLE thin in mature apothecia, thicker in younger ones, smooth, uneven, or fluted with narrow cracks, concolorous with thallus or with an orange tinge, often with minute perforations; perforations less than 0.01–0.02 mm wide, with raised rims which make the exciple look uneven; cracks originating from perforations. ASCI 115–150 μm × 47–65 μm at maturity, always one-spored at maturity. Young, immature asci rarely have two visible spore

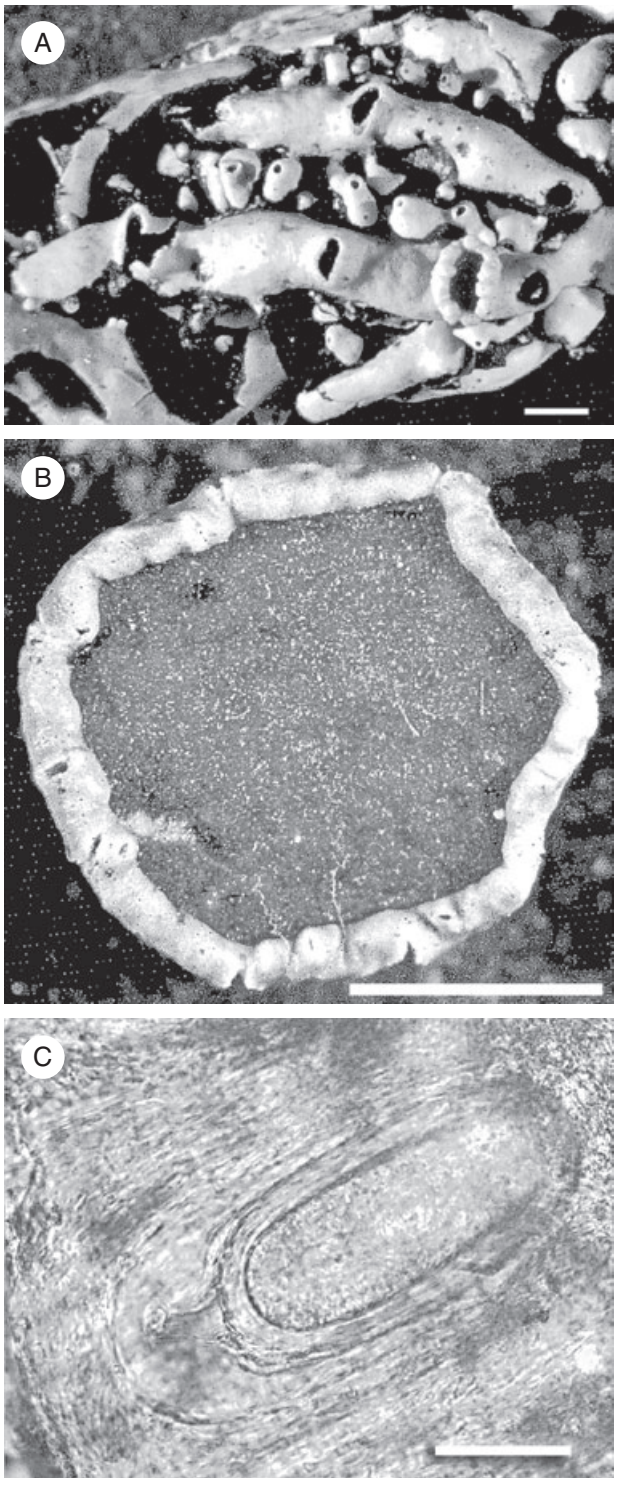

Figure 2. *Menegazzia monospora* Bjerke & Sipman (holotype). A, Habit. B, Apothecium with perforated and fissured exciple. C, Mature ascus with one large spore. Scale bars: A, B, 1 mm; C, 50 μm.

initials, but only one of them develops into a mature spore, whereas the other is aborted. ASCOSPORES oblong with rounded ends and more or less parallel sides, 95–120 μm × 40–55 μm at maturity; immature spores smaller; wall 4.0–6.5 μm thick, thinnest at maturity. PYCNIDIA numerous, dark brown, ostiole brown. CONIDIA narrowly fusiform, some appearing weakly arcuate, 3.5–6.0 μm × 0.5 μm.

Chemistry: Atranorin (major) and chloroatranorin (minor) in the upper cortex. Stictic (major), constictic (minor), cryptostictic (minor), menegazziaic (minor), norstictic (minor to trace) acids, and additional satellite compounds in the medulla. One satellite compound may be peristictic acid (cf. Elix & Wardlaw, 2000). The orange tinge in the pedicels and exciples of the apothecia is not caused by any acetone-soluble pigments.

Etymology: The epithet of the new species refers to the single, mature spore in the asci.

Taxonomic discussion: Menegazzia monospora is characterized by small, partial rosettes with numerous lateral lobes that are toe-like at first and later finger-like or narrowly obovate with a constricted base, gaping perforations, pedicellate apothecia, perforated or fissured exciples, and asci with one well-developed, very large, oblong spore.

Fertile species of the subgenus *Dispora* often have only one spore in some asci, but two in others. This situation can occur when one spore is shed and only one remains in the ascus, or in cases where one spore occasionally is abortive. *M. monospora* differs from all other species of the genus by constantly aborting one spore initial and by developing the remaining spore initial into a very large spore of up to 120 μm in length. Other species of *Menegazzia* which have abortive spore initials include, for example, the South American species *M. valdiviensis* (Räsänen) R. Sant. (Calvelo & Adler, 1994; Bjerke, 2005) and *M. kawesqarica* Bjerke & Elvebakk (Bjerke & Elvebakk, 2001). The abortion of one spore initial and the production of one large spore in *M. monospora* may be an adaptation to life in a habitat with many fast-growing cryptogams. A large spore holds more nutrients than a small spore, and hence is more likely to succeed during the initial growth stage, until it comes into contact with symbiotic algal cells.

Menegazzia monospora belongs to the '*M. asahinae* aggregate' (see discussion of *M. asahinae* and related species above and in Bjerke, 2004). Morphologically, *M. monospora* appears as an intermediate between the East-Asian *M. asahinae* and the Australasian *M. platytrema* (Müll. Arg.) R. Sant. and *M. aucklandica* (Zahlbr.) P. James & D. J. Galloway. *M. asahinae* differs from *M. monospora* by the following: a glaucous-green thallus; concave, mature apothecia; more perforations and fewer longitudinal cracks along the thalline exciple; two-spored as a rule; smaller, mature spores which are ellipsoid and not oblong; and mostly lacking lateral lobes. *M. aucklandia* also has smaller spores than *M. monospora*, and also differs by the two-spored asci, the lack of perforations along the exciple, and the larger thalli and apothecia. *M. platytrema* is distinguished from *M. monospora* by the inflated, slightly wider lobes, the crowded apothecia, and the two-spored asci with smaller spores.

Ecology and distribution: Menegazzia monospora is known from Kinabalu in Malaysia and from three different provinces in Papua New Guinea. It may have a more continuous distribution in South-East Asia and Melanesia. It prefers tiny twigs and small branches of forest trees at altitudes above *c*. 2000 m. In the key to species in New Guinea (James *et al*., 2001), *M. monospora* is keyed out in 'Species aggregate II'.

Additional material examined (paratypes): MALAYSIA: State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, altitude *c*. 2300 m, stunted mossy forest on ridge near Lowii shelter, 13.v.1989, *Sipman & Tan 31357a*, B 60 0085798. PAPUA NEW GUINEA: Eastern Highlands Province: Mt. Gahavisuki Nature Reserve, 8 km north of Goroka, 145°25′E, 6°01′S, altitude 2300 m, iii.1987, *Aptroot 18718*, *18729*, *18859*, *18728*, *18733*, *18776*, ABL. Morobe Province: Huon Peninsula, Saruwaged Range, near Honzeukngon village south of Derim in Timbe valley, 147°06′E, 6°14′S, altitude 2500 m, iii.1987, *Aptroot 18058*, ABL; Slate Creek and Gumi Creek Divide, 17 km west of Bulolo, 7°10′S 146°28′E, altitude 2100 m, 30.i.1981, *Streimann 13981*, CANB 8112401. Southern Highlands Province: *c*. 10 km west of Lake Onim, altitude *c*. 2200 m, 29.vi.1985, *Lambley 181/85c*, BM.

Menegazzia sabahensis *Bjerke & Sipman* ***sp. nov.***

Diagnosis: Species haec a *Menegazziae myriotrema* differt thallo sorediis.

Holotype: MALAYSIA, State of Sabah: Distr. Kota Belud, Kinabalu Park, sheltered woods just below Kambaranga radio tower, tourist trail, elevation *c*. 1900 m, viii.1964, *M.E. Hale 28689* (US).

Illustration: Figure 3.

Description: THALLUS corticolous, closely attached, forming small rosettes or irregular patches, to 5 cm wide. UPPER SURFACE smooth, shining, epruinose,

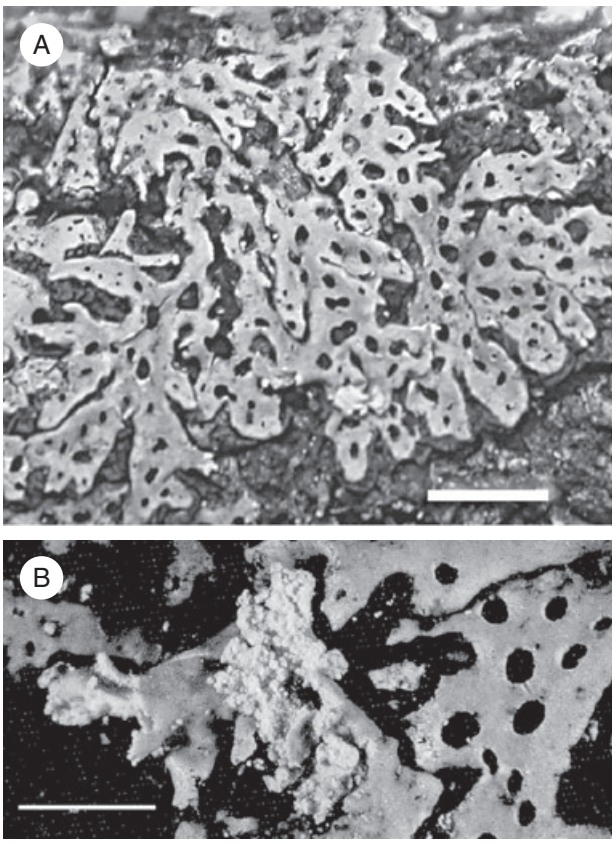

Figure 3. *Menegazzia sabahensis* Bjerke & Sipman (holotype). A, Habit. B, Details of sorediate, secondary lobe. Scale bars: A, 2.2 mm; B, 1 mm.

matt centrally, yellow–brown in herbarium material, probably green–grey in fresh material, black along margins and centrally. LOBES radiating, flabellate, plane to slightly concave, 0.3–1.6 mm wide, divergent, contiguous, sorediate. SORALIA terminal, bursting out from cracked lobe apices, making the upper cortex curl backwards exposing the sorediate medulla, labriform to slightly lacerate. SOREDIA grey–white, granular. PERFORATIONS abundant, laminal, often coalescing, small and oval at apices, larger and rounder or more irregular towards centre, less than 0.9 mm wide, the smallest less than 0.1 mm wide; rim plane, often with cracks through the upper cortex that occasionally reach the rims of adjacent perforations. LOWER SURFACE black, shining, pleated, without perforations. CENTRAL CAVITY creamy white on upper side from apices towards centre, grey–black on lower side. APOTHECIA and PYCNIDIA not seen.

Chemistry: Similar to that of *M. monospora* (see above).

Etymology: The new species is only known from the State of Sabah, Malaysia, hence the name.

Taxonomic discussion: Menegazzia sabahensis is virtually identical to the Tasmanian endemic *M. myriotrema* (Müll. Arg.) P. James, except that it lacks apothecia and is sorediate. They may also have minor chemical differences. According to James & Galloway (1992), *M. myriotrema* lacks constictic and menegazziaic acids, and may contain lecanoric acid. We detected both constictic and menegazziaic acids, but no lecanoric acid. These two species constitute a species pair. The latter species is illustrated in colour in Kantvilas & Jarman (1999). The different distribution ranges of the two species are peculiar. Other species constituting pairs in *Menegazzia* generally have overlapping distribution ranges, for example *M. wilsonii* (Vain. ex Räsänen) Bjerke and *M. tenuis* R. Sant., and *M. cincinnata* (Ach.) Bitter and *M. globulifera* R. Sant. Both of these species pairs have overlapping distribution ranges and similar habitat preferences in southern South America (Bjerke, 2005).

Ecology and distribution: Menegazzia sabahensis is only known from two collections, both from Kinabalu Park in Sabah, Malaysia. According to the labels, the collections were made at 1700–1900 m.

Additional material examined (paratype): MALAYSIA, State of Sabah: Distr. Kota Belud, Kinabalu Park, ascending Mesilau trail from West Mesilau River, elevation *c.* 1700 m, viii.1964, *Hale 28718* (US).

Menegazzia subsimilis (H. Magn.) R. Sant. *Ark. Bot.* **30A, 11:** 13 (1942).

Holotype: Hawaii, Kauai, Lehua makanoe [Lihue Makahuena], on Wikstroemia, 15.viii.1938, *L. M. Cranwell, O. Selling & C. Skottsberg 6034* (UPS!) = *Parmelia subsimilis* H. Magn., *Ark. Bot.* **30B, 3:** 5 (1941) = *M. pertusa* f. *dissecta* Rass., *Nov Sist. Niz. Rast.* **1:** 247 (1964). Holotype: Russia, Oriens extremus, Sichote-Alinj austr., publicum reservatum Sudzuchinskij, 29.vi.1944, *Zhudova & Pokrovskaja* (LE!) = *M. terebrata* var. *dissecta* (Rass.) Poelt, *Bestimmungsschl. eur. Flechten:* 756 (1969) = *M. pertusa* var. *dissecta* (Rass.) Rass., *Nov Sist. Niz. Rast.* **10:** 198 (1973) = *M. dissecta* (Rass.) Hafellner, *Fritschiana* **12:** 18 (1997).

Illustration: Figure 4.

Notes: This is a widespread sorediate species known from several countries in Asia and Oceania, including Papua New Guinea, Japan, Bhutan, and Tibet (Aptroot & Feijen, 2002; Bjerke, 2003, 2004; Bjerke & Obermayer, 2005). These are the first confirmed reports from Malaysia and Indonesia. In Kinabalu

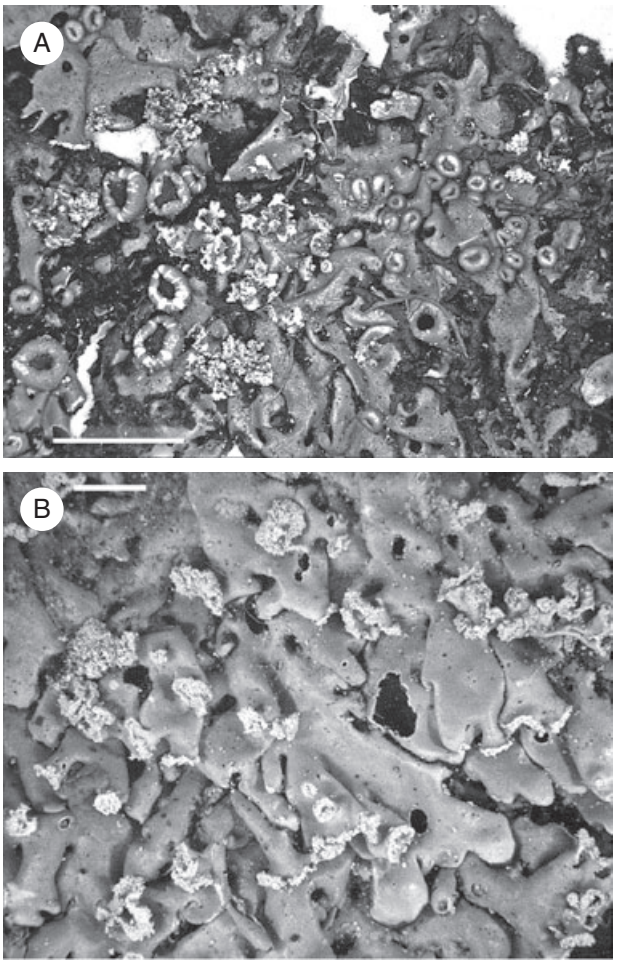

Figure 4. *Menegazzia subsimilis* (H. Magn.) R. Sant. from Indonesia. A, Richly fertile thallus (BM 000761528). B, Pale thallus with maniciform, sparingly lacerate soralia (B 60 0083499). Scale bars: A, 3 mm; B, 2 mm.

Park, it was found in montane forest at altitudes between 2300 and 3800 m. *M. subsimilis* is characterized by slightly raised maniciform soralia with noticeably lacerate margins, and by the occurrence of the stictic acid complex in the medulla.

This species is known to be morphologically variable (Bjerke, 2003; Bjerke & Obermayer, 2005). The examined Malaysian specimens are quite uniform, and correspond well with the most widespread and common morphotype of *M. subsimilis*, as described by Bjerke (2003). However, two specimens from Java, Indonesia, differ in separate directions. One specimen (BM 000761528) has numerous apothecia (Fig. 4A), which are very rare in this species, but is otherwise well within the morphological variation seen in this species. The other specimen (B 60 0083499) lacks brown–black margins and has soralia that are not very lacerate. This latter morphotype, which was collected at 1300 m altitude, is distinguished from more typical morphotypes of *M. subsimilis* by lacking blackened lobe margins and thereby appearing pale, and by having maniciform soralia that are only modestly lacerate (Fig. 4B). Species of *Menegazzia* tend to be less melanized when growing in sheltered, shady habitats (see, for example, Bjerke & Elvebakk, 2001; Bjerke, Elvebakk & Quilhot, 2003), and melanization is thus not necessarily an important taxonomic character. The lack of blackened margins may be an adaptation to life at relatively low altitudes in a warm, humid, and possibly shaded site. The soralia are intermediate between those of *M. terebrata s.s.* and those of *M. subsimilis s.s. Menegazzia* cf. *terebrata sensu* Sipman (1993) proved to be mostly *M. subsimilis*. Provisionally, we place this latter morphotype within *M. subsimilis s.l. M. subsimilis* is apparently a species actively diverging into several separate lineages.

We have not seen material of *M. malesiana*, but, according to the protologue (Elix *et al*., 2005), it is very similar to, if not conspecific with, *M. subsimilis*.

Additional material examined: INDONESIA: Java: without exact locality, s. annum, *Horsfield*, BM 000761528; Cibodas, Botanical Garden, 8.v.1991, *Sipman & Zainal 30091*, B 60 0083499; Mt. Gede near Cibodas. 21.iii.1979, *Arvidsson & Nilsson 2424*, GB. Sulawesi: without exact locality, s. annum, *Jermy 5525*, BM. MALAYSIA: State of Pahang: Fraser's Hill, Lady Maxwell road, 19.v.1989, *Sipman, Tan & Haji Mohamed 45008a*, B 60 0127109 (admixed with *M. capitata*); Fraser's Hill, Fraser's Hill Hotel, *c*. 1350 m, 31.iii.1964; *Degelius As-641*, UPS; Cameron highlands, above Tanah Rata, *c*. 2000 m, 29.iii.1964, *Degelius As-544b*, UPS. State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, 9–12.v.1989, *Sipman & Tan 31036*, B 60 0085790 (admixed with *M. efflorescens*), *30954*, B 60 0085789, *31038*, B 60 0085791, *31296*, B 60 0085804, *31178*, B 60 0085794, *31161*, B 60 0085793, *31093 b*, B 60 0085792; Kinabalu Park, open woods at base of slabs on tourist trail, viii.1964, *Hale 28572*, US; Kinabalu Park, along Mesilau trail on the plateau from Mesilau River to Kundason, viii.1964, *Hale 28559*, US; Kinabalu Park, East Mesilau River, viii.1964, *Hale 28488*, *28240*, *28244*, US; Kinabalu Park, Gunting Lagadan Hut to Power Station, *c*. 2400 m, 5.v.1984, *Yoshimura & Yamamoto 840431, 840442*, Hb. Yoshimura.

SUBGENUS ***MEGAMENEGAZZIA*** BJERKE & SIPMAN, **SUBGEN. NOV.**

Diagnosis: Subgenus haec a *Disporae* differt thallo et lobis majoribus et foraminibus deorsum numerosis et foraminibus sursum sparsis vel absentibus.

Generic type: Menegazzia efflorescens P. James, Aptroot, Sérus. & Diederich.

Taxonomic discussion: Santesson (1942) split the genus into two subgenera according to the number of spores in the ascus, namely subgenus *Dispora* and subgenus *Octospora*. All species belonging to these two subgenera are quite uniform with regard to thallus and lobe size, and placement of perforations. The species generally do not have lobes wider than 3 mm, except for the large species *M. grandis* P. James, which can have lobes that are up to 5 mm wide (James & Galloway, 1992). In many species, lobes are not wider than 1 mm. None of the species in the subgenera *Dispora* and *Octospora* have perforations on the lower surface.

Three species belong to the new subgenus, namely *M. efflorescens*, *M. isidiata* P. James, Aptroot, Sérus. & Diederich, and *M. megathallina* P. James, Aptroot, Sérus. & Diederich. All species were, until recently, only known from Papua New Guinea (James *et al*., 2001), but the former species is reported here as new to Malaysia (see below). These three species differ considerably from all other species of *Menegazzia*, and were treated as a distinct, separate group by James *et al*. (2001). They are characterized by large thalli and wide lobes, which generally are 4–5 mm wide, but up to 7 mm wide in a few specimens, by numerous large perforations on the lower surface, and by having very few or no perforations on the upper surface. When present on the upper surface, perforations are small and mostly restricted to lateral lobes.

Menegazzia efflorescens P. James, Aptroot, Sérus. & Diederich., *Bibl. Lichenol.* **78:** 100 (2001).

Holotype: Papua New Guinea, Simbu Province, Mount Wilhelm, Pindaunde valley, altitude *c*. 4100 m, 7.viii.1992, *H. Sipman 35774* (B 60 0093638!).

Notes: This species was previously only known from Papua New Guinea, where it grows on tree trunks and branches in montane forest and subalpine grassland at 2000–3600 m, and is the most common species of the genus there (James *et al*., 2001). In Kinabalu Park, it grows in similar habitats at altitudes of 2800–3800 m. This species is characterized by inflated, very wide lobes, perforations on the lower surface, labriform to gaping soralia with lacerate margins, and the stictic acid complex in the medulla (James *et al*., 2001). The specimens from Kinabalu Park are sterile.

Additional material examined: MALAYSIA: State of Sabah: Distr. Kota Belud, Kinabalu Park, south slope of Mount Kinabalu, along summit trail, 10–12.v.1989, *Sipman & Tan 31036*, B 60 0085790 (admixed with *M. subsimilis*), *31039*, B 60 0085799, *31093 a*, B 60 0085800, *31162*, B 60 0085801, *31285*, B 60 0085802; Kinabalu Park, in cloud forest above 3000 m, 1988, *Wolseley 41*, BM 000761529; Mount Kinabalu; eastern shoulder, 8.viii.1961, *Chew, Corner & Stainton 2092*, BM; Kinabalu Park, just above Kambaranga radio tower, tourist trail, viii.1964, *Hale 28970*, US; Kinabalu Park, Askews overlook, Mesilau trail, viii.1964, *Hale 28388*, US; Kinabalu Park, tourist trail between Layang Layang and Paka cave, viii.1964, *Hale 28649*, US; Kinabalu Park, open ridge between East and West Mesilau River, viii.1964, *Hale 29246*, US.

NOTES ON A SPECIES OF *HYPOGYMNIA*

Hypogymnia pectinatula (Zahlbr.) Elix, *Mycotaxon* **35:** 472 (1989) = *Parmelia* (*Menegazzia*) *pectinatula* Zahlbr., *Annls. Cryptog. Exot.* 1: 208 (1928). *Types:* [Indonesia], Java, in montis Pangerango regione alpina, 2985 m altitude, 9.v.1894, *V. Schiffner Iter Indicum 1893 / 1894 no. 3002* (W! – holotype, BM! – isotype).

Illustration: Figure 5.

Notes: Zahlbruckner (1928, 1932) regarded this species as belonging to *Menegazzia*. However, he stated that it is closely related to *Parmelia hypotrypa* Nyl. [= *Hypogymnia hypotrypa* (Nyl.) Rass.]. A formal transfer to *Hypogymnia* was made by Elix & Jenkins (1989). Notes on this species are added for various reasons. It was first affiliated in *Menegazzia*, its chemistry has still not been elucidated, its morphology is only known from the original description in Latin (Zahlbruckner, 1928), and the species has previously not been illustrated.

As stated in the protologue, the type specimens are sterile and lack soralia and isidia (Fig. 5). *H. pectinatula* is characterized by numerous dactyliform or narrowly pectinate (hence the epithet) lateral lobes, distinctly blackened margins that protrude into the lateral parts of the upper surface, scattered black patches on the central parts of the lobes, and scattered lateral and apical perforations on the lower surface. According to Elix & Jenkins (1989), it belongs to a species complex also consisting of the sorediate species *H. vittata* (Ach.) Parrique and *H. pseudobitteriana* (D. D. Awasthi) D. D. Awasthi, and the isidiate species *H. zeylanica* (R. Sant.) D. D. Awasthi.

Chemistry (TLC and HPLC): Atranorin (minor), chloroatranorin (minor), physodic acid (major), 3-hydroxyphysodic acid (major), alectoronic acid (trace), traces of two additional substances, one of them may be 2′-*O*-methylphysodic acid. Medulla is weakly UV+, probably because of the content of alectoronic acid.

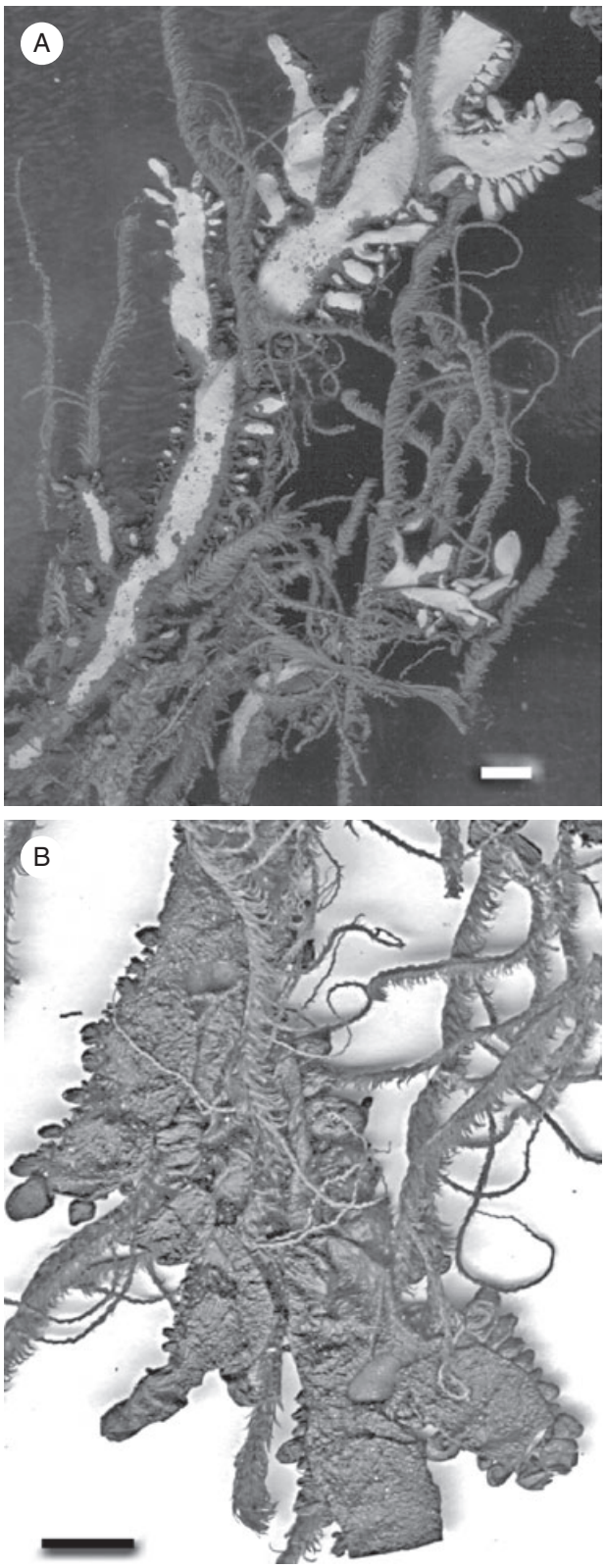

Figure 5. *Hypogymnia pectinatula* (Zahlbr.) Elix ex Elix & Jenkins (isotype). A, Upper surface showing the numerous lateral lobes. B, Lower surface with perforations. Scale bars, 3 mm.

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REFERENCES

Aptroot A, Feijen FJ. 2002. Annotated checklist of the lichens and lichenicolous fungi of Bhutan. *Fungal Diversity* **11:** 21–48.

Aptroot A, Lai M-J, Sparrius LB. 2003. The genus *Menegazzia* (Parmeliaceae) in Taiwan. *Bryologist* **106:** 157–161.

Bjerke JW. 2003. *Menegazzia subsimilis*, a widespread sorediate lichen. *Lichenologist* **35:** 393–396.

Bjerke JW. 2004. Revision of the lichen genus *Menegazzia* in Japan, including two new species. *Lichenologist* **36:** 15–25.

Bjerke JW. 2005. Synopsis of the lichen genus *Menegazzia* (Parmeliaceae, Ascomycota) in South America. *Mycotaxon* **91:** 423–454.

Bjerke JW, Elvebakk A. 2001. The sorediate species of the genus *Menegazzia* (Parmeliaceae, lichenized Ascomycotina) in southernmost South America. *Mycotaxon* **78:** 363–392.

Bjerke JW, Elvebakk A. 2004. Comparison of morphological, anatomical and chemical characters in *Pseudocyphellaria endochrysa* and *P. vaccina* (Lobariaceae, lichenised Ascomycota). *Annales Botanici Fennici* **41:** 27–35.

Bjerke JW, Elvebakk A, Quilhot W. 2003. Distribution and habitat ecology of the sorediate species of *Menegazzia* (Parmeliaceae, lichenised Acomycota) in Chile. *Revista Chilena de Historia Natural* **76:** 79–98.

Bjerke JW, Lerfall K, Elvebakk A. 2002. Effects of ultraviolet radiation and PAR on the content of usnic and divaricatic acids in two arctic-alpine lichens. *Photochemical and Photobiological Sciences* **1:** 678–685.

Bjerke JW, Obermayer W. 2005. The genus *Menegazzia* (Parmeliaceae, lichenized ascomycetes) in the Tibetan region. *Nova Hedwigia* **81:** 301–310.

Calvelo S, Adler M. 1994. *Menegazzia* (Ascomycotina, liquenizado) en la Argentina. *Boletín de la Sociedad Argentina de Botánica* **30:** 119–125.

Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin layer chromatographic method. *Journal of Chromatography* **72:** 113–125.

Elix JA, Bawingan PA, Lardizaval M, Schumm F. 2005. A new species of *Menegazzia* (Parmeliaceae, lichenized Ascomycota) and new records of Parmeliaceae from Papua New Guinea and the Philippines. *Australasian Lichenology* **56:** 20–24.

Elix JA, Jenkins GA. 1989. New species and new records of *Hypogymnia* (lichenized Ascomycotina). *Mycotaxon* **35:** 469–476.

Elix JA, Wardlaw JH. 2000. Lusitanic acid, peristictic acid, verrucigeric acid. Three new β-orcinol depsidones from the lichens *Relicina sydneyensis* and *Xanthoparmelia verrucigera*. *Australian Journal of Chemistry* **53:** 815–818.

James PW, Aptroot A, Diederich P, Sipman HJM, Sérusiaux E. 2001. New species of the lichen genus *Menegazzia* in New Guinea. *Bibliotheca Lichenologica* **78:** 91–108.

James PW, Galloway DJ. 1992. *Menegazzia*. *Flora of Australia* **54:** 213–246.

Kantvilas G, Jarman SJ. 1999. *Lichens of rainforest in Tasmania and south-eastern Australia. Flora of Australia Supplementary Series number 9.* Canberra: The Australian Biological Resources Study.

Orange A, James PW, White FJ. 2001. *Microchemical methods for the identification of lichens*. London: British Lichen Society.

Santesson R. 1942. The South American *Menegazziae*. *Arkiv för Botanik* **30A** (11)**:** 1–35.

Sipman HJM. 1993. Lichens from Mount Kinabalu. *Tropical Bryology* **8:** 281–314.

Smith CW. 1993. Notes on Hawaiian parmelioid lichens. *Bryologist* **96:** 326–332.

Zahlbruckner A. 1928. Neue und ungenügend beschriebene javanische Flechten. *Annales de Cryptogamie Exotique* **1:** 109–212.

Zahlbruckner A. 1932. *Catalogus Lichenum Universalis. Band VIII. Supplementum*. Leipzig: Verlag von Gebrüder Borntraeger.