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RESEARCH ARTICLE

Foliicolous lichens from Valdivian temperate rain forest of Chile and Argentina: evidence of an austral element, with the description of seven new taxa

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ABSTRACT

Aim To describe the composition, diversity and biogeographical affinities of the foliicolous lichen mycobiota in Valdivian temperate rain forest in southern South America.

Location Seven localities in Chile (IX to XI region) and Argentina (Neuquén province).

Methods Opportunistic sampling of leaf substrates, identification of taxa, and assignment to distribution types.

Results Thirty-seven species, including three lichenicolous fungi, were found in the studied collections, increasing the number of foliicolous taxa known from Valdivian temperate rain forest to 55. New records for the area include *Arthonia cyanea*, *Byssoloma marginatum*, *B. subdiscordans*, *Fellhanera bouteillei*, *F. dispersa*, *F. subfuscatula*, *Gyalectidium caucasicum*, *G. ciliatum*, *Logilvia gilva*, *Porina thaxteri*, *Strigula nitidula* and the lichenicolous *A. microsticta*, *Helicobolomyces lichenicola* and *Opegrapha sipmanii*. Seven taxa are described as new: *Enterographa falcata*, *Gyalectidium chilense*, *G. plicatum*, *Gyalideopsis choshuencensis*, *Porina fulvelloides*, *Strigula wandae* and *Trichothelium meridionale* ssp. *austroamericanum*.

Conclusions There are unexpected floristic affinities in the foliicolous lichen mycobiota of Valdivian temperate rain forest with those of New Zealand and Tasmania. Three typically foliicolous species clearly belong to an austral element: *Caprettia setifera* and *Badimiella pteridophila*, both known previously from New Zealand and Tasmania; and *Kantvilasia hians*, known already from Tasmania and Valdivian temperate rain forest. Other Southern Hemisphere lichens, such as *Parmeliella nigrocincta*, *P. thysanota* and *Psoroma caliginosum*, are also found commonly on leaves. On the other hand, specific affinities of the foliicolous lichen mycobiota of Valdivian temperate rain forest with the Neotropics are absent: most of the species shared between the two regions belong to a cosmopolitan-tropical or a circumpacific element. Thus far, nine taxa are endemic to Valdivia. The Valdivian temperate rain forest foliicolous lichen mycobiota is therefore regarded as one of six distinctive regions in the world.

Key words biogeographical regions, *Enterographa*, *Gyalectidium*, *Gyalideopsis*, New Zealand, *Porina*, Southern Hemisphere, *Strigula*, Tasmania, *Trichothelium*.

INTRODUCTION

Non-vascular cryptogams, namely lichens and bryophytes, are known for their wide distribution at the species level, caused by vicariance or long-distance dispersal (Grolle, 1968; Van Zanten & Pócs, 1981; Gradstein *et al*., 1983; Tibell, 1994; Lichtwardt, 1995; Galloway, 1996; Lücking *et al*., 1998; Dauphin, 1999; Nekola & White, 1999). Biogeographical regions based on lichen and bryophyte species do not correspond necessarily to those established for vascular plants or animals: they are usually larger and often fail to reflect fine-scaled palaeogeographical history. Perhaps the best example are lichens on leaves of vascular plants in tropical and temperate rain forests, whose taxonomy and distribution is comparatively well-established (Santesson, 1952; Lücking *et al*. 2000; Lücking, 2001). Recent studies of the Madagascarean and New Caledonian foliicolous lichen mycobiota (Lücking & Kalb, 2001; Lücking *et al*., in prep.) revealed an almost complete lack of endemism, compared to the extraordinarily high degree of endemism in vascular plants or animals on thsese islands (Takhtajan, 1986).

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While Madagascar and New Caledonia stand out as 'hot spots' of endemism, the Southern Hemisphere is one of the striking examples of strong floristic similarity between presently widely separated areas. Of specific interest are the cool temperate rain forests in southern South America (Chile, Argentina) and southern Australasia (Victoria, Tasmania, New Zealand). These rain forests are notable for the shared presence of *Nothofagus* and other floristic elements, explained by vicariance of a presumed Mesozoic cool temperate Gondwana flora and by terrane displacement (Galloway, 1988; Donosa, 1993; Arroyo *et al*., 1996), and they exhibit strong climatic and physiognomic similarities. They share high lichen diversity and biomass, the number of lichen species per area significantly outnumbering that of vascular plants (Kantvilas & Jarman, 1999). In vascular plants, the strong floristic affinity of these forests between South America and southern Australasia is obvious at the family and genus level (Manos, 1997; Setoguchi *et al*., 1998), while in lichens, many taxa are shared at the species level (Galloway, 1988, 1992; Calvelo & Lorenzo, 1989; Kantvilas & Jarman, 1999).

Contrary to warm tropical regions, the foliicolous lichen mycobiota of Southern Hemisphere cool temperate rain forest is less known than their non-foliicolous counterparts. This is especially true of southern South America, where only a few temperate rain forest collections have been studied so far (Santesson, 1952). Southern South America is of particular interest as it includes distinct rain forest biomes which are partially or completely isolated from each other (Fig. 1): (1) Amazonian tropical rain forest, reaching its southermost border in Peru and Bolivia; (2) coastal Atlantic rain forest of south-eastern Brazil; (3) subtropical moist forest in northern Argentina and adjacent areas of Paraguay, Uruguay and Brazil; and (4) Valdivian temperate rain forest in southern Chile and western Argentina. The foliicolous lichen mycobiota of Peru and Bolivia is virtually unknown, but preliminary studies indicate that most of its species belong to a wide neotropical or pantropical element, and the same is true of the Atlantic rain forest (Cáceres *et al*. 2000). The subtropical mycobiota of northern Argentina and adjacent areas (Osorio, 1992; Ferraro, 1997; Ferraro & Lücking, 2000) represents chiefly a depauperate tropical mycobiota, with a high percentage of widely distributed species with wide ecological amplitude. Only a few taxa seem to be endemic to this area, such as *Arthonia crystallifera* in the wet environment of Iguazu falls (Ferraro & Lücking, 1997).

Valdivian temperate rain forest is highly interesting from a biogeographical viewpoint, as it is isolated by 1500–2000 km from tropical rain forest (Arroyo *et al*., 1996), the principal habitat for foliicolous lichens. Nevertheless, it was a journey to Valdivia that initially inspired Santesson (1952) to produce a world monograph on foliicolous lichens, and the few collections available at that time already reveal the distinctiveness of its foliicolous lichen mycobiota. In biogeographical approaches based on vascular plants, Valdivia forms part of an ancient Southern Hemisphere, temperate Gondwana flora (Axelrod *et al*., 1991; Veblen *et al*., 1996), and this is also reflected in the distribution of non-foliicolous lichens (Galloway, 1988). Foliicolous lichens are, however, in the first place a tropical phenomenon, so their occurrence in these isolated temperate rain forest raises the question: are the species occurring here related to tropical rain forest taxa, or do they reflect the austral element evident in non-foliicolous lichens and vascular plants?

This paper presents the results of a study of recent collections gathered by the authors in Valdivian temperate rain forest of Chile and Argentina. Apart from several species new to science, these collections give new insight into the biogeographical affinities of the foliicolous lichen mycobiota of Valdivian temperate rain forest.

STUDY AREA

Valdivian temperate rain forest is developed along a narrow strip ranging from the IX to the XI region in Chile and including adjacent areas of Neuquén, Río Negro and Chubut provinces in Argentina. It covers an area of approximately 75 000 km^2 between 38° and 49° southern latitude and occupies an altitudinal range from sea level to 1500 m (Fig. 1). The climate is oceanic to hyperoceanic: average annual temperature is 8–12 °C, and annual precipitation amounts to 1400–4900 mm, depending on locality and elevation (Alaback, 1991; Arroyo *et al*., 1996). The flora comprises some 450 species of vascular plants in about 200 genera and 100 families (Arroyo *et al*., 1996). The vegetation was classified as Dombeyo–Eucryphietum, Laurelio–Weinmannietum and other associations (Oberdorfer, 1960), its local variation depending chiefly on altitude and drainage (Veblen & Schlegel, 1982; Veblen *et al*., 1983).

There is a high degree of endemism at the species and even at the genus level, many of the woody taxa being of Gondwanan origin, with their nearest relatives occurring in Australia and New Zealand. Dominant tree species include the southern beeches (Veblen *et al*., 1996), in particular *Nothofagus dombeyi*, *N. betuloides*, *N. obliqua* and *N. alpina* (Fagaceae), together with *Aextoxicon punctatum* (Aextoxicaceae), *Drimys winteri* (Winteraceae), *Laurelia sempervirens*, *Laureliopsis philippiana* (both Atherospermataceae), *Weinmannia trichosperma* (Cunoniaceae), *Podocarpus nubigena* (Podocarpaceae), as well as members of Myrtaceae, Proteaceae, and other families (Arroyo *et al*., 1996). Araucariaceae occur only at the northern and southern border of the area. *Drimys winteri*, *Laurelia* and *Laureliopsis* species are the predominant phorophytes for foliicolous lichens.

Foliicolous lichen collections were made by R. Lücking & M. Cáceres (2001) in the IX Region and by V. Wirth & T. Feuerer (1999) in the X Region in Chile, and by L. Ferraro

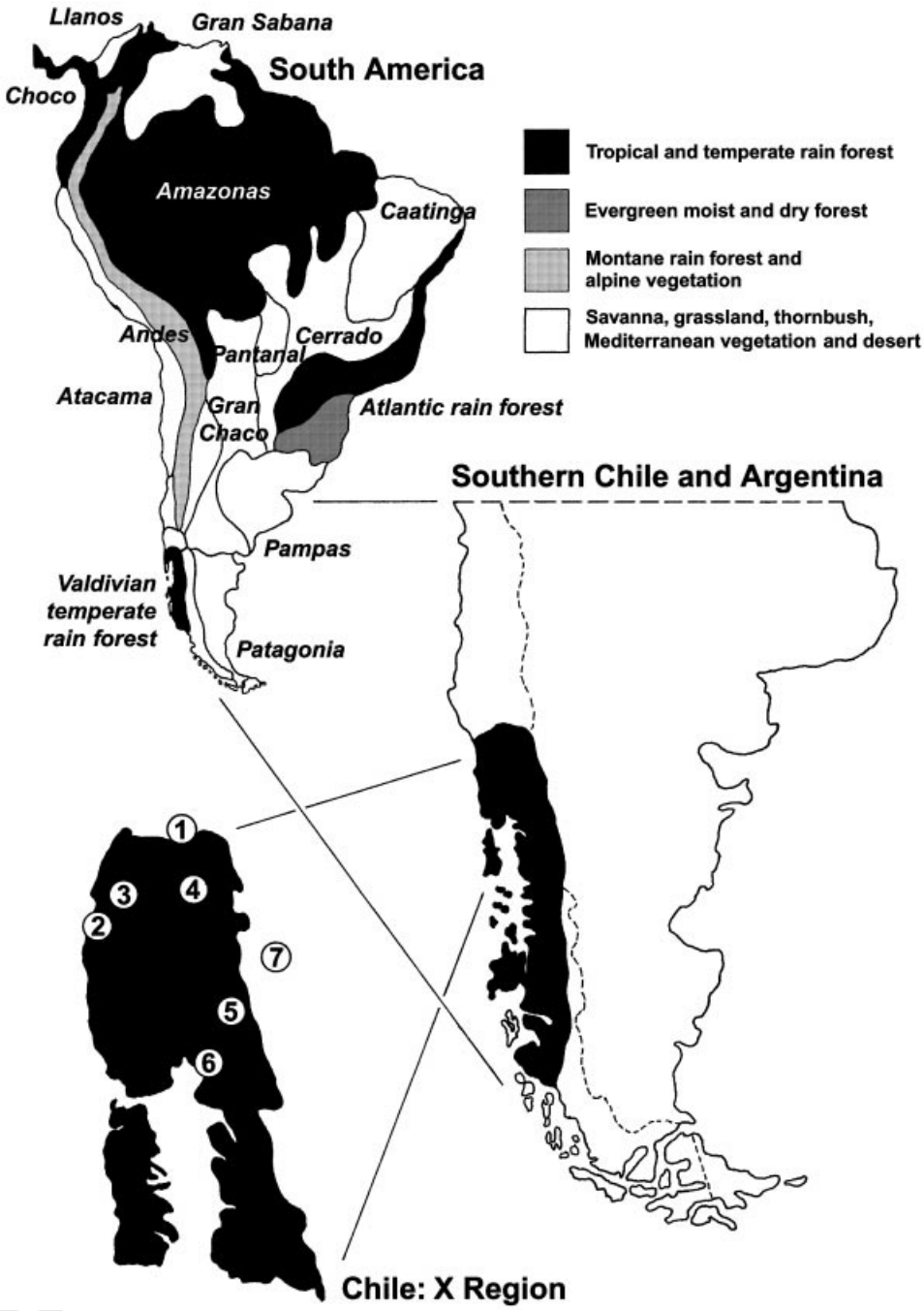

Fig. 1 Geographic situation of the study area relative to other main vegetation types in South America (after Hueck & Seibert, 1972).

(2001) in the province of Neuquén in Argentina. We also had access to a small sample provided by R. Santesson and collected by R. Thaxter in the X Region in Chile in 1905 (Figs 1 and 2). Thus, the collection sites are as follows:

1 Chile. IX Región (Región de la Araucanía): Lican Ray at Lake Calafquén, 120 km SSE of Temuco, trail through Peninsula de Lican Ray, disturbed Valdivian temperate rain forest remnant, XI. 2001, leg. R. Lücking & M. Cáceres (F, VALPL).

2 Chile. X Región (Región de los Lagos): Corral, 50 km SW of Valdivia, Valdivian temperate rain forest, on leaves of Laurelia sempervirens, XII. 1905, leg. R. Thaxter 8 : 1a (UPS).

Fig. 2 Aspect of Valdivian temperate rain forest remnant (with Drimys winteri) at locality 1 (Lican Ray Pensinsula).

3 Chile. X Región (Región de los Lagos): Valdivia, Botanical Garden, 10 m, anthropogenic vegetation, XI. 1999, leg. V. Wirth & T. Feuerer (STU).
4 Chile. X Región (Región de los Lagos): Vulcán El Mocho near Vulcán Choshuenco, 100 km E of Valdivia, 600–630 m, Valdivian temperate rain forest, XI. 1999, leg. V. Wirth & T. Feuerer (STU).
5 Chile. X Región (Región de los Lagos): Parque Nacional Vicente Pérez Rosales, Volcán Osorno, Saltos de Petrohué, 60 km NE of Puerto Montt, Valdivian temperate rain forest, XI. 1999, leg. V. Wirth & T. Feuerer (STU).
6 Chile. X Región (Región de los Lagos): Parque Nacional Alerce Andino, Lenca, 35 km SE of Puerto Montt, 180 m, Valdivian temperate rain forest, on leaves of Drimys winteri, XI. 1999, leg. V. Wirth & T. Feuerer (STU).
7 Argentina. Provincia de Neuquén: Parque Nacional Nahuel Huapí, 35 km WNW of San Carlos de Bariloche, trail from Puerto Blest to Cascada Los Cántaros, 800–1000 m, Valdivian temperate rain forest, on leaves of Laureliopsis, XI. 2001, leg. L. I. Ferraro & A. Giaiotti (CTES).

RESULTS AND DISCUSSION

New or otherwise interesting taxa

Thirty-seven species, including three lichenicolous fungi, were found in the collections studied here (Table 1). Selected species are annotated below in alphabetical order and illustrated according to their systematic affinities (Figs 3–6).

Arthonia microsticta Vain. This lichenicolous fungus was given a somewhat doubtful status by Matzer (1996) and Sérusiaux (1996). It is known with certainty only from the type collected in the Lesser Antilles. The present specimens grow on *Gyalectidium plicatum*; they agree with the type in morphological and anatomical features, but Matzer (1996) indicates the presence of a species complex on different host lichens, so we cannot exclude that it deals with an autonomous, yet undescribed taxon. Specimens examined: Chile. Locality 4, Wirth & Feuerer 33903 (STU, on G. plicatum). Argentina. Locality 7, Ferraro & Giaiotti 6506, 6507, 6508 (CTES, on G. plicatum). New to Valdivian temperate rain forest.

Badimiella pteridophila (Sacc.) Garnock-Jones & Malcolm (Fig. 6b). This enigmatic lichen is recognized easily by its conspicuous, whitish campylidia with acute lateral projections, its 1-septate campylidioconidia, and its *Fellhanera*-like, brownish apothecia. It was described from New Zealand as *Badimiella serusiauxii* (Malcolm & Vezda, 1994), but Garnock-Jones & Malcolm (2001) established conspecifity with the presumed basidiolichen *Cyphella pteridophila*. The material from Argentina is absolutely identical in morphological and anatomical features with the abundant collections from Tasmania and New Zealand. Specimen examined: Argentina. Locality 7, Ferraro & Giaiotti 6519 (CTES). New to the American continent.

Table 1 Foliicolous lichen species reported from Valdivian temperate rain forest in Chile and Argentina. Localities 1–7 denote collections studied in the present paper (37 taxa), while (8) refers to records in earlier publications (including an additional 15 taxa), in particular Santesson (1952). ● = typically foliicolous ('eufoliicole'; Sérusiaux, 1977), □ = indifferent ('pseudofoliicole'), + = lichenicolous

	Localities									
Species	1	2	3	4	5	6	7	(8)	Distribution type	
Arthonia cyanea Müll. Arg.	+				+				Pantr.-subtemperate	●
Arthonia microsticta Vain. (on *Gyalectidium plicatum*)				+			+		Neotropical	+
Arthonia trilocularis Müll. Arg.					+	+	+	(+)	Pantr.-subtemperate	●
Aspidothelium cinerascens Vain.						+		(+)	Circumpacific	□
Asterothyrium rotuliforme (Müll. Arg.) Sérus.								(+)	Pantr.-subtemperate	●
Bacidina apiahica (Müll. Arg.) Vezda		+				+		(+)	Pantr.-subtemperate	●
Bacidina pallidocarnea (Müll. Arg.) Vezda	+							(+)	Pantropical	●
Badimiella pteridophila (Sacc.) Garnock-Jones & Malcolm							+		Austral	●
Byssoloma discordans (Vain.) Zahlbr.								(+)	Pantr.-subtemperate	●
Byssoloma leucoblepharum (Nyl.) Vain.								(+)	Cosm.-tropical	□
Byssoloma marginatum (Arnold) Sérus.						+			Cosm.-temperate	□
Byssoloma subdiscordans (Nyl.) P. James						+			Cosm.-tropical	□
Caprettia setifera (Malcolm & Vezda) R. Sant *et al.*		+							Austral	●
Coccocarpia domingensis Vain.								(+)	Pantr.-subtemperate	□
Coccocarpia erythroxyli (Spreng.) Swinsc. & Krog								(+)	Pantr.-subtemperate	□
Coenogonium interplexum Nyl.								(+)	Pantr.-subtemperate	□
Coenogonium linkii Ehrenb.								(+)	Pantr.-subtemperate	□
Coenogonium luteum (Dicks.) Kalb & Lücking							+	(+)	Cosm.-tropical	□
Coenogonium subluteum (Rehm) Kalb & Lücking								(+)	Pantropical	●
Enterographa falcata Lücking & Wirth		+		+					Valdivian	●
Eremothecella cingulata (R. Sant.) Ferraro & Lücking								(+)	Neotropical	●
Fellhanera bouteillei (Desm.) Vezda			+						Cosm.-tropical	□
Fellhanera dispersa Lücking						+			Circumpacific	●
Fellhanera fuscatula (Müll. Arg.) Vezda								(+)	Pantr.-subtemperate	●
Fellhanera subfuscatula Lücking		+							Pantr.-subtemperate	●
Gyalectidium catenulatum (Cavalc. & A. A. Silva) Ferraro *et al.*								(+)	Neotropical	●
Gyalectidium caucasicum (Elenk. & Woron.) Vezda				+		+			Pantr.-subtemperate	●
Gyalectidium chilense Cáceres & Lücking	+								Valdivian	●
Gyalectidium ciliatum Thor *et al.*					+				Circumpacific	●
Gyalectidium conchiferum Lücking & Wirth				+					Valdivian	●
Gyalectidium filicinum Müll. Arg.								(+)	Pantr.-subtemperate	●
Gyalectidium plicatum Ferraro & Lücking				+		+	+		Valdivian	●
Gyalideopsis choshuencensis Lücking & Wirth				+		+	+		Valdivian	●
Gyalideopsis vulgaris (Müll. Arg.) Lücking								(+)	Neotropical	●
Helicobolomyces lichenicola Matzer (on *Porina fulvelloides*)							+		Neotropical	+
Kantvilasia hians McCarthy, Elix & Sérus.						+	+	(+)	Austral	●
Logilvia gilva (Müll. Arg.) Vezda			+			+			Circumpacific	●
Mazosia phyllosema (Nyl.) Zahlbr.								(+)	Pantr.-subtemperate	●
Opegrapha sipmanii Matzer (on *Porina fulvelloides*)							+		Neotropical	+
Parmeliella nigrocincta (Stirt.) Müll. Arg.					+	+		(+)	Austral	□
Parmeliella thysanota (Stirt.) Zahlbr.						+	+	(+)	Austral	□
Porina epiphylla (Fée) Fée								(+)	Pantropical	●
Porina fulvelloides Lücking & Wirth				+	+	+	+		Valdivian	●
Porina limbulata (Kremp.) Vain.								(+)	Pantropical	●
Porina rubrosphaera R. Sant.		+				+	+	(+)	Circumpacific	●
Porina thaxteri R. Sant.		+			+	+	+		Circumpacific	●
Psoroglaena stigonemoides (Orange) Henssen		+							Cosm.-temperate	□
Psoroma caliginosum Stirt.					+	+		(+)	Austral	□
Roccellinastrum epiphyllum Henssen & Vobis								(+)	Valdivian	□
Strigula nitidula Mont.					+				Pantr.-subtemperate	●
Strigula smaragdula Fr.								(+)	Pantr.-subtemperate	●
Strigula wandae Cáceres & Lücking		+		+					Valdivian	●
Tapellaria epiphylla (Müll. Arg.) R. Sant.						+		(+)	Pantr.-subtemperate	●
Trichothelium javanicum (F. Schill.) Vezda		+							Circumpacific	●
Trichothelium meridionale ssp. *austroamericanum* Lücking	+	+							Valdivian	●

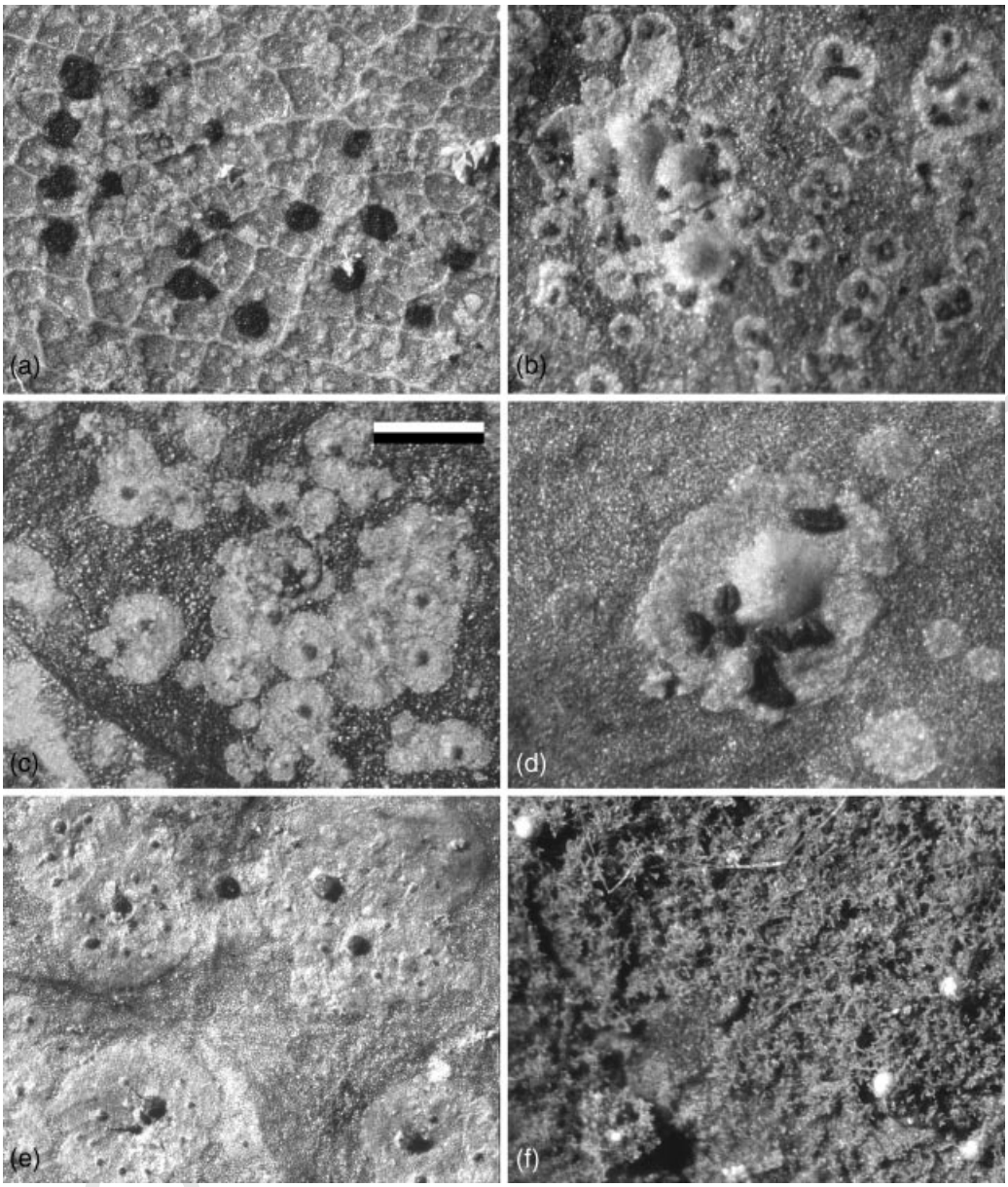

Fig. 3 Selected foliicolous lichens from Valdivian temperate rain forest. (a) *Arthonia trilocularis*. (b) *Helicobolomyces lichenicola* (on *Porina fulvelloides*). (c) *Enterographa falcata* (pycnidia). (d) *Opegrapha sipmanii* (on *Porina fulvelloides*). (e) *Caprettia setifera*. (f) *Psoroglaena stigonemoides*. Scale = 1 mm [in (d) = 0.5 mm].

Byssoloma marginatum (Arnold) Sérus. A very inconspicuous lichen often confused with other species, first described from Europe but discovered subsequently in the upper montane rain forest in Costa Rica and the temperate rain forest of south-eastern Australia (Lücking *et al*., 2001). Specimen examined: Chile. Locality 6, Wirth & Feuerer 33911 (STU, filed under *Kantvilasia hians*), 33912 (STU). New to Valdivian temperate rain forest.

Caprettia setifera (Malcolm & Vezda) R. Sant., Lücking & Sérus (Fig. 3e). This diminutive species was described as *Porinula setifera* from New Zealand (Malcolm & Vezda, 1995b), but recently transferred to *Caprettia* in the course of synonymization of *Porinula* Vezda *nom. inval*. with the latter genus (Sérusiaux & Lücking, 2002). The present material has more reddish-brown perithecia with less well-developed setae, and also features the tubular pycnidia typical of

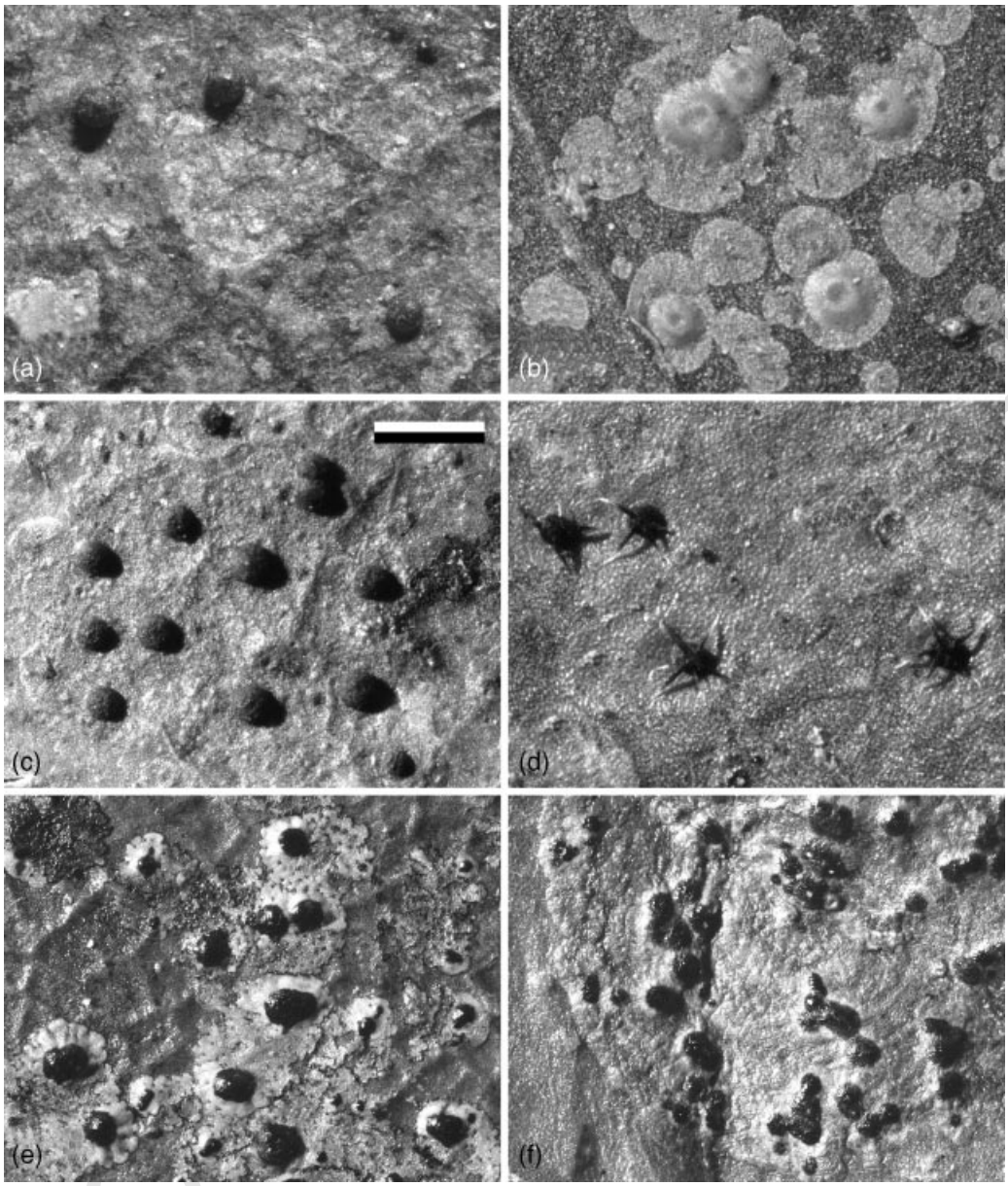

Fig. 4 Selected foliicolous lichens from Valdivian temperate rain forest. (a) *Porina rubrosphaera*. (b) *P. fulvelloides*. (c) *P. thaxteri*. (d) *Trichothelium javanicum*. (e, f) *Strigula wandae* (E = isotype). Scale = 1 mm [in (b, c) = 0.7 mm, in (d) = 0.5 mm].

Caprettia, but otherwise agrees with an isotype from New Zealand. The taxon is also known from Tasmania. Specimen examined: Chile. Locality 2, Thaxter 8 : 1a (UPS). New to the American continent.

Enterographa falcata Lücking & Wirth spec. nova (Fig. 3c). A *Enterographa bella* ascosporis 3-septatis et conidiis falcatis differt. Typus: Chile. Décima Región (Región de los Lagos): Vulcán El Mocho near Vulcán Choshuenco, 100 km E of Valdivia, 600–630 m, Valdivian temperate rain forest, XI. 1999, Wirth & Feuerer 33902 (STU, holotypus). Thallus epiphyllous, dispersed, single patches 0.5–1.0 mm diam., smooth, pale greenish-grey; photobiont a species of Phycopeltis, cells rectangular, 15–20 × 6–8 μm, in radiating plates. Apothecia single in the centre of each thallus patch, immersed-erumpent and distinctly elongate, unbranched or occasionally branched, 0.3–0.5 mm long and 0.1–0.15 mm broad; disc slit-like, brown, margin gently sloping outwards, pale yellowish-brown. Proper excipulum thin, 5–10 μm

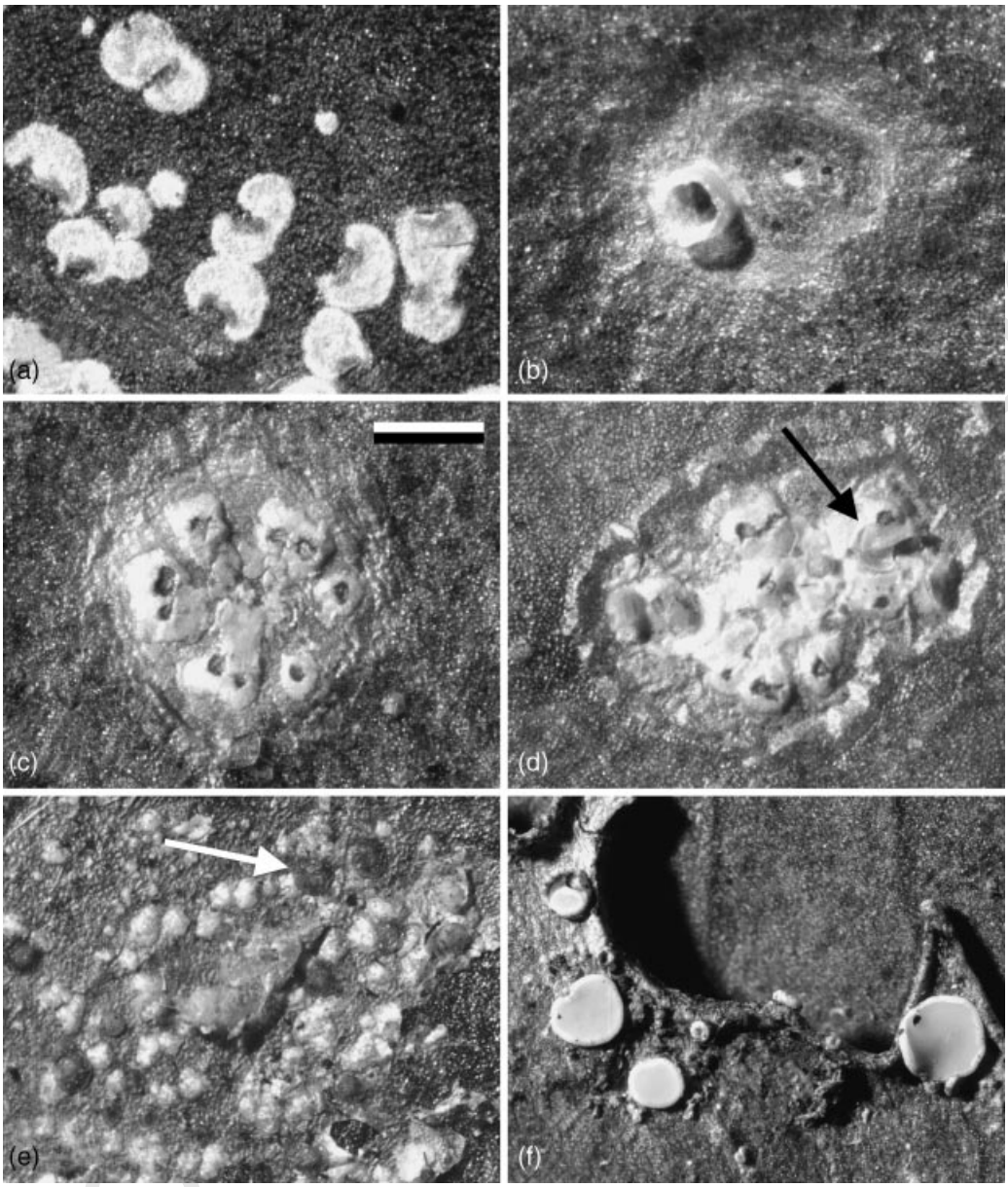

Fig. 5 Selected foliicolous lichens from Valdivian temperate rain forest. (a) *Gyalectidium chilense* (= isotype). (b) *G. conchiferum* (= holotype). (c, d) *G. plicatum* (= isotype). (e) *Gyalideopsis choshuencensis* (= isotype). (f) *Coenogonium subluteum*. Scale = 0.7 mm [in (e) = 1 mm, in (f) = 2 mm].

thick, pale yellowish; hypothecium 7–15 μm high, pale yellowish; epithecium 5–10 μm high, yellowish-brown; hymenium 50–60 μm high, colourless. Paraphyses 0.7–1.0 μm thick, branched and anastomosing; asci clavate, bitunicate, 45–55 × 9–12 μm. Ascospores 8 per ascus, narrowly fusiform, 3-septate, the upper median cell slightly enlarged, colourless, 18–27 × 2.5–3.0 μm. Pycnidia wart-shaped, 0.1–0.15 mm diam., yellowish-brown with dark brown top. Conidia narrowly sickle-shaped, with acute ends, unseptate, 13–17 × 1.0–1.2 μm. *Enterographa falcata* is distinguished by the mostly unbranched apothecia with smooth margins, the 3-septate ascospores, the sickle-shaped ('falcate') conidia and the photobiont with radiating cell rows. Externally and in anatomical details, it is most similar and perhaps most closely related to *E. bella* R. Sant., which differs by the 7-septate, broader ascospores. Two other species have 3(–5)-septate

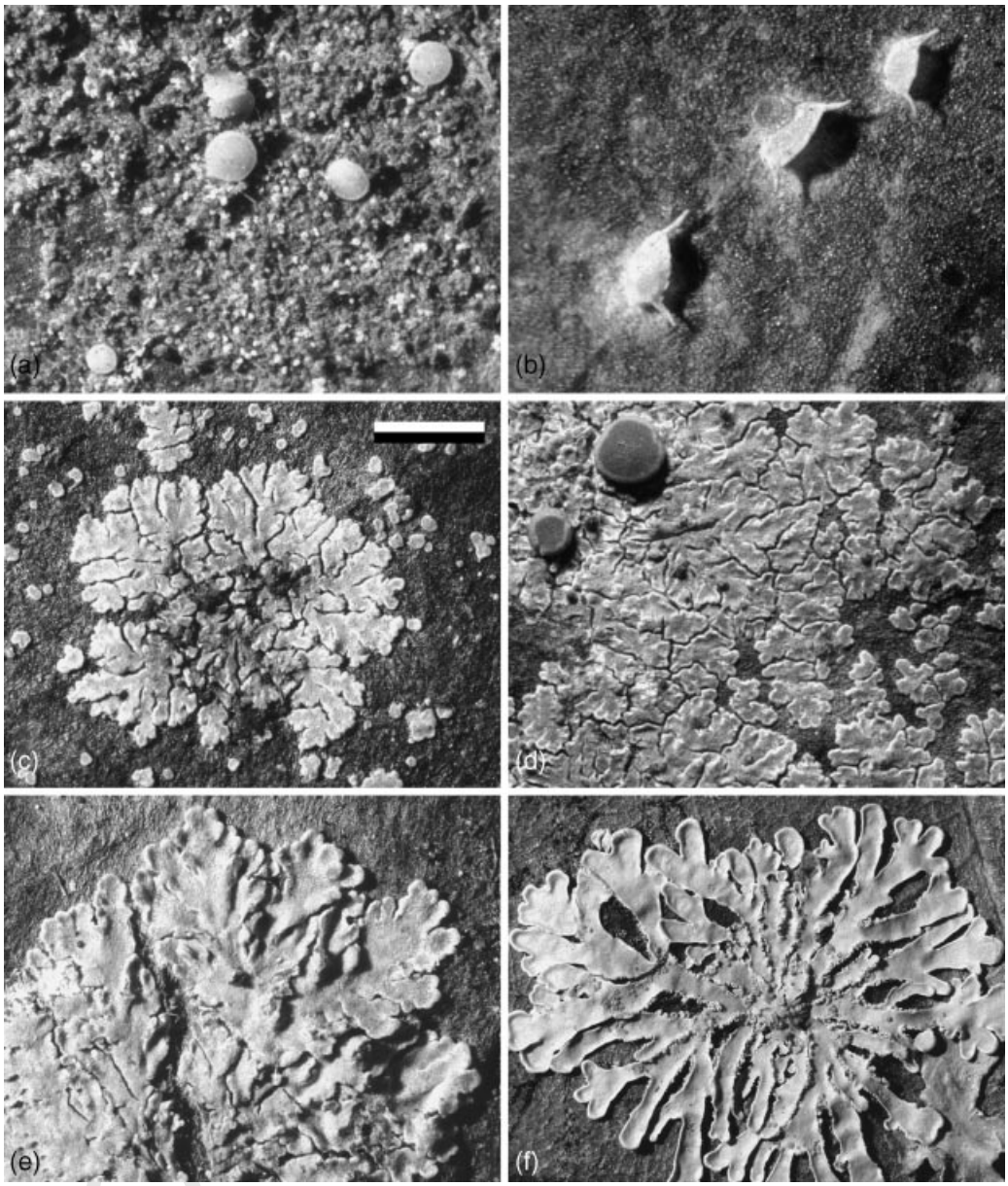

Fig. 6 Selected foliicolous lichens from Valdivian temperate rain forest. (a) *Bacidina pallidocarnea*. (b) *Badimiella pteridophila*. (c, d) *Parmeliella nigrocincta*. (e) *P. thysanota*. (f) *Psoroma caliginosum*. Scale = 1 mm [in C–e) = 1.5 mm, in (f) = 2 mm].

ascospores: *E. angustissima* (Vain.) R. Sant. has larger, often branched apothecia and relatively broader ascospores, and a dispersed thallus with a non-radiate photobiont, while *E. deslooveri* Sérus. has apothecia with a finely byssoid margin. In the holotype, *Enterographa falcata* grows intermingled with *Porina fulvelloides* (see below), which has a very similar thallus and most probably shares the same photobiont. We therefore believed at first *Enterographa falcata* to be a lichenicolous species on a *Porina*; however, careful examination demonstrated that the thallus patches carrying perithecia of the *Porina* or apothecia or pycnidia of the *Enterographa* are always separated. Additional specimen examined: Chile. Locality 1, Lücking & Cáceres 01–3011 (VALPL).

Gyalectidium chilense Cáceres & Lücking spec. nova (Fig. 5a). A *Gyalectidio maracae* hyphophoris reniformis differt. Typus: Chile. Novena Región (Región de la Araucanía): Lican Ray at Lake Calafquén, 120 km SSE of Temuco, trail through Peninsula de Lican Ray, disturbed Valdivian temperate

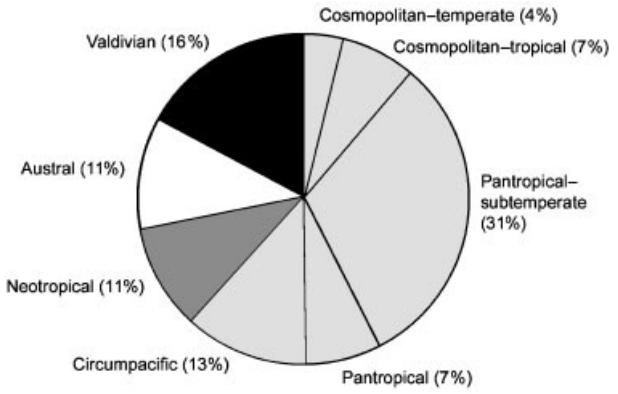

Fig. 7 Proportion of distribution types among the foliicolous lichens of Valdivian temperate rain forest.

rain forest remnant, XI. 2001, Lücking & Cáceres 01–3013 (VALPL, holotypus). Thallus epiphyllous, continuous, smooth but completely encrusted with calcium oxalate crystals, white to silvery grey, very small [0.3–0.7(–1.5) mm diam.]; photobiont chlorococcoid, cells 5–9 μm diam. Apothecia not observed. Hyphophores frequent, formed in incisions at the margin of the thallus, indistinctly squamiform, scales reniform to lunular, hardly raised and completely covering the diahyphal mass, 0.07–0.15 mm long and 0.2–0.4 mm wide, greyish translucent. Diahyphae produced beneath the scale at its base, branched and septate throughout, segments sausage-shaped, intermingled with small algal cells (3–5 μm diam.). This new species was mistaken at first for a sterile *Asterothyrium* until the very inconspicuous hyphophores were discovered. *Gyalectidium chilense* resembles *G. maracae* Lücking (Ferraro *et al.* 2001) in its crystalline but completely flat, whitish thallus, but the latter has triangular hyphophore scales projecting from the thallus margin. The individual thalli of *G. chilense* are extremely small but easily recognized under lens magnification due to their characteristic shape, which is caused by the marginal incisions where the hyphophores are formed.

Gyalectidium conchiferum Lücking & Wirth (Fig. 5b). This new species was described in a recently published world monograph of *Gyalectidium* (Ferraro *et al.*, 2001). It is characterized by a smooth thallus lacking crystals and marginal hyphophores with well-developed, mussel-shaped scales.

Gyalectidium plicatum Ferraro & Lücking spec. nova (Fig. 5c,d). A *Gyalectidio areolato* hyphophoris plicatis et thallo minore differt. Typus: Argentina. Provincia de Neuquén: Parque Nacional Nahuel Huapí, 35 km WNW of San Carlos de Bariloche, trail from Puerto Blest to Cascada Los Cántaros, 800–1000 m, Valdivian temperate rain forest, on leaves of Laureliopsis, XI. 2001, Ferraro & Giaiotti 6508 (CTES, holotypus). Thallus epiphyllous, continuous, distinctly areolate due to strong encrustation with calcium oxalate crystals, areolae white, thallus between the verrucae greenish; photobiont chlorococcoid, cells 5–8 μm diam. Apothecia immersed in white thallus areolae, angular-rounded in outline, 0.1–0.2 mm diam.; disc pale grey; proper margin visible as thin, dark brown line, thallus margin formed by the areolae. Excipulum reduced, 10–15 μm broad, prosoplectenchymatous; epithecium indistinct, with scattered, small algal cells; hypothecium 10–15 μm high, colourless; hymenium 40–50 μm high, colourless. Paraphyses 0.5–0.7 μm thick, richly branched and anastomosing; asci ellipsoid-ovate to saccate, 35–45 × 15–25 μm. Ascospores 1 per ascus, broadly ellipsoid, muriform, 30–40 × 12–20 μm, colourless. Hyphophores frequent, formed near the margin of the thallus, squamiform, scales at first mussel-shaped but soon erect and irregularly plicate, 0.2–0.5 mm long and 0.2–0.4 mm broad, greyish translucent. Diahyphae produced beneath the scale at its base, branched and septate throughout, segments sausage-shaped, intermingled with small algal cells (3–5 μm diam.). *Gyalectidium plicatum* is intermediate between *G. areolatum* Ferraro & Lücking and *G. conchiferum* Lücking & Wirth (Ferraro *et al.*, 2001). Its thallus structure is similar to *G. areolatum*, but the thalli are usually smaller and the areolae more delicate. In addition, while the hyphophores of *G. areolatum* form oblique, often rather broad scales, with two lateral projections, those of *G. plicatum* are thinner and very irregularly folded. The very young hyphophores resemble those of *G. conchiferum*, but this species differs in the smooth thallus lacking crystals, and its hyphophores remain mussel-shaped at the mature stage. All three taxa seem to be closely related. Additional specimens examined: Chile. Locality 4, Wirth & Feuerer 33907, 33908 (STU). Locality 6, Wirth & Feuerer 33913, 33916 (STU); Argentina. Locality 7, Ferraro & Giaiotti 6506, 6507 (CTES).

Gyalideopsis choshuencensis Lücking & Wirth spec. nova (Fig. 5e). A *Gyalideopsis verruculosa* apotheciis maioribus et ascis 4–8-sporis differt. Typus: Chile. Décima Región (Región de los Lagos): Vulcán El Mocho near Vulcán Choshuenco, 100 km E of Valdivia, 600–630 m, Valdivian temperate rain forest, XI. 1999, Wirth & Feuerer 33903 (STU, holotypus). Thallus epiphyllous, continuous, coarsely verrucose to minutely areolate due to strong encrustation with calcium oxalate crystals, verrucae applanate to areolate, white, 0.1–0.2 mm diam. but often fusing to form larger areolae, thallus between the verrucae greenish; photobiont chlorococcoid, cells 5–8 μm diam. Apothecia adnate to broadly sessile, without or with slightly constricted base, rounded, 0.2–0.6 mm diam.; disc at first pale flesh-coloured but soon yellowish-brown; margin not prominent, translucent. Excipulum well-developed, 20–50 μm broad, composed of thin, branched and anastomosing, radiate hyphae embedded in a gelatinous matrix; epithecium 5–15 μm high, pale yellowish-brown; hypothecium 10–15 μm high, colourless to pale yellowish;

hymenium 50–70 μm high, colourless. Paraphyses 0.5–0.7 μm thick, richly branched and anastomosing; asci ellipsoid-ovate to saccate, 50–80 × 25–35 μm. Ascospores 4–8 per ascus, cylindrical to oblong, often curved, muriform, with 15 transverse and 1–3 longitudinal septa per segment, colourless, 35–50 × 8–12 μm. Hyphophores abundant, formed on the thallus surface, shortly setiform, 0.15–0.25 mm high and 10–20 μm broad, black. Diahyphae produced laterally at the tip but often growing down to the thallus surface and forming a hyaline, 10–15 μm broad coat around the hyphophore, their final segments moniliform, cells clavate, 5–10 × 1.0–1.5 μm. *Gyalideopsis choshuencensis* is characterized by the combination of coarsely verrucose to minutely areolate thallus, applanate, yellowish-brown apothecia, 4–8-spored asci with narrow, muriform ascospores and black, setiform hyphophores. It seems to be related most closely to *G. verruculosa* Hafellner & Vezda, which has smaller, sessile apothecia with single-spored asci. Multispored asci with muriform ascospores are also found in *G. rubra* Lücking, but this species has dark reddish to reddish brown apothecia and a smooth thallus lacking hyphophores. The rich collection from Argentina differs in the more applanate apothecia resembling those of *Echinoplaca*, in particular *E. melanotrix* Lücking (Lücking, 1997). This species also has very similar hyphophores but differs in its 1-spored asci. Additional specimens examined: Chile. Locality 4, Wirth & Feuerer 33904, 33905 (STU). Locality 6, Wirth & Feuerer 33917 (STU); Argentina. Locality 7, Ferraro & Giaiotti 6509 (CTES).

Helicobolomyces lichenicola Matzer (Fig. 3b). This taxon is the anamorph of *Arthonia cinnabarinula* Müll. Arg., a common lichenicolous fungus of species of *Porina*, in particular those of the *P. epiphylla* group (Matzer, 1996). Here it occurs on the newly described *P. fulvelloides*. The collection is typical; the conidia formed by helically arranged, globose cells are unmistakable. Specimen examined: Argentina. Locality 7, Ferraro & Giaiotti 6509 (CTES, on Porina fulvelloides). New to Valdivian temperate rain forest.

Opegrapha sipmanii Matzer (Fig. 3d). Another lichenicolous species growing on thalli of *Porina fulvelloides*. Like *Helicobolomyces lichenicola*, this taxon usually occurs on species of the *Porina epiphylla*-group. The present specimens differ from other collections in the slightly larger ascospores which become greyish-brown and finely warty when old. This phenomenon is common in *Opegrapha* species (Sérusiaux, 1985; Matzer, 1996) and probably does not have taxonomic significance. Specimen examined: Argentina. Locality 7, Ferraro & Giaiotti 6509 (CTES, on Porina fulvelloides). New to Valdivian temperate rain forest.

Parmeliella nigrocincta (Stirt.) Müll. Arg. (Fig. 6c,d). This is an indifferent lichen as to its substrate preferences, usually found on bark but also on rocks, over bryophytes and on leaves, where it often forms large, fertile thalli. Its thallus is crustose-squamulose, while that of the related, also occasionally foliicolous *P. thysanota* (Stirt.) Zahlbr. (Fig. 6e) is more squamulose-subfoliose (Galloway, 1985). Both species were found in the present collections, as well as those made earlier by R. Thaxter and R. Santesson. Specimens examined: Chile. Locality 2, R. Thaxter 8 : 1a (UPS). Locality 6, Wirth & Feuerer 33919 (STU).

Porina fulvelloides Lücking & Wirth spec. nova (Fig. 4b). A *Porina rufula* peritheciis maioribus in apice depressis differt. Typus: Chile. Décima Región (Región de los Lagos): Vulcán El Mocho near Vulcán Choshuenco, 100 km E of Valdivia, 600–630 m, Valdivian temperate rain forest, XI. 1999, Wirth & Feuerer 33902 (STU, holotypus). Thallus epiphyllous, dispersed but soon confluent, single patches 0.5–1.5 mm diam., smooth, pale yellowish-green; photobiont a species of *Phycopeltis*, cells rectangular, 15–20 × 6–8 μm, in radiate plates. Perithecia single in the centre of each thallus patch, lens-shaped with the top distinctly depressed, 0.25–0.5 mm diam., orange to orange-brown, slightly nitidous. Outer perithecial wall 15–20 μm thick, basally expanded, orange brown, K + orange, externally covered by a 5–10 thick algal layer up to the ostiole; inner wall 10–15 μm thick, prosoplectenchymatous, pale yellowish, K + yellow-orange; laterally between the inner and outer wall a loose tissue of thin, interwooven hyphae. Paraphyses 0.7 μm thick, unbranched; asci narrowly fusiform to obclavate, 70–80 × 10–12 μm. Ascospores 8 per ascus, ellipsoid-fusiform with rounded ends, 3-septate, colourless, 18–24 × 3.5–4.5 μm. Pycnidia not seen. This new species closely resembles *Porina fulvella* Müll. Arg. in the orange, apically depressed perithecia. However, the perithecia of *P. fulvelloides* are larger and slightly nitidous, while those of *P. fulvella* are matt and often minutely pilose. An important difference is found further in the perithecial anatomy: while *P. fulvella* belongs to those species with an algal layer between the inner and outer perithecial wall, in *P. fulvelloides* the algal layer covers the outer wall. In this respect, *P. fulvelloides* corresponds to *P. rufula* (Kremp.) Vain., but the latter species has smaller perithecia which are never depressed but are provided with a translucent central part. Additional specimens examined: Chile. Locality 4, Wirth & Feuerer 33903 (STU). Locality 6, Wirth & Feuerer 33910 (STU); Argentina. Locality 7, L. I. Ferraro & A. Giaiotti 6509 (CTES).

Porina thaxteri R. Sant. (Fig. 4c). This previously unreported taxon is the most abundant and most widespread foliicolous lichen in Valdivian temperate rain forest. The black perithecia are rather variable, ranging from glabrous with a lateral greyish cover to minutely pilose around the ostiole. The species thus closely resembles *P. nitidula* Müll. Arg., but differs constantly in its 3-septate ascospores. The material agrees well with samples from Guatemala and Costa Rica, although the latter often feature weak radiate thallus ridges. Specimens examined: Chile. Locality 1, Lücking & Cáceres (F, VALPL). Locality 5, Wirth & Feuerer 33985 (STU). Locality

6, Wirth & Feuerer 33921 (STU); Argentina. Locality 7, Ferraro & Giaiotti (CTES).

Psoroglaena stigonemoides (Orange) Henssen (Fig. 3f). Previously known only from temperate Europe, this finding suggest a cosmopolitan distribution for this diminutive but unmistakable lichen. *P. stigonemoides* is related closely to *P. costaricensis* Henssen, a possibly widespread but overlooked neotropical rain forest lichen; both taxa differ only in their ascospore septation. Specimen examined: Chile. Locality 1, Lücking & Cáceres 01–3007 (F). New to the American continent.

Psoroma caliginosum Stirt. (Fig. 6f). Another lichen which is indifferent with regard to its substrate preferences, which may be found growing on bark, rock, over bryophytes and on leaves. The present collections are sterile but have abundant cephalodia. Specimens examined: Chile. Locality 5, Wirth & Feuerer 33895, 33897 (STU). Locality 6, Wirth & Feuerer 33921 (STU).

Strigula wandae Cáceres & Lücking spec. nova (Fig. 4e,f). A *Strigula microspora* ascosporis et macroconidiis maioribus differt. Typus: Chile. Novena Región (Región de la Araucanía): Lican Ray at Lake Calafquén, 120 km SSE of Temuco, trail through Peninsula de Lican Ray, disturbed Valdivian temperate rain forest remnant, XI. 2001, Lücking & Cáceres 01–3019 (VALPL, holotypus; F, isotypus). Thallus epiphyllous, subcuticular, forming rounded patches 2–5 mm diam. and 20–40 μm thick, patches often contiguous and covering large areas of the leaves, surface irregular, pale yellowish-green to bright green; photobiont a species of *Cephaleuros*, cells angular-rounded, 8–15 × 4–5 μm, in several layers. Perithecia numerous on each thallus patch, usually concentrically arranged, semi-immersed, hemispherical, 0.2–0.3 mm diam., their upper part jet-black and sharply delimited from the surrounding thallus, nitidous. Outer perithecial wall 20–30 μm thick, carbonaceous, just covering the perithecial chamber but not reaching beyond, laterally fusing with the thallus; inner wall 7–15 μm thick, prosoplectenchymatous, dark brown, in upper parts fusing with the outer wall; laterally of the inner wall a loose tissue of thin, pale brownish, interwooven hyphae. Paraphyses 1 μm thick, mostly unbranched; asci cylindrical, 50–60 × 9–12 μm. Ascospores 8 per ascus, irregularly biseriate, oblong-ellipsoid with rounded ends, 1-septate, very slightly constricted at the septum, 15–23 × 4–5 μm, their distal cell not distinctly enlarged, colourless. Pycnidia forming macroconidia usually present, 0.1–0.15 mm diam., semi-immersed, their upper half jet-black. Macroconidia bacillar, 1-septate, 12–15 × 2.5–3.0 μm, colourless, with filiform, gelatinous appendages (3–5 × 1 μm) at both ends. *Strigula wandae* is dedicated to Wanda Quilhot in recognition of her important contributions to Chilean lichenology. The new species closely resembles *Strigula microspora* Lücking, which differs chiefly by its smaller ascospores (8–15 × 2–3 μm) and smaller macroconidia (8–10 × 2.0–2.5 μm). *S. subelegans* Vain. is also similar in appearance but has a more greyish-green thallus with a slight bluish tinge, ascospores with the distal cell distinctly enlarged, and larger macroconidia (15–18 × 3–4 μm). These three species seem to form a group of closely related taxa with different distribution: *S. subelegans* is most common in the eastern Palaeotropics, *S. microspora* in the Neotropics and the anatomically intermediate *S. wandae* is restricted to Valdivia. Additional specimens examined: Chile. Locality 1, Lücking & Cáceres 01–3020 (VALPL, F). Locality 2, Wirth & Feuerer 33900, 33901 (STU).

Trichothelium javanicum (F. Schill.) Vezda (Fig. 4d). This species was thus far known from the eastern Palaeotropics, including Australia (McCarthy, 2001), and the present record means a considerable range extension. Specimen examined: Chile. Locality 2, Thaxter 8 : 1a (UPS). New to the American continent.

Trichothelium meridionale var. *austroamericanum* Lücking var. nova. A var. *meridionale* setis longioribus horizontalibusque differt. Typus: Chile. Novena Región (Región de la Araucanía): Lican Ray at Lake Calafquén, 120 km SSE of Temuco, trail through Peninsula de Lican Ray, disturbed Valdivian temperate rain forest remnant, XI. 2001, Lücking & Cáceres 01–3019 (VALPL, holotypus). Differing from var. *meridionale* in the longer perithecial setae (200–300 vs. 40–100 μm) that form a well-developed, horizontally projecting crown. This taxon agrees with the southern Australian *Trichothelium meridionale* P.M. McCarthy & Kantvilas (McCarthy, 2001) in the irregular photobiont, black perithecia and comparatively small, 7-septate ascospores. The only difference is found in the longer, horizontally projecting setae, and for the moment we have accorded this taxon subspecific status.

Diversity and biogeography

To date, 52 species of foliicolous lichens and three lichenicolous fungi are known from Valdivian temperate rain forest in Chile and Argentina (Table 1). This number is slightly higher than that of the temperate rain forests of Australia (Victoria, Tasmania) and New Zealand (Zahlbruckner *et al.*, 1928; Lumbsch & Hayward, 1990; Malcolm & Vezda, 1994, 1995a, 1995b, 1996; Malcolm *et al.*, 1996; Sérusiaux & Polly, 1996; Polly, 1997; Sérusiaux & Aptroot, 1998; Sérusiaux, 1998; McCarthy & Kantvilas, 2000; McCarthy *et al.*, 2000, 2001). The European–Macaronesian foliicolous lichen mycobiota is also poorer in species (Sérusiaux, 1993, 1996; Puntillo *et al.*, 2000), which is attributable to the absence of temperate rain forest vegetation and the strong isolation from tropical rain forest. There is a high percentage of indifferent taxa ('pseudofoliicoles'; Sérusiaux, 1977) in these extratropical mycobiota, growing equally well on leaves and other substrata, including bark and rock surfaces. Species

such as *Aspidothelium cinerascens*, *Byssoloma marginatum*, *Coccocarpia domingensis*, *Coenogonium luteum*, *Fellhanera bouteillei*, *Parmeliella nigrocincta*, *Psoroglaena stigonemoides*, *Psoroma caliginosum* and *Roccellinastrum epiphyllum* belong here. In the present case, 15 of the 55 species (27%) are indifferent as to their substrate preferences.

Nearly half of the species (47%) are new records for the area or new to science. New for Valdivian temperate rain forest are *Arthonia cyanea* (Chile), *Byssoloma marginatum* (Chile), *B. subdiscordans* (Chile), *Fellhanera bouteillei* (Chile), *F. dispersa* (Chile), *F. subfuscatula* (Chile), *Gyalectidium caucasicum* (Chile), *G. ciliatum* (Chile), *Logilvia gilva* (Chile), *Porina thaxteri* (Chile, Argentina), *Strigula nitidula* (Chile) and the lichenicolous *A. microsticta* (Chile, Argentina), *Helicobolomyces lichenicola* (Argentina) and *Opegrapha sipmanii* (Argentina). Seven taxa are described as new, including no less than three in the genus *Gyalectidium*, which now comprises 37 species (Ferraro *et al*., 2001; Herrera-Campos & Lücking, 2002). Most remarkable, however, are the first records of *Badimiella pteridophila*, *Caprettia setifera*, *Psoroglaena stigonemoides* and *Trichothelium javanicum* for the American continent. *Badimiella pteridophila* (= *B. serusiauxii*) and *Caprettia* (= *Porinula*) *setifera* were formerly known from Tasmania and New Zealand (Malcolm & Vezda, 1995b; Garnock-Jones & Malcolm, 2001). *Psoroglaena stigonemoides* was thought to be restricted to temperate Europe, while *Trichothelium javanicum* was considered a typical representative of the eastern Palaeotropics (McCarthy, 2001).

The 52 foliicolous lichens and three lichenicolous fungi thus far encountered in Valdivian temperate rain forest can be assigned roughly to eight distribution types (Fig. 7). Of these, widely distributed, intercontinental taxa amount to 34 (62%) or even 40 (73%), if the austral element is included. Four species, *Byssoloma leucoblepharum*, *B. subdiscordans*, *Coenogonium luteum* and *Fellhanera bouteillei*, are cosmopolitan–tropical, i.e. also found in tropical rain forest, while *Byssoloma marginatum* and *Psoroglaena stigonemoides* are considered cosmopolitan–temperate, in the tropics being restricted to the upper montane zone. The largest group, with 17 species (31%), comprises the pantropical–subtemperate element, i.e. tropical species extending into subtropical regions. This group includes *Arthonia cyanea*, *A. trilocularis*, *Asterothyrium rotuliforme*, *Bacidina apiahica*, *Byssoloma discordans*, *Coccocarpia domingensis*, *C. erythroxyli*, *Coenogonium interplexum*, *C. linkii*, *Fellhanera fuscatula*, *F. subfuscatula*, *Gyalectidium caucasicum*, *G. filicinum*, *Mazosia phyllosema*, *Strigula nitidula*, *S. smaragdula* and *Tapellaria epiphylla*. Four additional taxa, namely *Bacidina pallidocarnea*, *Coenogonium subluteum*, *Porina epiphylla* and *P. limbulata* are pantropical.

The circumpacific element comprises seven species that are known from the Neotropics and eastern Palaeotropics, but extent into subtropical–temperate regions: *Aspidothelium cinerascens*, *Fellhanera dispersa*, *Gyalectidium ciliatum*, *Logilvia gilva*, *Porina rubrosphaera*, *P. thaxteri* and *Trichothelium javanicum*. A circumpacific element is well recognized in lichens and other organisms, but some species may actually belong to the pantropical–subtemperate element and are simply not yet known from the African Palaeotropics.

Most interesting from a biogeographical viewpoint is the austral element, with six species: *Badimiella pteridophila*, *Caprettia setifera*, *Kantvilasia hians*, *Parmeliella nigrocincta*, *P. thysanota* and *Psoroma caliginosum*. The latter three are indifferent taxa and belong to a well-established austral element in lichens (Galloway, 1988, 1996). In foliicolous lichens, however, such an element has not yet been recognized, except for the recently described *Kantvilasia hians* (McCarthy *et al*., 2000). Due to the wide distribution of many foliicolous lichen species, distinctive biogeographical patterns that would correspond to those of vascular plants are almost inapparent (Lücking, 2001). However, the finding of *Badimiella pteridophila*, a widespread foliicolous lichen in Tasmania and New Zealand, and of *Caprettia setifera*, indicates a distinctive austral element in this predominantly tropical group of organisms.

The distinctiveness of the foliicolous lichen mycobiota of Valdivian temperate rain forest is evidenced further by the fact that the neotropical element is poorly represented and includes only six species, three of which are lichenicolous fungi. Indeed, the only typically neotropical representative is *Gyalideopsis vulgaris*, while the distribution of *Eremothecella cingulata* and *Gyalectidium catenulatum* is not yet known with certainty. The nine taxa thus far known only from and possibly endemic to Valdivian temperate rain forest, namely *Enterographa falcata*, *Gyalectidium chilense*, *G. conchiferum*, *G. plicatum*, *Gyalideopsis choshuencensis*, *Porina fulvelloides*, *Roccellinastrum epiphyllum*, *Strigula wandae* and *Trichothelium meridionale* ssp. *austroamericanum* add to the distinctness of this biome, although further studies are needed to verify their restricted distribution.

The high number of seven *Gyalectidium* species in Valdivian temperate rain forest, of which three are new to science, is also remarkable. For a long time, *Gyalectidium* was thought to be poor in species, possibly comprising only the type, *G. filicinum*, but recent studies revealed an extraordinary diversity, with 37 taxa distinguished so far (Ferraro *et al*., 2001; Herrera-Campos & Lücking, 2002). Apart from those described in this paper, many of the newly discovered species are found primarily in the Southern Hemisphere, such as *G. fantasticum* (Paraguay, but also Costa Rica), *G. areolatum* (Argentina), *G. microcarpum* (South Africa, Malaysia, Australia), *G. verruculosum* (Papua New Guinea, Australia) and *G. australe* (Australia). *Gyalectidium* is the only genus within the *Gomphillaceae* that exhibits a chiefly Southern

Hemisphere distribution type; at the same time, phylogenetic studies suggest it to be the most advanced genus in the family (Lücking *et al*., in prep.).

The foliicolous lichen mycobiota of Valdivian temperate rain forest is thus distinctive and very different from the Neotropics, and it also differs remarkably from the subtropical areas in northern Argentina and adjacent areas (Ferraro, 1997; Ferraro & Lücking, 2000). Species in common between these mycobiota are widespread, either cosmopolitan or pantropical taxa, without potential to indicate small-scale biogeographical affinities. While neotropical rain forests in Central and South America contain mainly pantropical and neotropical taxa, the Valdivian foliicolous lichen mycobiota is characterized chiefly by a circumpacific, an austral and an endemic element. This suggests that, although affinities with neotropical mycobiota at the genus level exist, Valdivian foliicolous lichens evolved partly separately, influenced by a temperate and an austral rather than a neotropical element. Indeed, two of the three typically foliicolous austral taxa, *Badimiella pteridophila* and *Kantvilasia hians*, represent monospecific genera whose closest relatives are not yet known with certainty. The only species that shows some taxonomic affinity to *Kantvilasia hians*, namely *Logilvia gilva*, has a similar distribution, but in the Neotropics extends northward to Guatemala, although it is restricted to montane and subalpine vegetation. Thus, the distinctiveness of Valdivia in terms of its foliicolous lichen mycobiota is reflected by its recognition as one of six regions at the world level (Lücking, 2002).

Like most other forest types, Valdivian temperate rain forest has undergone severe destruction and alteration due to land use change and production of timber and wood chips. It is estimated that the present-day forest cover represents about 25% of the original forest (Barnett, 1992; Ormazábal, 1993). Foliicolous lichens are more susceptible to such changes than many other lichens, because most species prefer sheltered understorey microsites (Lücking, 1995; Cáceres *et al*., 2000). The isolated Valdivian temperate rain forest remnant at Lican Ray is an alarming example of how the rich foliicolous lichen mycobiota can be reduced dramatically: even after a thorough search, only nine species were found at this site, and in only a few, very sheltered places. Remarkably enough, two of them were new to science.

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SUPPLEMENTARY MATERIAL

The following material is available from http://www.blackwell-science.com/products/journals/suppmat/GEB/GEB319/GEB319sm.htm

Appendix 2

Key to the foliicolous lichens in Valdivian temperate rain forest of Chile and Argentina

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