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Number 42, January 1998

Pseudocyphellaria homoeophylla (Nyl.) C.W. Dodge   1 mm

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Discussion and Field Meeting of Australasian Lichenologists
Dunedin, New Zealand, 12–16 November, 1998
— first announcement —

A discussion and field meeting for Australasian lichenologists will be held in Dunedin at Otago University, Botany Department, from Thursday 12 November until Monday 16 November, 1998. An organizing committee comprising Jennifer Bannister and John Steel (Botany Department, Otago University) and David Galloway and Peter Johnson (Landcare Research NZ Ltd) is putting together an attractive programme of lectures, field trips (to coastal, lowland, and subalpine habitats), and demonstrations. Since 1998 is the sesquicentennial (150 years) of the founding of the Province of Otago, an Otago theme will prevail at the meeting.

The meeting will precede the New Zealand Bryological Field Meeting, and it is expected that additional field trips catering to both lichenologists and bryologists will be arranged. It is hoped that several overseas lichenologists will attend, with Australia, Tasmania, Chile, and the Northern Hemisphere represented. Further details and a programme will appear in the next issue of *Australasian Lichenology*.

For further information and details of travel and accommodation, please contact the Meeting Secretary Jennifer Bannister, Department of Botany, University of Otago, P.O. Box 56, Dunedin. Telephone 03–479–7577. Fax 03–479–7583.

13th Meeting of Australasian Lichenologists
Coffs Harbour, New South Wales, 18–19 April, 1998
— Venue and Format —

This meeting will be held at the Botanic Gardens in Coffs Harbour, New South Wales, on Saturday and Sunday, 18–19th April, 1998. Participants are advised to arrive at the Botanic Gardens at 9:00 a.m. on Saturday, April 18th, where the main meeting will be held in the Conference Room (at the Botanic Gardens). During the morning of Saturday 18th, a number of 20–30 minute talks/discussions will be presented, including Dr David Eldridge (Lichens in the Negev Desert, Israel), Dr Alan Archer (*Pertusaria* in PNG), Simone Louwhoff (Parmeliaceae on Lord Howe Island), Prof. Jack Elix, and Dr Gintaras Kantvilas. Other volunteers would be most welcome. In the afternoon, discussions will centre on progress and problems with the lichen volumes of the *Flora of Australia* project, and other agenda items. On Sunday, April 19th, there will be a field trip led by Gordon and Bronwen Myall to several localities in the vicinity of Coffs Harbour. So in detail:

Location: The meeting and talks will be held in the Conference Room in the grounds of the Coffs Harbour Botanic Gardens, corner Hardacre and Coff Street, Coffs Harbour. Participants are advised to arrive at the Botanic Garden at 9:00 a.m. on Saturday, April 18, 1998. Cars can be parked at the gardens. A registration fee of $5.00 will be required from participants to cover costs of coffee and refreshments, etc., payable at the meeting.

Field trip: A field trip led by Gordon and Bronwen Myall will be conducted on Sunday 19th to several localities in the vicinity, visiting a variety of lichen habitats, including temperate rainforest, sclerophyll forest, and mangroves. Whilst sensitive collecting will be possible, bulk collecting for exsiccatae etc. will not be permitted.

Accommodation: Coffs Harbour is a city of 50,000 people situated 543 km north of Sydney, and offers a wide variety of accommodation, from 5-star motels to budget motels and hotels. Sawtell, a coastal resort, is also close by. Intending participants are advised to book their accommodation as soon as possible because April 18–19 falls within the school holiday period.

Those intending to attend the meeting should inform Prof. Jack Elix of Chemistry, Australian National University, Canberra ACT 0200 by fax (0262–249–0760), phone (0262–249–2937), or e-mail (jae651@leonard.anu.edu.au) by April 1, 1998.

I, ..., will be attending the Lichenologists' Meeting on Saturday, April 18th, 1998.

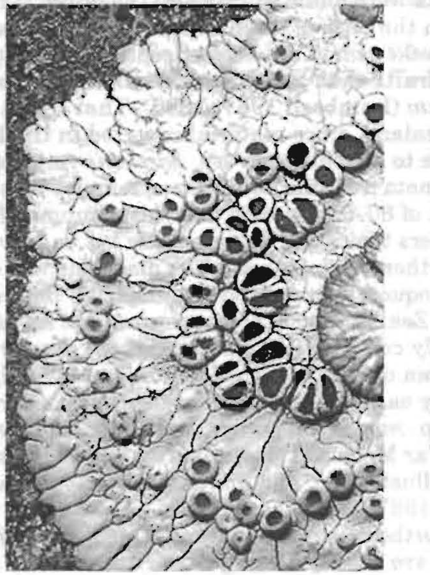
I, ..., will be participating in the field trip on Sunday, April 19th, 1998, and will/will not require transport.

I wish to add the following items to the agenda for discussion.

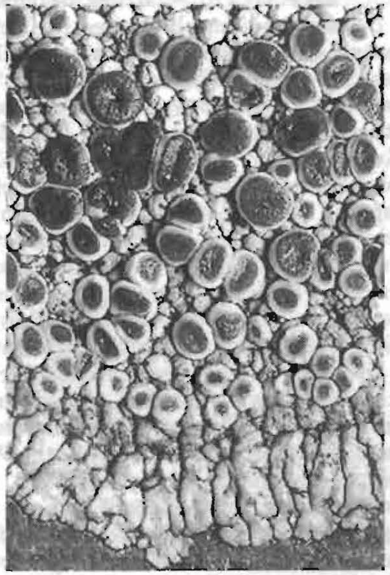
....

I would like to present a talk on the following topic.

....



Placopsis salazina 1 mm



Placopsis perrugosa 1 mm

Additional lichen records from New Zealand 26. *Diploschistes muscorum* (Scop.) R. Sant. ssp. *muscorum*

David Galloway
Landcare Research New Zealand Limited
Private Bag 1930, Dunedin, New Zealand

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In recent checklists of New Zealand lichens (Galloway 1992; Malcolm & Galloway 1997), 10 taxa of *Diploschistes* are listed, including *Diploschistes muscorum* ssp. *bartlettii* Lumbsch. In both checklists, the taxon *D. australasicus*, which is an unpublished herbarium name, refers to *D. hensseniae* Lumbsch & Elix (Lumbsch & Elix 1985), and *D. bisporus* must now be referred to *Ingvariella bispora* (Bagl.) Guderley & Lumbsch (Guderley *et al.* 1997). *D. muscorum* ssp. *bartlettii*, which was described from a specimen collected by the late John Bartlett in the Ruahine limestone plateau (Lumbsch 1987), is widespread in the mountains of New Zealand from Ruapehu to Fiordland, and is also known from East Africa, Madagascar, Indonesia, Ecuador, Brazil, Argentina, Chile (including Easter Island), Australia, and Tasmania (Lumbsch 1987). It is characterized by 8-spored asci, a hymenium 120–140 µm tall, and brown, ellipsoid to broadly ellipsoid, submuriform ascospores 19.5–30 × 4–14 µm. It has a wide Southern Hemisphere distribution.

Recently *Diploschistes* ascomata were found growing on the upper surface of *Cladonia* squamules collected from the base of a schist outcrop in Roxburgh, Central Otago. The ascomata were 0.1–0.4 mm in diameter, deeply urceolate, and blackish with a light white pruina, traits that are characteristic of the young stages of *D. muscorum* ssp. *muscorum* (Lumbsch 1987, 1989). That taxon has hitherto not been recorded for New Zealand, since material reported in the 1985 *Flora* (Galloway 1985) was all referable to *D. muscorum* ssp. *bartlettii*. Anatomical investigation of the *Diploschistes* ascomata from the *Cladonia* squamules revealed 4-spored asci and a hymenium height of 80–90 µm with brownish, submuriform ascospores, 20–25 × 10–12 µm, characters typical for *D. muscorum* ssp. *muscorum*, which is widely distributed in the Northern Hemisphere. The diagnosis was confirmed by Dr H.T. Lumbsch, who subsequently examined the material. Both subspecies are therefore present in New Zealand, with *D. muscorum* ssp. *bartlettii* being widespread and fairly commonly collected. *D. muscorum* ssp. *muscorum*, on the other hand, is so far known from only this one collection, but is likely to be more widely distributed as it is very easily overlooked. Interestingly, near the Roxburgh site where *D. muscorum* ssp. *muscorum* occurs, *Ingvariella bispora* is also abundantly present, close to the War Memorial monument on flat schist rocks used as a footpath. For a description, illustration, and discussion of *D. muscorum* and its two subspecies, see Lumbsch (1987, 1989). Accounts of *Diploschistes* and *Ingvariella* are in preparation for the forthcoming *Supplement to the New Zealand Lichen Mycobiota*. The two subspecies are readily distinguished as follows:

1a. Spores 8 per ascus; hymenium 120–150 µm tall; distribution Southern Hemisphere .... *D. muscorum* ssp. *bartlettii*
1b. Spores 4 per ascus; hymenium 80–120 µm tall; distribution mainly Northern Hemisphere .... *D. muscorum* ssp. *muscorum*

SPECIMEN EXAMINED
New Zealand. • South Island, Otago, Roxburgh, 45°33'S, 169°19'E, on soil in cracks and crevices of schist outcrops close to War Memorial, 30.x.1997, *D.J. Galloway 0151* (OTA).

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Additional lichen records from New Zealand 27. *Xanthoria polycarpa* (Hoffm.) Th.Fr. *ex* Rieber

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During a revision of distributions of taxa in the genera *Teloschistes* and *Xanthoria* in New Zealand, a small, cushion-forming species was noted in collections from twigs and branches of introduced trees in urban and rural environments. It was at first thought to be an ecotype of *X. novozelandica*, but subsequently was determined to be conspecific with the mainly Northern Hemisphere taxon *X. polycarpa*, which was not formerly recorded from New Zealand (Malcolm & Galloway 1997). The species is illustrated in Moberg & Holmåsen (1982: 190), Wirth (1987: 506), Kärnefelt (1989: 194, fig. 123), Dobson (1992: 363 & pl. 16), McCune & Geiser (1997: 322), and Lindblom (1997: 119, fig. 14C). A description is given below.

Xanthoria polycarpa (Hoffm.) Th.Fr. *ex* Rieber, *Jahreshefte Ver. vaterl. Kultur im Württemberg* **42**, 252 (1891). *Lobaria polycarpa* Hoffm., *Deutschl. Flora* **159** (1796).

Thallus (2–)5–10(–20) mm diam., forming small, rounded to elongated hummocks or cushions. Lobes 0.05–0.2 mm wide at margins and there crenulate-lobulate to delicately coralloid, widening to 1–2 mm centrally, 1–3 mm long and tapering from centre to margins, ± discrete to densely imbricate at margins, obscured by apothecia centrally. Upper surface ± convex, minutely lumpy-papillate (10× lens), pale grey-green (in shade) to mustard-yellow to orange (in high light), without isidia or soredia. Lower surface white, pale greenish at margins, corticate, ridged-striate, matt, with scattered, short white attaching hapters. Pycnidia scattered, minute, papillate, orange. Apothecia generally abundant, ± crowded centrally, rounded to contorted through mutual pressure, 0.05–1.5(–3) mm diam., shortly pedicellate, pedicel broad, as wide as or slightly less than disc, margins persistent, broad and obscuring disc at first, narrowing with age, entire, minutely roughened-crenulate, concolorous with thallus; disc concave at first, becoming plane to undulate with age, greenish yellow to mustard-yellow to orange, matt. Ascospores ellipsoid, 11–15 × 6–8 µm.

Chemistry: parietin (major) with fallacinal, emodin, teloschistin, and parietinic acid (Lindblom 1997).

X. polycarpa is a bipolar species and very likely an introduction to our lichen mycobiota since it is known from mainly urban and modified rural environments in both North and South Islands (between latitudes 39°04'S and 46°14'S). Elsewhere in its range, it is a widespread circumboreal-montane lichen of bark known from the British Isles (Purvis *et al.* 1992), Europe (Nimis 1993), Scandinavia (Santesson 1993), Morocco (Egea 1996), Ukraine (Kondratyuk *et al.* 1996), and North America (Lindblom 1997), but not recorded from Australia (Filson 1996).

It is characterized by small, rounded to elongated cushion-like thalli of congested-imbricate, ± tapering, subterete lobes, often almost coralloid at the margins, which are often hidden by the crowded apothecial discs. It is not easily confused with any other species of *Xanthoria* in New Zealand, but is similar in some respects to the mainly North Island species *Teloschistes xanthorioides*, which has a hummocky

thallus and well-developed central apothecia obscuring the thallus. However, *T. xanthorioides* has well-developed white rhizines on the lower surface of the thallus, and larger fruits which are distinctly pedicellate. *X. polycarpa* is a very uniform species throughout its range in New Zealand, differing mainly in the colour of the thallus depending on the light regime of the substratum (and the corresponding development of parietin in the upper cortex). Collections from shaded and/or polluted inner city sites are generally greenish yellow to green-grey or grey, while specimens from high-light environments are conspicuously orange.

X. polycarpa occurs on twigs and/or trunks of mainly introduced trees (*Acer pseudoplatanus, Berberis glaucocarpa, Betula pendula, Crataegus monogyna, Fraxinus excelsior, Gingko biloba, Larix europaea, Prunus × domestica, Prunus serrulata, Quercus robur, Rosa rubiginosa*, and *Sophora microphylla*), being most commonly found in parks, gardens, roadside plantings and hedges, and very rarely in modified tussock grasslands grazed by sheep and cattle. In urban environments, it apears to be able to survive moderate to high levels of atmospheric pollution. Specimens are always small (and are often overlooked) and tend to develop on rather young, smooth surfaces, being lost as the bark ages and furrows. This probably explains why it has been so infrequently collected to date. It was first collected in New Zealand by William Martin in December 1957 from a roadside hawthorn hedge near Brighton, Otago. In New Zealand, *X. polycarpa* associates with the following lichens: *Amandinea punctata, Caloplaca inclinans, Candelariella reflexa, Hyperphyscia adglutinata, Lecanora carpinea, Parmelina labrosa, Physcia adscendens, Physcia poncinsii, Ramalina celastri, R. glaucescens, Rinodina exigua, Teloschistes chrysophthalmus, T. velifer*, and *Xanthoria parietina*.

SPECIMENS EXAMINED

North Island. •Taranaki, New Plymouth–Turangi Road, on *Berberis* twigs in hedge, 14.iii.1994, *P.N. Johnson 1095* (CHR). *South Island.* •Canterbury, Christchurch, Avonside, Stanmore Road, Beverley Park, on *Gingko biloba*, 5.x.1993, *P.N. Johnson & A.J. Fife JF29* (CHR). •Christchurch, Cashmere, Wherstead Road, on *Betula pendula*, 4.x.1993, *P.N. Johnson & A.J. Fife JF26* (CHR). •Christchurch, Avon Park, on *Sophora*, 5.x.1993, *P.N. Johnson & A.F. Fife JF52* (CHR). •Christchurch, S. Hagley Park, on sycamore, 26.x.1995, *P.N. Johnson 1530* (CHR). •Christchurch, Hanson's Park, plum tree by Scout hall, 5.viii.1993, *P.N. Johnson 795* (CHR). •Lincoln Township Reserve, on oak, 16.xii.1970, *T. W. Rawson* (CHR 162627). •Lincoln Railway Station, on oak, 14.xii.1970, *T. W. Rawson* (CHR 162628). •Lincoln Cemetery, 12.xii.1970, *T. W. Rawson* (CHR 162625). •Lincoln, DSIR garden, on *Sophora*, 6.vi.1991, *P.N. Johnson 234* (CHR). •Otago, Teviot Valley, The Retreat, on *Betula pendula*, 10.vi.1997, *D.J. Galloway* (OTA). •East slopes Mt Benger, on sweet brier in modified tussock grassland, 5.i.1997, *D.J. Galloway* (OTA). •Brighton River roadside, on rocks and hawthorn, 27.xii.1959, *W. Martin 6113* (CHR 487201). •Dunedin, 691 Cumberland Street, on *Prunus serrulata*, 18.vi.1997, *D.J. Galloway* (OTA). •Dunedin, North Ground, Cumberland Street, on *Acer pseudoplatanus*, 18.vi.1997, *D.J. Galloway* (OTA).

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Additional lichen records from Australia 33. *Xanthoparmelia eilifii* and *X. pumila* from Victoria

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The following two soil-inhabiting *Xanthoparmelia* species were found on a field trip in the semi-arid mallee areas in the northwest of Victoria in December 1996. Both species are endemic, and occur on soil in mallee scrub and arid shrubland in drier inland areas of W.A., S.A., and N.S.W., so their discovery in the Victorian mallee is not surprising.

1. *Xanthoparmelia eilifii* Elix & J. Johnst. *in* J.A. Elix, J. Johnston, & P.M. Armstrong, Bulletin *of the British Museum (Natural History), Botany* **15**, 235 (1986).

Characterized by a foliose, loosely adnate, pale yellow-green thallus forming patches 3–5 cm wide. The lobes are convolute and entangled, elongate, subdichotomously branched, 1–2(–3) mm wide. Medulla white, lower surface pale brown to brown; rhizines moderately dense, simple and concolorous. Apothecia not present. Chemistry: contains usnic acid, loxodin, norlobaridone. Cortex K–, medulla K–, C–, KC+ rose, P–.

Found on sandy soil adjacent to Crosbie Salt Lake, Pink Lakes National Park, near Underbool, Victoria, 35°03'S, 141°44'E, December 1996.

The species is described in detail in Elix (1994).

2. *Xanthoparmelia pumila* (Kurok. & Filson) Elix & J. Johnst. *in* J.A. Elix, J. Johnston & P.M. Armstrong, *Bulletin of the British Museum (Natural History), Botany* **15**, 311 (1986).

Characterized by a foliose, adnate, pale yellow thallus 2–3 cm wide. Lobes are imbricate and concave (but this specimen consisted mainly of subterete to terete lobules), branched, ascending, 0.2–0.4 mm wide, often blackened at the apices. Medulla white. Lower surface yellow, darkening near centre. Rhizines sparse, dark brown, simple. Apothecia absent. Chemistry: usnic acid, salazinic acid. Cortex K–, medulla K+ yellow then red, C–, KC–, P+ intense yellow.

Found in Hattah-Kulkyne National Park, between Ouyen and Mildura, Victoria, 34°40'S, 142°20'E, December 1996.

The species is described in detail in Elix (1994).

OTHER SPECIMEN EXAMINED
Victoria. •Thurla, 9.6 km west of Red Cliffs, Victoria, in stunted mallee on ground covered with limestone nodules, September 1940 (MEL).

Acknowledgment
Thanks to Professor J. Elix and K. Wells, who identified these specimens.

Reference
Elix, JA (1994): *Xanthoparmelia. Flora of Australia* **55**, 201–308.

Additional lichen records from Australia 34. New or interesting lichen records from CANB

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Botanisches Museum
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H. Streimann
Australian National Botanic Gardens
GPO Box 1777, Canberra, Australia

The lichen herbarium at CANB (formerly CBG) contains many thousands of recent collections, mainly by J.A. Elix and H. Streimann. Duplicates sent to B and determined by H. Sipman include the following new and otherwise interesting records.

A. Lichens new to Australia:

Graphina colliculosa (Mont.) Hale., Hale, Lichenes Americanici Exsiccati, No. 156. Washington D.C. (1976).

SPECIMEN EXAMINED
Queensland: •Clarke Range, 46 km SSW of Proserpine, 20°21'S, 148°41'E, 600 m alt., on sapling in "dry" rainforest with *Argyrodendron trifoliatum* and *A. actinophyllum* ssp. *diversifolium*, 29 June 1986, *J.A. Elix 20879 & H. Streimann* (B, CANB).

This species is widespread in Southeast Asian forests, and its occurrence in Queensland is no surprise. It forms large greenish thalli, usually with a wide, ascocarp-free marginal zone and long, linear lirellae with exposed brownish discs which are more or less connected into stellate clusters.

Ochrolechia africana Vain., *Annal. Univ. Fenn. Aboënsis Ser. A*, **2**(3): 3 (1926).

SPECIMEN EXAMINED
Queensland: •Leichhardt Highway, 12 km SSE of Taroom, 25°45'S, 149°51'E, 200 m alt., in poor, disturbed monsoon scrub on flats, on treelet stem, 30 August 1993, *H. Streimann 52609* (B, CANB).

The material was identified with Brodo's (1991) key. The species is superficially similar to *O. pallescens* (L.) A. Massal., and Australian records of the latter species perhaps belong to *O. africana*.

B. Lichenicolous fungus new to Australia:

Stigmidium schaereri (A. Massal.) Trevis., *Consp. Verruc.*: 17 (1860).

SPECIMEN EXAMINED
New South Wales: •Merimbula Point, 3 km SE of Merimbula, 36°54'S, 149°56'E, 8 m alt., rocky foreshore below cliff with scattered shrubs and *Casuarina*, on foreshore boulders affected by salt spray, 16 June 1991, *H. Streimann 48113* (B, CANB, NY).

A lichenicolous fungus forming small black perithecia on the thallus of a species of *Caloplaca*.

C. New to New South Wales:

Buellia badia (Fr.) A. Massal., *Mem. Lichenogr.* **124** (1853).

SPECIMEN EXAMINED
New South Wales: •Merungie Gap Road, 20 km WSW of Rankins Springs, 33°52'S, 146°02'E, 260 m alt., in *Eucalyptus–Acacia*-dominated rocky side of ridge, on shaded boulder, 12 June 1990, *H. Streimann 44847* (B, CANB).

This forms small, brown squamules over the central part of a poorly developed *Xanthoparmelia* sp. on red sandstone rock. In Australia previously known from only Tasmania (Filson 1996).

D. Otherwise interesting:

Gymnographa medusulina Müll. Arg., *Flora* **70**, 62 (1887).

SPECIMENS EXAMINED
Queensland: •"First Turkey", Mt Archer Environmental Park, 7 km NE of Rockhampton, 23°21'S, 150°34'E, 250 m alt., in low, dry monsoon scrub beside seasonal creek, on semi-exposed conglomerate rock face, 25 August 1993, *H. Streimann 52358* (B, CANB). •Isla Gorge, Isla Gorge National Park, 27 km NNE of Taroom, 25°10'S, 149°59'E, 220 m alt., dry monsoon scrub with *Brachychiton* on gently sloping terrace above stream, on shaded basalt-like boulder, 31 August 1993, *H. Streimann 52630A* (B, CANB).

This species is rarely recorded, and probably is known from only the type (Müller Arg. 1887). In our material, the hymenium is 70–75 µm high, I-negative and clear. The paraphyses are straight with swollen, brown tips. The spores measure c. 14–16 × 6 µm, and are 3-septate. When ripe, they are grey and have a thick I-negative endospore layer, causing the lumina to be lenticular. However, most available spores are old, brown, without endospore and with angular lumina. These characters, together with the stellate ascocarps, suggest that the species is very close to the corticolous genus *Sarcographa*, and not to *Sclerophyton* as suggested by Müller Arg. (*l.c.*). TLC: no substances found.

The type material is from Rockhampton (Müller Arg. *l.c.*: Thozet, in G, seen), and the recent collections were found in the same general area.

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Additional lichen records from Indonesia and Malaysia 4. Lichens from Bario, Sarawak, with four new records for Borneo

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Abstract: Thirteen lichen species from 7 genera have been identified from Bario. The major metabolites present in these species were determined by thin-layer chromatography (TLC) and high performance liquid chromatography (HPLC).

Introduction

Bario lies 1200 metres above sea level, on a plateau in the Kelabit Highlands, southeast of Miri in the Fourth Division of Sarawak. It is bordered by the Tamabu Range in the west and the Apo Duet Mountains to the east. It has a mild and cool climate, with temperatures of 18–22°C and an annual rainfall of about 2213 mm. Knowledge of the lichen flora of Malaysia, especially of Sabah and Sarawak, has made great progress during recent years. Din *et al.* (1997) recently presented a comprehensive account of the lichen flora of Malaysia, summarizing the results of many research efforts undertaken by scientists at several collecting localities in Peninsula Malaysia, Sabah and Sarawak. In May 1995, a scientific expedition was carried out in Bario, Sarawak. The general objective of the expedition was to enrich our understanding of the biodiversity of the Kelabit Highlands as a continuing series of the "Scientific Journey through Borneo" activity organized by the Universiti Malaysia Sarawak (UNIMAS) (Din *et al.* 1998). This paper reports the discovery of a further 13 species from Bario, Sarawak, and the identification of their chemical constituents (Table 1).

Materials and Methods

The specimens were collected from Kerangas Forest (3°4'22"N, 115°27'53"E), and lodged in Natural Products Research Laboratory, Universiti Kebangsaan Malaysia (NPRL, UKMB). The lichen fragments were freed as far as possible of any trace of organic substratum material, and extracted with warm acetone for thin-layer chromatography (TLC). Compounds were characterized by TLC using the methods standardized for lichen products (Culberson 1972, Culberson & Johnson 1982, Elix & Ernst-Russel 1993) and gradient-elution high performance liquid chromatography (HPLC) (Feige *et al.* 1993).

Results and Discussion

Phytochemistry:

The TLC and HPLC analyses of *Pseudocyphellaria* (*P. argyracea, P. aurata, P. beccarii*, and *P. desfontainii*) revealed the presence of a diversity of lichen substances, with the depsidone stictic acid, the triterpene 7β-acetoxyhopane-22-ol, and the depsides tenuiorin and methyl gyrophorate as the major components. Of all the species, *Pseudocyphellaria desfontainii* produced the largest number of lichen substances, including the depsides tenuiorin and methyl gyrophorate; the depsidones stictic acid, constictic acid, α-acetylconstictic acid, and menegazziaic acid; the triterpenes hopane-6α,7β,22-triol, 7β-acetoxyhopane-6α,22-diol, and 6α-acetoxyhopane-7β,22-diol; and the 4-ylidenetetronic acid pigments pulvinic dilactone and calycin.

Distribution:

Systematic study of the lichen flora of Malaysia has received considerable attention in recent years. Galloway *et al.* (1997) recently published an annotated bibliography with the comprehensive inclusion of chemistry, distribution, ecology, and taxonomy details to complement earlier documentation on the same subject (Galloway *et al.* 1994). During this time, our knowledge of the lichen flora of both Sabah and Sarawak has advanced substantially. Sipman (1993) produced an annotated catalogue of 286 species of lichens from Mount Kinabalu (elevation 4101 m), and four new species were described from that area alone. Mount Murud (elevation 2424 m) located on the boundary of the Limbang and Miri Divisions in the Kelabit Highlands, is the highest mountain in Sarawak. Our expedition site, Bario, an intermontane plateau that has been delineated into the Melingan and Kelabit Formations, is comprised primarily of massive sandstones, mudstones, and thin lenses of impure limestones (Singh 1998). As in Mount Kinabalu, both the geological and climatic features of Bario are deemed likely to support an unexpected and unusual assemblage of lichen species. Indeed, an earlier collecting trip to Bario resulted in the discovery of the new species *Parmotrema barioense*, which was described by Elix *et al.* (1997). Further, a more recent study of lichen species collected from Bario yielded seven new records for the island of Borneo, including three Australasian species (Din *et al.* 1998). Our present report provides four additional new records for Borneo, namely *Cladonia rappii, C. ramulosa, Coccocarpia dissecta* and *Pseudocyphellaria aurata* (Din *et al.* 1995, Din *et al.* 1998).

Acknowledgments

The authors would like to thank Universiti Malaysia Sarawak (UNIMAS) and Universiti Kebangsaan Malaysia (UKM) for providing the financial support through Research Grants UNIMAS 32/95(1) and UKM S/4/97 respectively.

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Table 1. Species and chemical constituents

species	**chemical constituents**	**collection**
Cladonia ramulosa (With.) J.R. Laundon	fumarprotocetraric acid, homosekikaic acid	Bario 23, 55
Cladonia rappii Evans	fumarprotocetraric acid	Bario 27
Coccocarpia dissecta Swinscow & Krog	no lichen substances	Bario 54, 69
Coccocarpia erythroxyli (Spreng.) Swinscow & Krog	no lichen substances	Bario 53
Coenogonium leprieurii (Mont.) Nyl.	no lichen substances	Bario 84, 86
Parmotrema dilatatum (Vain.) Hale	atranorin (major), chloroatranorin (minor), protocetraric acid (major), echinocarpic acid (minor)	Bario 77
Parmotrema mellissii (C.W. Dodge) Hale	atranorin (major), chloroatranorin (minor), alectoronic acid (major), unknown pigment (minor)	Bario 76
Physcidia wrightii (Tuck.) Tuck.	sekikaic acid (minor), divaricatic acid (major), alectorialic acid (minor)	Bario 75
Pseudocyphellaria argyracea (Delise) Vain.	gyrophoric acid, methyl gryophorate, 7β-acetoxyhopane-22-ol, hopane-7β,22-diol (trace) hopane-15α,22-diol	Bario 41A
Pseudocyphellaria aurata (Ach.) Vain.	pulvinic acid, pulvinic dilactone, calycin, 3β-acetoxyfern-9(11)-en-12-one, 3β-acetoxyfern-9(11)-en-12β-ol, fern-9(11)-ene-3β,12β-diol, 3β-acetoxyfern-9(11)-en-19β-ol, 3β-hydroxyfern-9(11)-en-12-one, lupeol acetate	Bario 79
Pseudocyphellaria beccarii (Kremp.) D.J. Galloway	7β-acetoxyhopane-22-ol (major), hopane-15α,22-diol (minor), hopane-7β,22-diol (minor)	Bario 66

Table 1 (continued)

Pseudocyphellaria desfontainii (Delise) Vain.	pulvinic dilactone (minor), calycin (minor), tenuiorin (major), methyl gyrophorate (major) stictic acid (major), constictic acid (minor), α-acetylconstictic acid (minor), menegazziaic acid (trace), hopane-6α,7β,22-triol (major), 7β-acetoxyhopane-6α,22-diol (trace), 6α-acetoxyhopane-7β,22-diol (trace)	Bario 56
Relicina gemmulosa (Kurok.) Streimann	usnic acid (major), gyrophoric acid (major), echinocarpic acid (minor), conechinocarpic acid (minor)	Bario 67

Coccocarpia erythroxyli 1 mm

Aquatic pyrenolichens in New Zealand 2, key to the species

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The pyrenolichens of aquatic rocks in New Zealand have shown themselves to be a quite diverse and locally very abundant component of the lichen flora. We have already outlined their distribution at 19 localities (mainly in the southern half of the South Island), and have tentatively identified their site preferences along the altitudinal gradient from lowland to alpine sites (Johnson & McCarthy 1997).

In this second part of a preliminary account of aquatic pyrenolichens, we provide a key to the 25 taxa currently known from the region. Table 1 shows that the New Zealand representatives include pantemperate and Australasian elements as well as a strong endemic component; the references listed have fuller descriptions, often accompanied by illustrations.

We hope that the availability of a key to this well-defined but neglected part of the flora will encourage others to investigate these interesting lichens and habitats elsewhere in New Zealand, especially in the North Island. Experience in eastern Australia suggests that additional species of Verrucariaceae will almost certainly be found in the south. However, moving north, their diversity and abundance will diminish as they are gradually replaced by *Strigula, Anisomeridium*, and more robust species of *Porina*.

1. Thallus crustose 2
1: Thallus foliose, multi-lobed; lobes greyish brown to dark brown and cartilaginous when dry, bright green and flaccid when wet, plane to convex, 5–15 mm wide. Perithecia immersed, 0.2–0.3 mm diam. Ascospores simple, colourless, 10–23 × 5–8 µm .... **Dermatocarpon luridum** (With.) J.R. Laundon

2. Ascospores simple, colourless 3
2: Ascospores septate, colourless to dark brown 12

3. Ascospores 6–15 µm long 4
3: Ascospores (12–)15–25(–35) µm long 5

4. Ascospores broadly ellipsoid to subglobose, 6–11 × 4.5–7 µm. Thallus 20–50 µm thick, gelatinous when wet, dark green to blackish, not black-punctate. Perithecia prominent, 0.13–0.26 mm diam. .... **Verrucaria aquatilis** Mudd
4: Ascospores elongate-ellipsoid, 8.5–15 × 4.5–7 µm. Thallus 60–120 µm thick, somewhat gelatinous when wet, grey-brown to greenish black, frequently black-punctate. Perithecia usually immersed, 0.16–0.26 mm diam. .... **Verrucaria rheitrophila** Zschacke

5. Thallus pale pink-grey to pale grey-green 6
5: Thallus medium to dark grey-green or almost black 7

6. Involucrellum contiguous with the hyaline excipulum. Ascospores 15–24 × 6.5–9.5 µm. Perithecia 0.18–0.3 mm diam., immersed. Thallus rimose to areolate, usually with a brown-black basal layer .... **Verrucaria praetermissa** (Trevis.) Anzi
6: Involucrellum absent; excipulum brown-black. Ascospores 19–30 × 6–12.5 µm. Perithecia 0.23–0.32 mm diam., immersed. Thallus ± continuous, lacking a dark basal layer .... **Verrucaria fiordlandica** P.M. McCarthy & P.N. Johnson

7. Perithecia (0.16–)0.24(–0.4) mm diam. 8
7: Perithecia (0.2–)0.4(–0.64) mm diam 10

8. Ascospores 12–24 × 5–10.5 µm 9
8: Ascospores 18–35 × 8–14 µm. Perithecia 0.18–0.3 mm diam., ± immersed. Thallus mid-brownish, mostly continuous, with a black basal layer; algae 5–10 × 3–6 µm. .... **Verrucaria austroschisticola** P.M. McCarthy & P.N. Johnson

9 . Involucrellum 40–50 µm thick; perithecia 0.16–0.27 mm diam. Thallus lacking a black basal layer; algae 7–20 × 7–16 µm .... **Verrucaria phaeoderma** P.M. McCarthy
9: Involucrellum 60–120 µm thick; perithecia 0.18–0.35(–0.4) mm diam. Thallus usually with a black basal layer; algae 4–11 × 4–8 µm .... **Verrucaria inconstans** P.M. McCarthy

10. Ascospores 12–27 µm long 11
10: Ascospores 19–34 µm long, 9.5–18.5 µm wide. Perithecia (0.25–)0.42(–0.64) mm diam., usually prominent; involucrellum black, usually contiguous with the excipulum, sometimes with a thin thalline covering. Thallus grey-green to greenish black, continuous ..... **Verrucaria margacea** (Wahlenb.) Wahlenb.

11. Ascospores mostly ellipsoid, 6.5–10(–12) µm wide. Perithecia (0.2–)0.35(–0.5) mm diam., usually prominent; involucrellum black, spreading, sometimes with a thin thalline covering. Thallus grey-green to dark green, continuous to rimose .... **Verrucaria hydrela** Ach.
11: Ascospores mostly subglobose, (9–)12(–15) µm wide. Perithecia 0.22–0.44(–0.5) mm diam. Thallus dark greenish brown to green-black, continuous .... **Verrucaria amnica** P.M. McCarthy & P.N. Johnson

12. Paraphyses and pseudoparaphyses absent; periphyses present. Ascospores colourless to dark brown 13
12: Paraphyses or pseudoparaphyses present; periphyses usually absent. Ascospores colourless 15

13. Perithecia containing globose-cuboid algal cells. Asci 1–2-spored 14
13: Perithecia not containing algae. Thallus whitish to pale greenish grey, continuous to rimose, 40–100 µm thick. Perithecia 0.4–1 mm diam., black, prominent. Asci 8-spored. Ascospores medium to dark brown, muriform, 27–40 × 18–27 µm .... **Polyblastia melaspora** (Taylor) Zahlbr.

14. Thallus rimose to areolate, greenish brown to brown-black. Perithecia 0.24–0.4 mm diam., immersed in thalline verrucae. Asci 2-spored. Ascospores colourless to pale brown, muriform, 32–50 × 14–20 µm .... **Staurothele fissa** (Taylor) Zwackh
14: Thallus deeply areolate towards the centre, with radiating cracks towards the margin, dark grey-brown. Perithecia 0.23–0.33 mm diam., semi-immersed in areolae. Asci 1-spored. Ascospores dark brown, muriform, 50–74 × 20–26 µm .... **Staurothele sp.**

15. Ascospores transversely septate 16
15: Ascospores submuriform or muriform 24

16. Ascospores 1-septate. Hamathecium of anastomosing pseudoparaphyses 17
16: Ascospores with 3 or more septa. Hamathecium of simple or sparingly branched paraphyses 18

17. Ascospores 9–15 × 4.5–6.5 µm. Asci 38–50 × 10–17 µm. Perithecia 0.18–0.27 mm diam., black, semi-immersed. Thallus 40–80 µm thick .... **Anisomeridium carinthiacum** (J. Steiner) R.C. Harris
17: Ascospores 12–23 × 4.5–7 µm. Asci 63–83 × 13–16 µm. Perithecia 0.17–0.32 mm diam., black, semi-immersed. Thallus 60–140 µm thick .... **Anisomeridium laevigatum** (P.M. McCarthy) R.C. Harris

18. Perithecia yellowish-brown, orange-brown, or orange-grey 19
18: Perithecia greenish black to black 20

19. Perithecia 0.14–0.3 mm diam. Ascospores 3-septate, 15–25 × 2.5–5 µm. Thallus 20–50 µm thick, yellowish brown to olive-brown, continuous to rimose .... **Porina leptalea** (Durieu & Mont.) A.L. Sm.
19: Perithecia 0.45–0.65 mm diam. Ascospores 7(–9)-septate, 36–66 × 6–10 µm. Thallus 40–100 µm thick, yellowish brown, continuous to rimose .... **Porina ahlesiana** (Körber) Zahlbr.

20. Ascospores (3–)5–9-septate 21
20: Ascospores 3-septate, 14–32 × 3–6 µm. Perithecia black, semi-immersed to superficial, 0.2–0.3 mm diam. Thallus grey-green to dark grey-brown, thin, continuous to rimose .... **Porina chlorotica** (Ach.) Müll. Arg.

21. Asci unitunicate, without an ocular chamber 22
21: Asci fissitunicate, with a distinct ocular chamber. Thallus pale greenish grey, smooth, ± glossy. Perithecia semi-immersed, black, 0.34–0.64 mm diam. Ascospores 7-septate, 23–33 × 5.5–7.5 µm. Macroconidia 5–7-septate .... **Strigula** aff. **stigmatella** (Ach.) R.C. Harris

22. Most or all perithecia <0.45 mm diam. Conidia 2–4 × c. 0.8 µm 23
22: Perithecia 0.46–0.66 mm diam., subglobose. Thallus dark green to blackish. Ascospores (5–)7(–9)-septate, 30–50 × 3.5–6.5 µm. Conidia 3–7 × c. 0.8 µm ... . **Porina aptrootii** P.M. McCarthy

23. Ascospores (3–)7)–9)-septate, 22–49 × 3.5–6.5 µm; apices usually pointed. Perithecia 0.23–0.48 mm diam., not overgrown by the thallus, hemispherical to subglobose. Thallus usually pale to medium grey-brown, continuous to areolate .... **Porina guentheri** (Flotow) Zahlbr.

23: Ascospores 5-septate, 18–30 × 5–8 µm; apices usually rounded. Perithecia 0.2–0.37 mm diam., at least partly overgrown by the thallus, hemispherical. Thallus dark grey-green, continuous .... **Porina fluminea** P.M. McCarthy & P.N. Johnson

24. Perithecia 0.32–0.58 mm diam. Ascospores submuriform, 23–36 × 7–11.5 µm. Thallus pale greenish grey or brownish, dull .... **Strigula australiensis** P.M. McCarthy

24: Perithecia 0.42–0.82 mm diam. Ascospores muriform, 37–63 × 10–19 µm. Thallus pale silvery grey, somewhat glossy .... **Strigula johnsonii** P.M. McCarthy

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Table 1. The aquatic pyrenolichens of New Zealand: distribution and literature

Anisomeridium carinthiacum	Europe, North America, Eastern Australia	McCarthy & Johnson 1995
A. laevigatum	—	McCarthy 1993a
Dermatocarpon luridum	Northern Eurasia, North America	Galloway 1985 (as *D. weberi*)
Polyblastia melaspora	Eruope	Purvis *et al.* 1992
Porina ahlesiana	Europe	Purvis *et al.* 1992
Porina aptrootii	Tasmania	McCarthy 1993c
Porina chlorotica	± pantemperate	Purvis *et al.* 1992
Porina fluminea	—	McCarthy & Johnson 1995
Porina guentheri	± pantemperate	McCarthy 1993c
Porina leptalea	± pantemperate	Purvis *et al.* 1992
Staurothele fissa	Northern Eurasia, North America, Tasmania	Purvis *et al.* 1992
Staurothele sp.	—	—
Strigula australiensis	Northeast Australia	McCarthy 1995a
Strigula johnsonii	—	McCarthy 1995a
Strigula aff. *stigmatella*	Eastern Australia	McCarthy 1993b
Verrucaria amnica	—	McCarthy & Johnson 1997
Verrucaria aquatilis	Eurasia	Purvis *et al.* 1992
Verrucaria austroschisticola	—	McCarthy & Johnson 1995
Verrucaria fiordlandica	—	McCarthy & Johnson 1995
Verrucaria hydrela	Eurasia, North America, Eastern Australia	McCarthy 1995b
Verrucaria inconstans	Tasmania	McCarthy 1995b
Verrucaria margacea	Eurasia, North America, Southeast Australia	McCarthy 1995b
Verrucaria phaeoderma	Southeast Australia	McCarthy 1995b
Verrucaria praetermissa	Europe, Eastern Australia	McCarthy 1995b
Verrucaria rheitrophila	Europe, North America	McCarthy 1991

Clarification of the synonymy and chemistry of *Parmotrema zollingeri* and related species

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Abstract: The accepted circumscription of the pantropical species *Parmotrema zollingeri* has been shown to be in error, in large part due to the misdetermination of the medullary chemistry. In contrast to previous reports, *P. zollingeri* has now been shown to contain succinprotocetraric acid and fumarprotocetraric acid as major medullary substances. The nomenclature and distinguishing characters of this and related species of *Parmotrema* are discussed. The new combinations *Parmotrema overeemii* (Zahlbr.) Elix and *Parmotrema platyphyllinum* (Vain.) Elix are made.

Materials and Methods

Chromatographic methods have been described previously (Elix *et al.* 1997b).

SPECIMENS EXAMINED

Parmotrema barioense Elix, Din & Ismail
Malaysia. •Sarawak, Kerangas Forest, Bario, 3°44'N, 115°28'E, 1220 m, *L.B. Din, I.B. Ipor & B.A. Fasihuddin B44* (CANB, isotype; UNIMAS, holotype).

Parmotrema bogoriense (Zahlbr.) Elix
Indonesia. •Buitenzorg Garden, Java, *Overeem 4* (W, holotype).

Parmotrema elacinatulum (Kurok.) Streimann
Papua New Guinea. •Eastern Highlands, Waiopa, Aiyura–Omaura road, 13 km SE of Kainantu, 6°22'S, 145°58'E, 1450 m, *J.A. Elix 12413 & H. Streimann*, 8 Dec. 1982 (CANB). •Southern Highlands, Lama sawmill, 6 km SE of Ialibu, 6°20'S, 144°01'E, 1840 m, *J.A. Elix 12833 & H. Streimann*, 11 Dec. 1982 (CANB).

Parmotrema merrillii (Vain.) Hale
Philippines. •Mt Halcon, Mindoro, 2485 m, *E.D. Merrill 6163*, Nov. 1906 (TUR, lectotype).

Parmotrema neocaledonicum (Nyl.) Elix
New Caledonia. •Wagup, Vieillard (H-NYL, holotype).

Parmotrema overeemii (Zahlbr.) Elix
Australia. •Queensland, Carlisle Island, 350 m, *B. Ballingall 2309*, 4 April 1987 (CANB). •Cook District, McIlwraith Range, Lankelly Creek, 11 km from Coen, 13°57'S, 143°15'E, *G. Butler 570*, 2 Aug. 1978 (CANB). *Indonesia.* •Mt Tjibodas, Java, *Overeem 94* (W, holotype). *Tonga.* •Eua, Ara Ahu, 350 m, *J. Child 1736*, 14 Jan. 1971 (CANB, CHR).

Parmotrema platyphyllinum (Vain.) Elix
Thailand. •Koh Chang, *J. Schmidt* (TUR, holotype).

Parmotrema submerrillii Elix
Australia. •Queensland, Paluma road, Mt Spec National Park, WNW of Townsville, *M.E. Hale 64052*, 28 July 1983 (CANB, holotype).

Parmotrema zollingeri (Hepp) Hale
Indonesia. •Bantam, Java, *H. Zollinger 1241* (G, isotype; H, isotypes ×4).

Discussion and Results

According to Hale (1965) and Krog and Swinscow (1981), *Parmotrema zollingeri* (Hepp) Hale is a widespread tropical species found in East Africa, North, Central and South America, and Southeast Asia, and is characterized by the sparingly ciliate lobes, the lack of soredia and isidia, and the presence of protocetraric acid in the medulla. I accepted this circumscription (Elix 1994), but after encountering a series of morphologically and chemically related species from Malaysia and Australasia (Elix *et al.* 1997a), have now examined the type material of *P. zollingeri* and its various synonyms (Hale 1965). Indeed, the chemistry of *P. zollingeri* has consistently been misrepresented (Elix *et al.* 1997, Hale 1965, Krog & Swinscow 1981), for I have found that in addition to the cortical atranorin and chloroatranorin, fumarprotocetraric acid and succinprotocetraric acid are the preponderant depsidones present, and that protocetraric acid is present in only minor amounts (see Fig. 1). The closely related species containing only protocetraric acid in the medulla and with slightly larger spores, should be referred to as *Parmotrema overeemii* (Zahlbr.) Elix, while *Parmotrema platyphyllinum* contains additional butlerin derivatives in the medulla (Fig. 2) and has smaller spores. The synonymy, chemistry and distinguishing characters of these and related species are summarized below (Table 1).

Synonymy and New Combinations

Parmotrema zollingeri (Hepp) Hale, *Phytologia* **28**: 339 (1974)
≡ *Parmelia zollingeri* Hepp in H. Zollinger, *Syst. Verz.* **1**: 9 (1954).
= *Parmelia bogoriensis* Zahlbr., *Ann. Crypt. Exot.* **1**: 206 (1928).
≡ *Parmotrema bogoriense* (Zahlbr.) Elix, in Elix, Din & Ismail, *Mycotaxon* **62**: 343 (1997).

Parmotrema overeemii (Zahlbr.) Elix, comb. nov.
Basionym: *Parmelia overeemii* Zahlbr., *Ann. Crypt. Exot.* **1**: 204 (1928).

Parmotrema platyphyllinum (Vain.) Elix, comb. nov.
Basionym: *Parmelia platyphyllina* Vain., *Hedwigia* **46**: 168 (1907).

Parmotrema elacinatulum (Kurok.) Streimann, *Bibl. Lichenol.* **22**: 94 (1986).
≡ *Parmelia elacinatula* Kurok., *Studies Crypt. Papua New Guinea* : 132 (1979).
= *Parmotrema submerrillii* Elix, *Mycotaxon* **47**: 120 (1993).

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Table 1.

taxon	**thallus**	**lobes**	**cilia**
barioense	membranaceous	central lobes convolute, ± laciniate	short, sparse
elacinatulum	membranaceous	flat, elaciniate	long, dense
merrillii	coriaceous	flat, laciniate-lobulate	absent or very sparse in axils
neocaledonicum	coriaceous	flat, ± laciniate	absent
overeemii	membranaceous	flat, ± laciniate	short, common
platyphyllinum	membranaceous	flat, ± laciniate	absent
zollingeri	coriaceous	flat or concave, ± laciniate	short, moderate

Table 1. (continued)

spores (µm)	**conidia** (µm)	**medullary chemistry**
21–27 × 9–13	not seen	butlerins D, E (major) protocetraric acid (minor)
25–34 × 12–16	bacilliform, 6–7	protocetraric acid (major) lichesterinic acid (major) protolichesterinic acid (major)
24–26 × 12–16	not seen	protocetraric acid (major)
16–29 × 9–14	sublageniform, 7–9	gyrophoric acid (major) protocetraric acid (minor)
18–22 × 8–12	sublageniform, 6–8	protocetraric acid (major)
14–20 × 7–10	fusiform-acicular, 6–7	protocetraric acid (major) butlerins D, E (minor)
18–25 × 7–10	sublageniform, 6–8	fumarprotocetraric acid (major) succinprotocetraric acid (major) protocetraric acid (minor/trace)

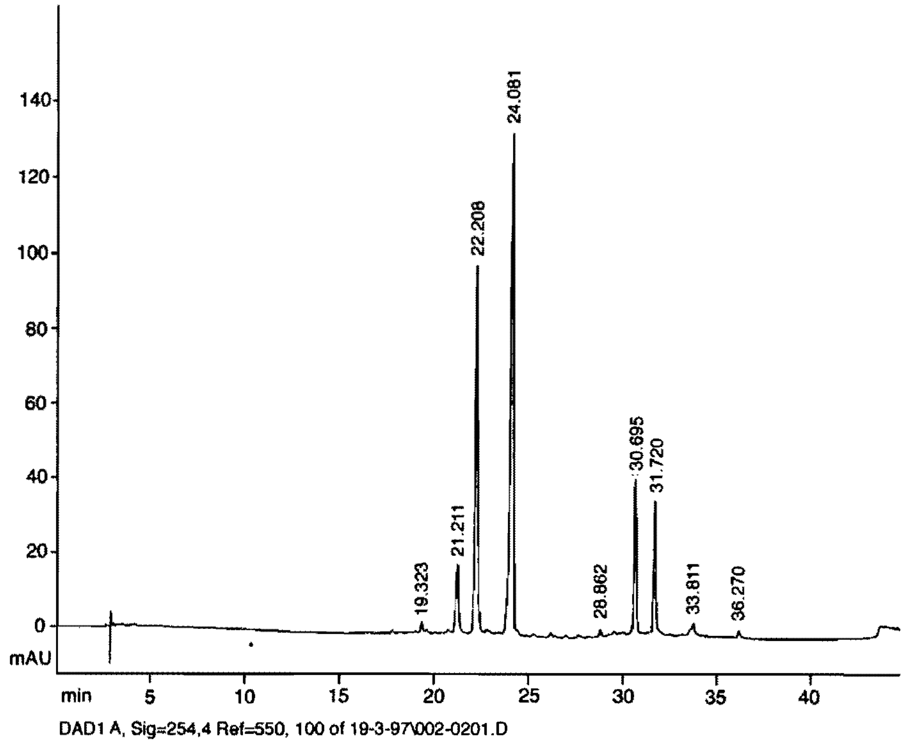

Figure 1. HPLC of methanol extract of *Parmotrema zollingeri* (*H. Zollinger 1241*, isotype G). R_T 19.323 = confumarprotocetraric acid; R_T 21.211 = protocetraric acid; R_T 22.208 = succinprotocetraric acid; R_T 24.081 = fumarprotocetraric acid; R_T 30.695 = atranorin; R_T 31.720 = chloroatranorin.

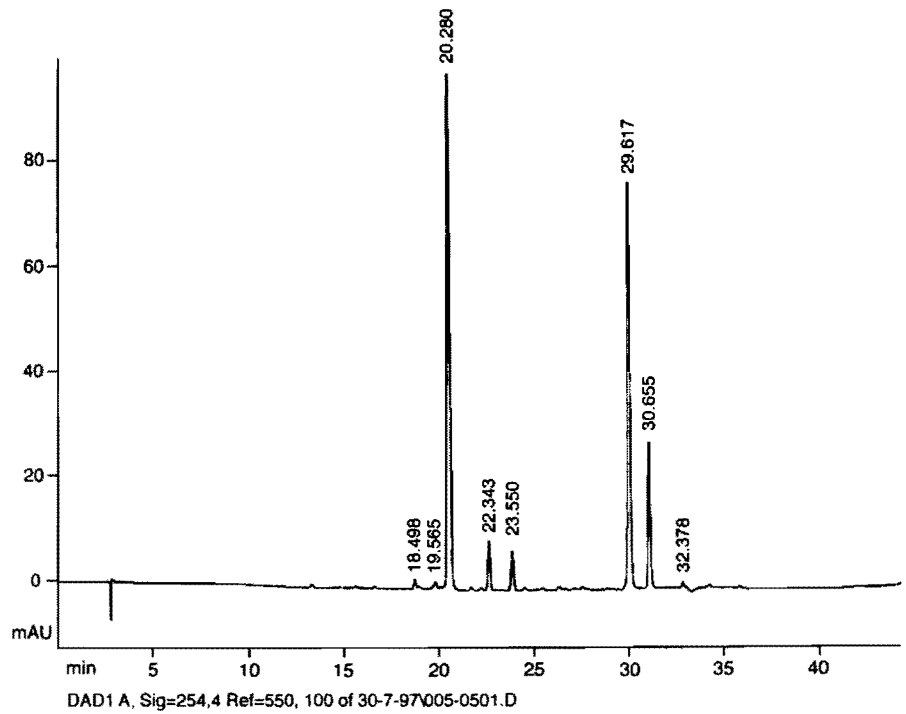

Figure 2. HPLC of methanol extract of *Parmotrema platyphyllinum* (*J. Schmidt*, holotype). R_T 20.280 = protocetraric acid; R_T 22.343 = butlerin E; R_T 23.550 = butlerin D; R_T 29.617 = atranorin; R_T 30.655 = chloroatranorin.

A Practical Guide to Soil Lichens and Bryophytes of Australia's Dry Country, by David Eldridge and Merrin E. Tozer, with photos by Heino Lepp. viii + 80 pp. New South Wales Department of Land and Water Conservation, Sydney. Available from: Information Centre, Department of Land and Water Conservation, GPO Box 39, Sydney, New South Wales 2001, Australia. Price A$14.95 plus $2.00 postage. FAX: +61–2–9228–6458.

This handsome paperback attempts a layman's introduction to the ecological role of soil crusts and the recognition of the species comprising them in Australia's dry land, with emphasis on the state of New South Wales.

The first chapter briefly defines six broad associations of landforms, soils, and vegetation, occurring where annual rainfall is between 150–700 mm. The second chapter is a cogent explanation of the role of soil crusts in the dry land environment, focusing on their role in minimizing erosion, affecting soil permeability and water flow, plant and soil nutrition, and as a substratum for invertebrates and higher plant seedlings. The third is a very brief introduction to the morphology, reproduction, and adaptations of lichens, mosses, and hepatics to the dry land environment. There is brief but interesting mention of the role of cyanobacteria in colonization of dry soils, but cyanobacteria are not considered subsequently in the identification portion of the volume.

More thought could have gone into the key to major groups of soil crust organisms on p. 24. While a functional and brief key is very difficult to write, this key, with dichotomies varying greatly in length, will likely confuse the beginner. Chapter 3 on the whole does a nice job introducing the groups of organisms involved, and this key detracts from rather than enhances the chapter. Could it have been an editorial afterthought?

Chapter 4 begins by providing hints as to how a beginner might inspect a soil crust organism. The idea is a good one, but unfortunately the instructions rely heavily on the aforementioned inadequate key. The bulk of the chapter, indeed the core of the book, is a series of brief morphological descriptions, usually with some ecological notes, for the common crust-forming organisms, identified to the generic or specific level according to difficulty. The notes are interesting and, given the specialized habitat forming the focus of the book, appear adequate for recognition of the organisms. The lichens and bryophytes are grouped into broad, mostly morphology-based categories, e.g. "lichen group 1: photobiont blue-green"; or "lichen group 5: thallus or apothecia pink to orange". In some instances, further suggestions as to how the beginner could recognize a member of the category (e.g., a lichen with a blue-green photobiont) would be helpful, but for the most part the groupings will soon become meaningful to the user. Reference to more detailed floristic manuals is provided.

Heino Lepp's superb colour species photographs are a highlight of the book. They will facilitate species recognition for the beginner and will delight the more experienced cryptogamist. Twenty-four are of lichens (mostly crusts), 18 of mosses, and 7 of hepatics. Only a few are disappointing; that of *Bryum pachytheca*, cited as "probably the most common moss in Australia's dry country" illustrates none of its distinguishing features.

Chapter five outlines in very general terms the impact of various land use or management practices upon soil crusts and the role that destruction of crusts can have leading to further ecological degradation. The discussion of soil crusts as indicators of soil or climatic conditions is especially interesting. Importantly, reference to more detailed studies is provided.

A key, to genera or species, using mostly macroscopic features, is included as an appendix. Many terms (e.g. inflated *versus* flat areolae; lichen spore septations; incised leaf margins in mosses) are nicely illustrated by marginal line drawings which will facilitate its use, and a two-page glossary is provided. Overall, the key should work with this specialized flora. Some frustration may occur when lichen genera such as *Diploschistes* and *Lecidea* are distinguished solely by ascospore characters (p. 75), but here the student will be helped by the line drawings and habit photos.

The book is aimed at amateur naturalists and land managers, but it will be of interest also to biology teachers working in the regions discussed, and to cryptogamic specialists. The attempt to introduce three (lichens, mosses, and hepatics) disparate groups of organisms growing in a specialized habitat to the layman is on the whole a success. The authors maintain their focus well, and presuppose no prior experience with cryptogamic plants. If it increases public awareness of the importance of biological soil crusts and of the oft-neglected organisms that compose them, it will serve its purpose well. The book is attractively produced and there are relatively few printing errors. While it will be of greatest value to land managers and amateurs, I recommend the book to more experienced lichenologists and bryologists as well because of the high quality of the photographs. At A$15, the price is not excessive.

Allan Fife

Chondropsis semiviridis 1 mm

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