

Gibbosporina* revisited: new records from Fiji, Indonesia, New Caledonia, Papua New Guinea and Queensland, with one species from the Solomon Islands transferred to *Pannaria

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Abstract

More than 40 Australasian collections of the genus *Gibbosporina* have been studied and found to confirm the concepts of the six species previously known from Australia and Papua New Guinea. Perispore morphology is the character most useful for identification. *Gibbosporina nitida* appears to be the most common species in the area. *Gibbosporina elixii* and *G. leptospora* were previously thought to be very rare, known from only two localities each, but they are reported here from several new localities. *Gibbosporina thamnifera* was previously known from only the Eungella National Park in Queensland and from one locality in Papua New Guinea, but is now known from further localities. New Caledonia is now known to have three species, *G. leptospora* newly reported. Fiji also has three species, *G. leptospora*, *G. nitida* and *G. sphaerospora* newly reported here, and *G. sphaerospora* is also reported as new to Papua New Guinea. *Gibbosporina phyllidiata*, previously known from only the sterile holotype specimen from the Solomon Islands, is now shown to contain pannarin, and is therefore much better accommodated in *Pannaria* under its new name *P. melanesica*.

Introduction

The genus *Gibbosporina*, described by Elvebakk *et al.* (2016), ranges from western parts of the Indian Ocean (Réunion and Mauritius) to the Central Pacific (Samoa), and includes 13 known species, all large and foliose. *Gibbosporina* belongs to a major tropical clade within Pannariaceae, as shown by the phylograms provided by Elvebakk *et al.* (2016) and Weerakoon *et al.* (2018). It was also found as a strongly deviating *Pannaria* in the phylogram of Magain & Sérusiaux (2014), prior to the description of the new genus. However, it is tripartite and is dominated by the chlorobiont, and has a gross morphology much more similar to austral tripartite *Pannaria* species than to its phylogenetic relatives such as *Physma*, *Leightoniella* and *Lepidocollema*.

The 2016 study by Elvebakk *et al.* was based on the examination of 119 specimens of *Gibbosporina*. That might sound like a reasonably large sample of a conspicuous genus of lichens, and seven of the new species were also described with good molecular support. However, given the high number of newly described lichens represented by this material, one would certainly expect important gaps of knowledge in addition to the possibility of misidentification. Based on superficial impressions, most species appear broadly similar, in addition to being modified by local habitat conditions.

The principal centre of species diversity of *Gibbosporina* is Queensland in Australia, with six species, and with *G. elixii* Elvebakk, Hong & P.M.Jørg. as the only endemic taxon. However, if Queensland is treated together with neighbouring Papua New Guinea, *G. leptospora* Elvebakk and *G. thamnophora* Elvebakk & P.M.Jørg. can be added as endemic species. Our understanding of these six species has so far been based on 24 specimens from Australia and four from Papua New Guinea.

Further studies are required, particularly as this genus is probably common in suitable habitats in many parts of its range. There are also many additional specimens in CANB, apart from those documented by Elvebakk *et al.* (2016). This is also true of B, which has many duplicates of collections housed at CANB, in addition to numerous samples collected in Papua New Guinea by the second author. This contribution is based primarily on the collections in B, while some *Gibbosporina* samples from BM were also investigated, leading to the taxonomic

revision of a previously described species. The aim of the present study is to determine whether the new *Gibbosporina* specimens match existing species concepts.

Material and methods

The material studied included 40 samples deposited at B, in addition to duplicates of CANB and H specimens already published, as well as four samples deposited at BM. The samples were studied applying the same methods as used by Elvebakk *et al.* (2016), including extensive sketch drawings of all fertile specimens, including *c.* 280 spores.

New name

Pannaria melanesica Elvebakk, nom. nov.
Mycobank number: MB 836353

Basionym: *Gibbosporina phyllidiata* Elvebakk, *Lichenologist* **48**, 37 (2016). Type: Solomon Islands, Guadalcanal Island, Mt Popomansiu, on ridge SE of Sutakiki River (Vunuvalukama), *c.* 4400 ft, [on bark in] montane rainforest, *D. Jackson Hill 9729*, 9.xi.1965 (BM 000731914 — holotype!).

Following its description, a second TLC analysis was performed on the holotype of *Gibbosporina phyllidiata* Elvebakk, the only species in the genus with specialized vegetative propagules and without known apothecia. Surprisingly, whereas all other *Gibbosporina* species are TLC negative, this specimen was found to contain pannarin. No foliose and tripartite *Pannaria* species reach tropical or subtropical areas, except for *P. lobulifera* Elvebakk from New Caledonia (Elvebakk 2007) and *P. papuana* (Aptroot & Diederich) P.M.Jørg. & Sipman (Jørgensen & Sipman 2006) from Papua New Guinea. The former contains vicanicin, while the latter is a brittle species with a single-layered cortex and without TLC-detectable compounds. Both species represent different complexes in *Pannaria* and are very different from *P. melanesica*. Pannarin occurs in many species of *Pannaria*, and for a sterile species like *G. phyllidiata*, chemistry is decisive. Its initial and erroneous status as TLC-negative, combined with its distribution, explains why this species was originally described as a *Gibbosporina*. However, now that it is known to contain pannarin, it is much better accommodated in *Pannaria*, certainly pending future discoveries of fertile and/or fresh material. A new name is required, since *P. phyllidiata* Elvebakk already exists for a different species (Lumbsch *et al.* 2011).

Etymology: the epithet reflects the known distribution of the species in Melanesia.

New records

1. *Gibbosporina acuminata* Elvebakk

This species is known from tropical forests in Australia (Queensland) and the Philippines.

SPECIMENS EXAMINED

Australia. Queensland: ● Crediton State Forest, 20 km SSW of Finch Hatton, 21°19'S, 148°33'E, rainforest dominated by *Syzygium* and *Argyrodendron trifoliatum*, on canopy of *Argyrodendron*, *J.A. Elix 21050*, 1.vii.1986 (B 60 0119628, CANB, H); ● Tully Falls Road, 18 km SE of Ravenshoe, alt. 760 m, 17°46'S, 145°33'E, rainforest on flats, on roadside shrub, *H. Streimann 29140*, 23.vi.1984 (B 60 0069980, CANB).

2. *Gibbosporina elixii* Elvebakk, Hong & P.M.Jørg.

This rare species is known from only two Queensland localities. Its concept is confirmed by the three specimens added. However, it maintains its position as a Queensland endemic. In two of the specimens, pycnidia were observed for the first time. They were small (0.1 mm wide), black and conspicuously glossy.

SPECIMENS EXAMINED

Australia. Queensland: ● Cardwell Range, 24 km WNW of Cardwell, alt. 750 m, 18°12'S, 145°48'E, rainforest on broad ridge, in tree crown, *H. Streimann 28578*, 20.vi.1984 (B 60 0119639, CANB); ● Mount Windsor Tableland, 39 km NW of Mossman, alt. 1080 m, 16°16'S, 145°04'E, in rainforest beside small stream, on sapling, *J.A. Elix 16506*, 26.vi.1984 (B 60 0119630, B 60 0119631, CANB); ● Cooroo Logging Area, 16 km WNW of Innisfail, alt. 100 m, 17°31'S, 145°53'E, in coastal rainforest on felled tree, *J.A. Elix & H. Streimann 16653*, 28.vi.1984 (B 60 0119629, CANB, cf., sterile, no pycnidia seen).

3. Gibbosporina leptospora Elvebakk

This lichen, previously known from only two locations, is now shown to be much more widespread. It is reported here as new to Fiji and New Caledonia. The collection from New Caledonia was previously reported as *Psoroma araneosum* Church.Bab. (now in *Pannaria*) by Smith (1922).

SPECIMENS EXAMINED

Australia. Queensland: ● The Boulders, 6 km W of Babinda, alt. 80 m, 17°21'S, 145°53'E, remnant rainforest surrounding stream, on tree trunk, *H. Streimann 45682*, 3.xii.1990 (B 60 0088006, CANB); ● Barron State Forest, Herberton Range, 11 km SSW of Atherton, alt. 1050 m, 17°22'S, 145°36'E, rainforest, logged in the past, on tree trunk, *H. Streimann 27314*, 2.iii.1983 (B 60 0131528, CANB); ● Moses Creek, Rossville–Bloomfield River road, 35 km SSE of Cooktown, alt. 240 m, 15°47'S, 145°17'E, lowland rainforest on flats beside creek, on shaded upper tree trunk, *H. Streimann 57369*, 21.x.1995 (B 60 0119643, CANB); ● Rex Creek, Mossman Gorge, Daintree River National Park, 6 km W of Mossman, alt. 80 m, 16°28'S, 145°19'E, lowland rainforest with *Tristania* near stream, on tree trunk, *H. Streimann 45880*, 5.xii.1990 (B 60 0087993, CANB).

Fiji. Viti Levu: ● Nasori Highlands, Nadi–Sigatoka road, 13 km E of Vanturu Dam turnoff, in regrowth forest along roadside on trees, *J.A. Elix 15204*, 26.viii.1983 (B 60 0119637, CANB).

Papua New Guinea. Milne Bay: ● Woodlark Island, Mt Kabati–Kulumadau road, 5 km E of Kulumadau, alt. 100 m, 09°04'S, 152°47'E, lowland forest disturbed by roading, on *Endospermum* tree, *R. Kumei 92*, 11.x.1984 (B 60 0063194, CANB); ● Woodlark Island, Kaurai logging area, 9 km N of Kulumadau, alt. 100 m, 09°01'S, 152°43'E, forest dominated by *Syzygium*, *Endospermum*, *Calophyllum*, *Dysoxylum* and *Pometia*, on *Syzygium* branches, *R. Kumei 58*, 8.x.1984 (B 60 0079184, CANB). **Morobe:** ● Herzog Mountains, 15 km WNW of Lae, alt. 760 m, 06°45'S, 146°51'E, on *Castanopsis*- and Dipterocarpaceae-dominated ridge, on large tree trunk, *H. Streimann & T. Umba 10990*, 13.i.1981 (B 60 0113111, CANB).

New Caledonia. ● Mont Humboldt, on soil in moist gully forest, alt. 1000 ft, *Compton 1086*, v.1914, (BM 000760144).

4. Gibbosporina nitida Elvebakk, Hong & P.M.Jørg.

By far the most common species in the material under study, with 19 new collections identified and reported here. Previously, it was known from two localities in Papua New Guinea. Now it is known from 12 more collections there, although five are from the same area. It is characterized by highly glossy lobes, distinctly bullate perispores and proper spores (Nordin 1997) that range from globose and subglobose to short-ellipsoid. Some sterile specimens were determined based on the presence of dark, verrucose, marginal pycnidia. The species is reported here as new to Fiji.

SPECIMENS EXAMINED

Australia. Queensland: ● Crediton State Forest, 20 km SSW of Finch Hatton, alt. 840 m, 21°19'S, 148°33'E, tropical forest dominated by *Argyrodendron trifoliatum* and *Syzygium*, crown of *Argyrodendron*, *H. Streimann 37668*, 1.vii.1986 (B 60 0060963, CANB, NY); ● Ravenshoe State Forest, Tully Falls Road, 18 km SE of Ravenshoe, alt. 760 m, 17°46'S, 145°33'E, along rainforest margin on *Schefflera*, *J.A. Elix 16153*, 23.vi.1984 (B 60 0119626, CANB); ● Cooroo Logging Area, 16 km WNW of Innisfail, alt. 100 m, 17°31'S, 145°53'E,

in coastal rainforest on felled tree, *J.A. Elix & H. Streimann 16668A*, 28.vi.1984 (B 60 0119627, CANB).

Fiji. Viti Levu: ● Nasori Highlands, Nadi–Sigatoka road, 3 km W of Vanturu Dam turnoff, in regrowth forest along roadside, on *Dacridium* in thicket, *J.A. Elix 15264*, 27.viii.1983 (B 60 0119635, B 60 0119636, CANB).

Papua New Guinea. Central: ● Owen Stanley Range, Kagi village, along Kokoda Trail towards Gap, alt. 1700 m, 09°08'S, 147°40'E, *Lithocarpus* forest on mountain ridge, *H. Sipman 38602*, 20–21.x.1995 (B 60 0185956, UPNG). **Eastern Highlands:** ● Waioipa, Aiyura–Omara road, 13 km SE of Kainantu, alt. 1450 m, 06°22'S, 145°58'E, in remnant *Castanopsis* forest on *Cerbera floribunda*, *J.A. Elix 12406*, 8.xii.1982 (B 60 0119633, CANB); ● Wopeia, Aiyura–Omara road, 10 km SE of Aiyura, alt. 1550 m, 06°20'S, 145°55'E, pure *Castanopsis* forest on a broad ridge, on trunk of medium-sized *Cerbera floribunda*, *H. Streimann 18324*, 10.iv.1982 (B 60 0063171, CANB). **Madang:** ● S side of Ramu valley, Bundi village, along road to Bundi Gap, alt. 1500 m, 05°44.9'S, 145°14.1'E, epiphytes in disturbed forest on steep slope, *H. Sipman 39372*, 9.xi.1995 (B 60 0185958). **Morobe:** ● Araulu Logging Area, 26 km SE of Wau, alt. 1900 m, 07°28'S, 146°48'E, *Podocarpus*, *Phyllocladus*- and *Fagaceae*-dominated ridge forest, on large, shaded tree trunk, *H. Streimann 13583*, 29.i.1981 (B 60 0119647, CANB); ● Upper Nawata Banda, 9 km S of Bulolo, alt. 1400 m, 07°17'S, 146°38'E, *Castanopsis acuminatissima*-dominated forest on ridge, on *Sloanea* trunk, *H. Streimann 24904*, 3.x.1982 (B 60 0063193, CANB); ● Upper Watut River, 13 km SSW of Bulolo, alt. 1750 m, 07°17'S, 146°36'E, *Castanopsis-Ternstroemia britteniana*-dominated ridge, on treelet stem, *H. Streimann 23081*, 22.viii.1982 (B 60 0119646, CANB). **New Britain:** ● Geleo-Lasilai logging area at Laliti Mountain, Nakanai Mountains, 40 km SE of Hoskins, alt. 200 m, 05°42'S, 150°41'E, lowland forest on pumice on gentle slope dominated by *Meliaceae*, *Pometia* and *Garcinia*, in *Pometia* crown, *H. Streimann 40961*, 21.ii.1989 (B 60 0119641, CANB); ● *loc. id.*, *H. Streimann 40967*, 21.ii.1989 (B 60 0087992, CANB); ● *loc. id.*, *H. Streimann 40968*, 21.ii.1989 (B 60 0087995, CANB, NY, TU); ● *loc. id.*, *H. Streimann 40974*, 21.ii.1989 (B 60 0087994, CANB); ● *loc. id.*, *H. Streimann 41280*, 21.ii.1989 (B 60 0087991, CANB); ● Ibona Logging Area, slopes of Mt Ulawun (The Father), 10 km SSE of Ulamona Mission, alt. 250 m, 05°06'S, 151°17'E, lowland forest on volcanic ash, dominated by *Pometia*, *Calophyllum* and *Homalium*, on upper trunk of large tree (*Homalium foetidum*), *H. Streimann 41409*, 23.ii.1989 (B 60 0087990, CANB, KRAM). **Southern Highlands:** ● Piribu Sawmill, Tari–Komo road, 3 km SW of Tari, alt. 1650 m, 05°52'S, 142°56'E, in *Castanopsis* forest on dead tree, *J.A. Elix 13198*, 15.xii.1982 (B 60 0119632, CANB).

Philippines. Leyte, Leyte Prov.: ● Weg vom Gipfel des Mt Agipo nach Kadwa-An, alt. 780 m, c. 10°48'N, 124°47'E, *F. Schumm & U. Schwarz 7785*, 18.viii.2000 (B 60 0116418).

5. Gibbosporina sphaerospora Elvebakk & P.M.Jørg.

Nine specimens were determined as *G. sphaerospora*, which is reported as new to Fiji and Papua New Guinea. If present, the ascospores were very characteristic, with globose or subglobose proper spores (Nordin 1997) with thin and weakly gibbose perispores. The Fijian sample had some more gibbous than most other specimens of *G. sphaerospora*. Sterile specimens were determined by the presence of very conspicuous and large pycnidia. Some of the specimens proved to be a little more glossy compared to the description given by Elvebakk *et al.* (2016).

SPECIMENS EXAMINED

Fiji. Viti Levu: ● Mba (formerly Thole North), hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–970 m, dense forest, 9–25 Sept. 1947, *A.C. Smith 6243* (BM).

Indonesia. West Java: ● Cibodas, Botanical Garden, alt. c. 1300 m, on tree trunks in garden. *H. Sipman & Zainal 30080*, 8.v.1991 (B 60 0083576).

Papua New Guinea. Central: ● K.B. Sawmill, Ehu Creek, 12 km SW of Sogeri, alt. 750 m, 09°28'S, 147°31'E, *Castanopsis*- and *Hopea*-dominated ridge, on a vine in the crown of a large *Castanopsis*, *H. Streimann & E.K. Naoni 16626*, 16.ii.1981 (B 60 0119652, CANB). **Morobe:** ● Aseki–Menyamy road, 6 km NE of Aseki, alt. 1950 m, 07°19'S, 146°09'E, in

disturbed montane forest on dead wood, *J.A. Elix & M. Toia 12142*, 5.xii.1982 (B 60 0119634, CANB); ● Araulu Logging Area, 26 km SE of Wau, alt. 1900 m, 07°28'S, 146°48'E, *Podocarpus*-, *Phyllocladus*- and *Fagaceae*-dominated ridge, on treelet trunk, *H. Streimann 13613*, 29.i.1981 (B 60 0119648, CANB). *Northern*: ● Owen Stanley Range, Myola, near guesthouse, along Iora River, alt. 2100 m, 09°09'S, 147°46'E, in primary montane forest in valley, *H. Sipman 38179*, 14.x.1995 (B 60 0185957, UPNG); ● Owen Stanley Range, Myola, c. 0.5 km along trail from guesthouse to Naduri, alt. 2100 m, 09°09'S, 147°46'E, in primary montane forest, *H. Sipman 38391*, 17.x.1995 (B 60 0185955, UPNG). *Southern Highlands*: ● Tari-Komo road, 6 km N of Komo, alt. 1480 m, 06°01'S, 142°51'E, in lower montane forest on tree, *J.A. Elix 13267*, 16.xii.1982 (B 60 0119638, CANB).

Philippines. *Luzon, Prov. Sorsogon*: ● Irosin, alt. 1500 ft, on the large limbs of a *Dipterocarpus*. *A.D.E. Elmer 15104*, xi.1915 (B 60 0060351).

6. *Gibbosporina thamnophora* Elvebakk & P.M.Jørg.

This species is now added from two new Australian localities. It was previously known from only Eungella National Park, as documented by collections deposited in Swedish herbaria. With its small-fruticose cephalodia, it was previously confused with the much more southern *Pannaria durietzii* (P.James & Henssen) Elvebakk & D.J.Galloway.

SPECIMENS EXAMINED

Australia. *Queensland*: ● Crediton State Forest, 20 km SSW of Finch Hatton, alt. 840 m, 21°19'S, 148°33'E, in rainforest dominated by *Syzygium* and *Argyrodendron trifoliatum*, on canopy of *Argyrodendron*, *J.A. Elix 21039*, i.vii.1986 (B 60 0113110, CANB); ● Mount Windsor Tableland, 38 km NW of Mossman, alt. 1140 m, 16°17'S, 145°04'E, in rainforest with *Agathis robusta* along steep slope, on *Syzygium*, *J.A. Elix & H. Streimann 16516*, 26.vi.1984 (B 60 0113108, CANB).

Papua New Guinea. *Morobe*: ● Herzog Mountains, 15 km WSW of Lae, alt. 760 m, 06°45'S, 146°51'E, on *Castanopsis*- and *Dipterocarpaceae*-dominated ridge, on trunk of small *Myristica*, *H. Streimann & T. Umba 10965*, 13.i.1981 (B 60 0116419); ● Herzog Mountains, 15 km WNW of Lae, alt. 760 m, 06°45'S, 146°51'E, on *Castanopsis*- and *Dipterocarpaceae*-dominated ridge, large tree trunk, *H. Streimann & T. Umba 10990*, 13.i.1981 (B 60 0113111, CANB, among *Gibbosporina leptospora*).

Conclusions

The diversity patterns within *Gibbosporina*, with vicariant species in eastern or western parts of the Palaeotropics, has been upheld. All the collections could be assigned to the six species already known from Queensland, and the present study confirms existing species concepts. Two previously rare taxa, *G. elixii* and *G. leptospora*, are now recorded from additional localities, and *G. thamnophora* has its distribution in Queensland extended. *Gibbosporina nitida* appears to be the most common species in the area, whereas three species are recorded as new to Fiji, one to New Caledonia and one to Papua New Guinea. Co-occurrence of several species in one island was discussed by Elvebakk *et al.* (2016), and that is now confirmed by three species each known from Fiji and New Caledonia.

Detailed studies (with a substantial number of measurements) of the highly distinctive perispore morphology facilitates the recognition and separation of species. Individual spores of *G. sphaerospora* and *G. nitida* can overlap somewhat, but overall they conform to the patterns of perispore described by Elvebakk *et al.* (2016). As well, proper spores (Nordin 1997) have distinctive shapes ranging from globose to subglobose and short-ellipsoid in *G. sphaerospora*, to short-ellipsoid in *G. nitida*, intermediate-ellipsoid in *G. acuminata* and long-ellipsoid in *G. elixii*.

Pycnidia were used in a few cases to determine sterile samples. They are comparatively large and conspicuous in *G. sphaerospora*, moderately large and brown in *G. nitida*, sometimes with nodulose shapes, whereas they are newly described here as being small (0.1 × 0.1 mm), black and conspicuously glossy in *G. elixii*.

In regard to non-spore traits, glossy lobes are characteristic of most of the specimens, even

some samples of *G. sphaerospora*, which appears more glossy than reported by Elvebakk *et al.* (2016).

Pannaria melanesica has uncertain affiliations within *Pannaria*, but it might be most closely related to an as yet undescribed, pannarin-containing species from Queensland and New Caledonia.

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