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Pannaria isidiosa, a new Australian lichen with a new chemosyndrome

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Abstract: *Pannaria isidiosa* sp. nov. is newly described from montane forests in New South Wales, Australia. It is characterized by abundant globose to coralloid isidia, long-ellipsoid spores with a verrucose and citriform perispore. It is related to *P. xanthomelana*, but in addition to pannarin and porphyrilic acid, it contains methylplacodiolic acid and a chemosyndrome of four unidentified terpenoids.

Key words: Australia, lichens, new species, methylplacodiolic acid, *Pannaria*, *Pannariaceae*

Introduction

Foliose species of *Psoroma* s. lat. are now treated as tripartite species of the genus *Pannaria* (Elvebakk & Galloway 2003). They are distributed in austral areas, where they are often important components of the epiphytic lichen vegetation. Jørgensen & Galloway (1992) reported five tripartite species of *Pannaria* from Australia, and the only later addition has been *Psoroma contortum* Müll. Arg. (Passo *et al*. 2004), a poorly understood taxon not yet transferred to *Pannaria*. Jørgensen & Galloway (1992) reported on several undescribed taxa occurring in Tasmanian rainforests, and three such unidentified species were briefly referred to by Kantvilas & Jarman (1999). Filson (1996) also listed three species which were incorrectly reported from Australia. Our studies have confirmed that Australia has several undescribed species within this group of lichens. The present study describes one of these, and also emphasizes its characteristic chemistry.

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Material and Methods

The herbaria AK, BG, H, PC, S, UPS, and WELT were examined, but the present species was found only in UPS. All cited specimens were studied by thin-layer chromatography of acetone extracts using standardized procedures and solvents A, B, and C (Culberson 1972; Orange *et al*. 2001). Iodine+ reactions were studied by adding IKI to mounts pretreated with KOH (Orange *et al*. 2001). Perispore structures were studied in water mounts and restricted to spores liberated from their asci. High performance liquid chromatography utilized standard procedures as described in Elix *et al*. (2003) and comparison with authentic samples. The holotype was also studied by SEM at the EM Laboratory at the Faculty of Medicine, University of Tromsø. Nomenclature of ascospore structures follow Nordin (1997).

The Species

Pannaria isidiosa Elvebakk & Elix sp. nov.

Differt a *Pannaria xanthomelana* thallis isidiatis, longioribus citriformibusque sporis, et methylplacodiolicis acidis quattuorque terpenoidis distinguibilibus praesentibus.

Typus: Australia, New South Wales, New England National Park, along Lyrebird Walk, 30°30′S, 152°24′E, alt. 1250–1450 m, on bark of *Eucalyptus nitens*, 18 April 1981, *L. Tibell* 12405 (UPS L-97508—holotypus).

(Figs 1–5)

Thallus foliose, corticolous, forming rosettes 5–20 cm diam., loosely attached to

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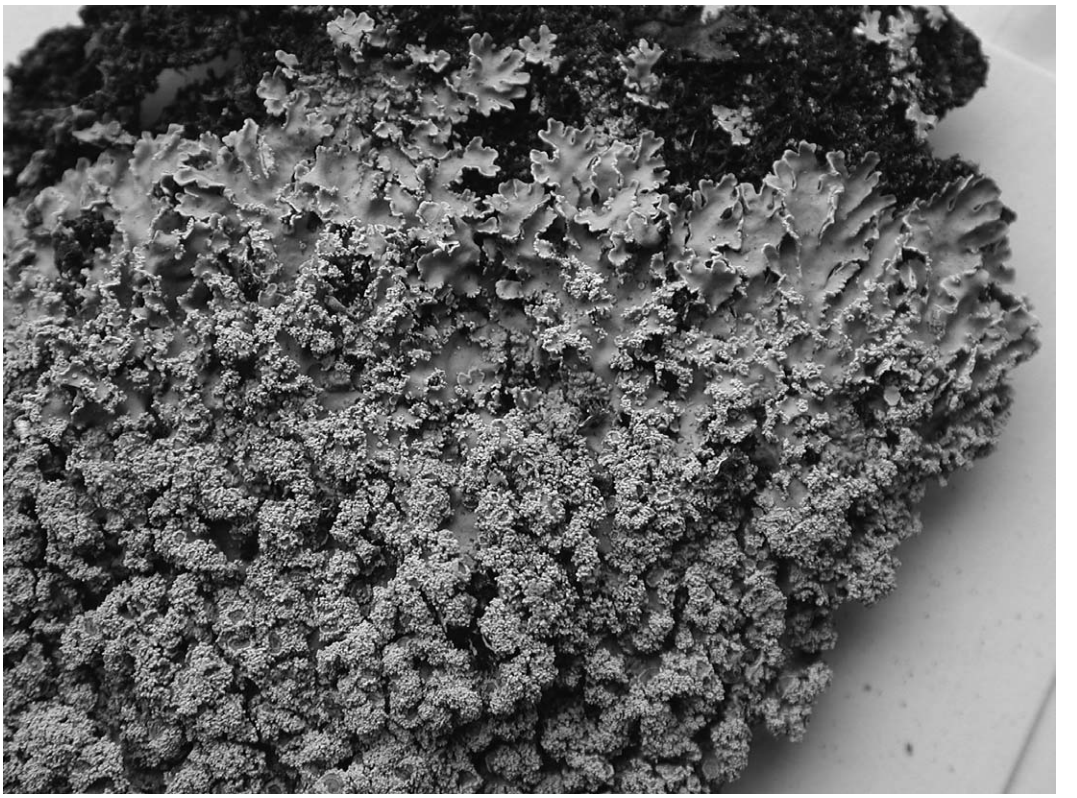


FIG. 1. *Pannaria isidiosa* (holotype).

the substratum, particularly when growing over bryophytes on tree trunks, 170–250 µm thick. *Lobes* irregularly branched, discrete to slightly overlapping in peripheral parts, coalescing centrally, weakly concave, 0·5–1·5 mm broad. *Upper surface* probably whitish grey when fresh and dry, changing to yellowish brown after storage in herbaria, matt to slightly glossy, glabrous, but uneven when strongly magnified (Fig. 2). *Isidia* numerous, originating marginally, mostly globose and *c.* 0·1 mm diam. (Fig. 3), but developing into a coralloid mass which can cover thalli in their central parts. *Epicortex* 35–45 µm thick, upper third with brown pigmentation, paraplectenchymatous with luminae globose to irregularly ellipsoid, 5–11 µm long, walls *c.* 1·5–3 µm thick. *Photobiont* layer 30–40 µm thick, of globose to subglobose cf. *Myrmecia* cells, 7–11 µm diam. *Medulla* 100–170 µm thick. *Lower cortex* lacking; *rhizines* common, brown and simple; *hypothallus* felted, brown, moderately developed and not observed forming a prothallus.

Cephalodia common, laminal on the upper side, 2–5 mm wide, placodioid, lobes weakly striate, convex, young lobes often tomentose; *epicortex* as in the chlorobiont; *cyanobiont* cf. *Nostoc*, cells greyish blue, subglobose to ellipsoid, 4·5–7 × 3–4·5 µm large, organized within spherical glomeruli, 20–45 µm large, delimited by a mucilaginous sheath; no chain structures observed.

Apothecia common, laminal, substipitate, 1–2·5(–3) mm broad, disc rufous brown, often pruinose and with concentric depressions; *thalline excipulum* crenulate-striate, but soon becoming isidiate, and apothecia often partly hidden by a mass of isidia; *epithecium* pale brown, 15–30 µm thick, IKI negative; *hymenium* colourless, but strongly

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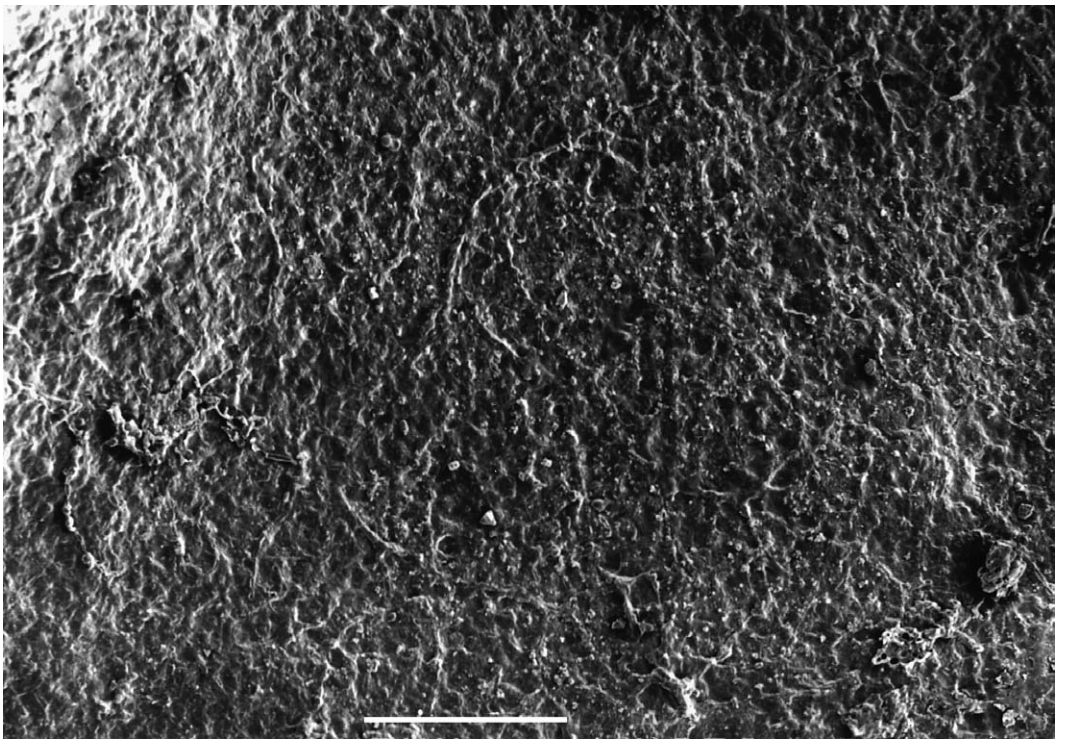


FIG. 2. *Pannaria isidiosa* (holotype), SEM micrograph of the surface of the epicortex. Scale=100 μm.

IKI+ blue, 100–130 μm thick; *hypothecium* light brown, IKI negative, 60–90 μm thick; *paraphyses* simple, with slightly swollen apices; *asci* clavate, 100–120 × 15–17 μm large, no internal amyloid structures observed, containing eight ascospores. *Proper ascospores* ellipsoid, rarely lacrymiform, 16–19 × 6–10 μm; *perispores* citriform, verrucose, 18–23 × 9–13 μm large, 0·5–1 μm thick, with verruciform apical extensions, 2–3 × 1–2 μm large (Figs 4 & 5).

Chemistry. Pannarin, methylplacodiolic acid, porphyrilic acid (all major), four unidentified terpenoids (minor to major) and one unidentified substance (minor) are constant compounds. Occasionally, vicanicin, dechloropannarin, contortin and an additional unidentified compound were detected in trace amounts by HPLC analysis.

Notes. The species is most closely related to *Pannaria xanthomelana* (Nyl.) Hue, a species redescribed by Galloway (1985), and considered a New Zealand endemic. The lobes of *P. isidiosa* are almost as glossy as those of *P. xanthomelana*, although some specimens of *P. isidiosa* are almost matt. The description of the thallus of *P. xanthomelana* as 'mustard-yellow' by Galloway (1985) refers to the colour of old herbarium specimens, a fact also reflected in its epithet name. When fresh, the colour of this and other tripartite species of *Pannaria* is whitish grey when dry and grey-green or green when moist, although there are no field observations on *P. isidiosa* available to us yet. The distinct blackish prothallus reported from *P. xanthomelana* may not be a constant character, and thus not a fundamental distinguishing character between these two species.

The isidia of *P. isidiosa* are basically globose, although a few originating exactly at thallus margins are dorsiventrally compressed. They may also become somewhat less regular when influenced by coralloid

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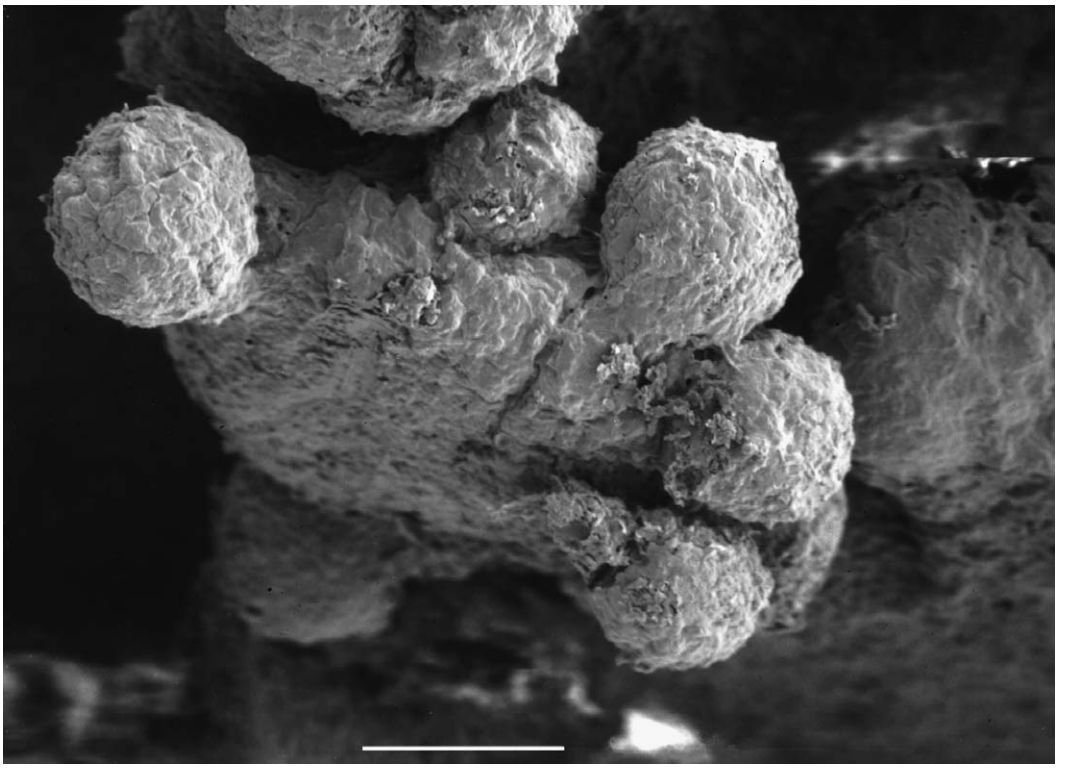


FIG. 3. *Pannaria isidiosa* (holotype), SEM micrograph of isidia. Scale = 100 μm.



FIG. 4. *Pannaria isidiosa* (holotype), SEM micrograph of spore deposited on an apothecial disc. The spore measures 16 × 9·5 μm in the dry state.

branching. They are very different from the glomerulate to lobulate isidia described from the New Zealand species *P. allorhiza* (Stirt.) Elvebakk & D. J. Galloway, the only truly isidiate, tripartite *Pannaria* species known to date.

The apothecia of *P. isidiosa* have exactly the same structure as those of *P. xanthomelana*, with a central depression in the disc, surrounded by concentric ring-like depressions. The ascospores of *P. isidiosa* are, however, distinctly longer, albeit not broader, and are therefore more elongate-ellipsoid. They are also citriform because of the large, verrucose apical extensions of their perispores. What is also striking with this species, is its abundance of apothecia. Primarily isidiate or sorediate species generally produce significantly fewer apothecia than their primarily fertile counterparts, in cases where such species-pairs are known. The well-developed, large holotype of *P. isidiosa*, and the numerous large specimens available for isotype material, have numerous apothecia. Many of these appear to be sub-optimally located within depressions, almost covered by the robust crust of coralloid isidia. A possible interpretation is that *P. isidiosa* is an evolutionarily rather young species, and an isidiate member of a

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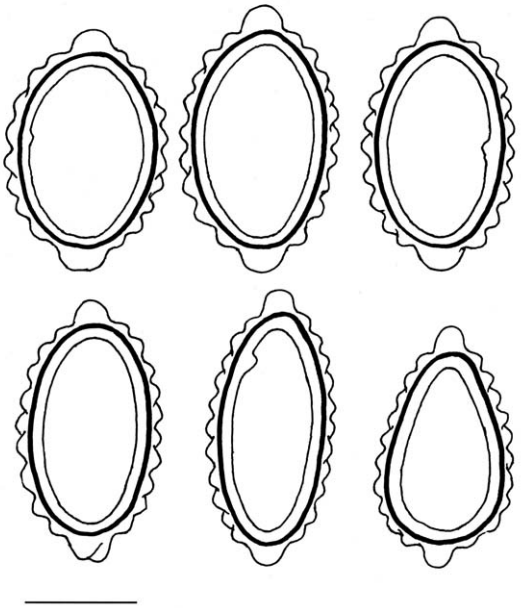


FIG. 5. *Pannaria isidiosa* (holotype), spores. Scale = 10 µm.

complex comprising (one or more) several unknown species, more closely related to it than *P. xanthomelana*. A search for such species is now being undertaken, where the characteristic chemical profile of *P. isidiosa* is considered a key factor.

Distribution and habitat ecology. The localities of the six known collections are confined to two areas, 4–500 km apart along the Great Dividing Range west and north-west of Sydney, at elevations between 1200 and 1400 m. Two of the collections are from trunks of *Doryphora sassafras* Endl., one on cf. *Prostanthera* within a *Doryphora–Eucalyptus* forest, one on the tree fern *Dicksonia antarctica* (Labill.) Aus. within a *Ceratopetalum–Doryphora* rainforest, one on *Eucalyptus nitens* Maiden, and one on a planted *Castanea* along an alley. Details of the distribution, abundance and ecology of *P. isidiosa* must await future investigations.

Additional specimens studied. **Australia:** *New South Wales*: Blue Mountains, Mount Wilson, 1926, *G. E. & G. Du Rietz* 713:5; 796:9; 805:4; 806:15; 828:3 (UPS).

Discussion of the chemistry

The chemistry of what is now considered a tripartite *Pannaria* species was initiated in several chemical studies made by the second author and coauthors two to three decades ago, involving compounds such as the depsidones, vicanicin, norvicanicin, isovicanicin and pannarin, based on Australian and New Zealand lichen material (Jackman *et al.* 1975; Sargent *et al.* 1976; Elix *et al.* 1978, 1982). Earlier studies dealing with the key substances pannarin and vicanicin were reviewed by Culberson (1969). Elix *et al.* (1978, 1984) described the diphenylether leprolomin and the biphenyl contortin. Piovano *et al.* (1985) and Quilhot *et al.* (1989) screened no less than 18 species of *Psoroma* s. lat. from Chile for chemical compounds, and eight of these species are now accommodated within *Pannaria*. However, we do not believe that the species names associated with the various chemical profiles are reliable. One reason for this interpretation is that the key compounds pannarin and

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vicanicin hardly ever co-occur within a single lichen thallus, and probably not even within a single species of tripartite *Pannaria* (A. Elvebakk, unpublished TLC-based studies). Most chemosyndromes within tripartite species of *Pannaria* are therefore centred around either pannarin or vicanicin.

The only taxonomic studies of this group of lichens providing additional information on their chemistry are those of James & Henssen (1975), Elvebakk & Galloway (2003), Passo *et al.* (2004) and Elvebakk & Bjerke (2005). Apart from the last publication, they dealt with chemosyndromes involving pannarin. So also did the flora treatment of Kantvilas & Jarman (1999). According to these published sources the following chemical combinations involving pannarin are known: (I) pannarin, zeorin and two unknowns in *Pannaria durietzii* (P. James & Henssen) Elvebakk & D. J. Galloway (James & Henssen 1975); (II) pannarin, porphyrilic acid, several terpenoids, also in *P. durietzii* (Elvebakk & Galloway 2003, who also indicated the presence of additional chemotypes); (III) pannarin and porphyrilic acid in *P. euphylla* (Nyl.) Elvebakk & D. J. Galloway (Kantvilas & Jarman 1999); (IV) pannarin in *P. leproloma* (Nyl) P. M. Jørg. and '*Psoroma* sp. 7' (Kantvilas & Jarman 1999); (V) pannarin (major), norpannarin, pannarin methyl acetal and two unknowns in *P. pallida* (Nyl.) Hue (Passo *et al.* 2004); (VI) pannarin, contortin (both major) and porphyrilic acid in *Psoroma contortum* Müll. Arg. (Passo *et al.* 2004); and, (VII) contortin, zeorin (both major) and pannarin and its derivates (minor) in *Pannaria xanthomelana* (Nyl.) Hue (Passo *et al.* 2004).

The first major conclusion one can draw from the above data is that there are inconsistencies in the identity of the chemical profiles within particular species, due no doubt to mistakes in the identification of some substances and to different interpretations of species delimitation. Thus the report of Passo *et al.* (2004) on the chemistry of *P. xanthomelana* is not in agreement with our own studies (A. Elvebakk, unpubl.) of the holotype of *Psoroma xanthomelanum*, as we found this to contain porphyrilic acid (major) and pannarin (trace to minor), but none of the terpenoids reported above for *P. isidiosa*.

The second conclusion is that there is a much higher diversity of chemical variation within tripartite species of *Pannaria* than among the bipartite ones. A review of studies of bipartite *Pannaria* species where chemical information is available (Jørgensen 2003*a*,*b*, 2004; Jørgensen & Sipman 2004; and studies of the same major author or with coauthors, cited there) showed that 30 species have pannarin, 21 species no compounds detected by TLC, and only two species contain vicanicin, one of them with intermittent, additional leprolomin. Two of the 51 species were represented by two chemodemes, and very few species are cited to have additional minor compounds. It is difficult to explain this pattern, but it accords with the well-known fact that cyanolichens normally tolerate more shaded habitats than green algal lichens. In such shaded habitats the need for light protection is lower. However, there are also chemically diverse cyanolichens in other genera, and there could also be an evolutionary history explaining chemical patterns within the genus *Pannaria*.

The present investigation of *P. isidiosa* has established that this species exhibits the most complex pattern of chemical variation yet known within *Pannaria*, with eight constant compounds, as well as several additional compounds detected in single HPLC analyses. Methylplacodiolic acid, so far reported only from *Haematomma chilenum* Dodge and *H. hilare* Zahlbr. (Staiger & Kalb 1995), is the first dibenzofuran to be reported from *Pannaria*. The importance of several distinct and constant terpenoids, some in major amounts, is also a novelty within *Pannaria*. None of the triterpenes correspond to zeorin, so previous reports of zeorin in this genus need confirmation.

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