

New species and records of *Lepraria* (*Stereocaulaceae*, lichenized Ascomycota) from South America

Adam FLAKUS, John A. ELIX, Pamela RODRIGUEZ and Martin KUKWA

Abstract: Two new corticolous lichen species are described, *Lepraria nothofagi* Elix & Kukwa (atranorin, strepsilin, porphyritic acid) from Argentina and *L. stephania* Elix, Flakus & Kukwa (4-*O*-methylleprolomin, zeorin, salazinic acid, unknown terpenoid) from pre-Andean Amazon forest of Bolivia. In addition, the paper presents new records of 16 species of *Lepraria* from South America. *Lepraria adhaerens*, and *L. diffusa* are new to the Southern Hemisphere; *L. borealis* is new to South America; *L. alpina* is new to Chile, Colombia, Peru and Venezuela; *L. caesia* (chemotype I) is new to Venezuela, *L. lobificans* new to Argentina, *L. pallida* new to Peru, and *L. sipmaniana* new to Bolivia and Chile. The Chilean records of *L. membranacea* appeared to belong to *L. sipmaniana*. Therefore, the number of *Lepraria* spp. known at present from South America is enlarged to 27 species. 4-*O*-methylleprolomin is reported for the second time from lichens.

Keywords: Argentina, Bolivia, chemistry, lichenized fungi, Neotropics, taxonomy

Introduction

Lepraria Ach. is a cosmopolitan genus of leprose to byssoid, permanently sterile lichenized fungi, with more than 60 species known worldwide (e.g. Laundon 1989, 1992; Tønsberg 1992, 2007; Sipman 2004; Slavíková-Bayerová & Orange 2006; Flakus & Kukwa 2007; Knudsen & Elix 2007a; Slavíková-Bayerová & Fehrer 2007; Elix & Kalb 2008; Lendemé *et al.* 2008; Kukwa & Flakus 2009; Saag *et al.* 2009). Of these, 22 species have been reported from South America (see Calvelo & Liberatore 2002; Sipman 2004; Flakus *et al.* 2006; Flakus & Kukwa 2007; Nöske *et al.* 2007; Kukwa &

Flakus 2009 and literature cited therein). However, the number of *Lepraria* present in the continent is expected to be much greater. In this paper we present new records of 18 *Lepraria* species, two of them new to the Southern Hemisphere and one new to South America, with the description of two new species from Argentina and Bolivia. As a consequence, the number of *Lepraria* known from South America is enlarged to 27 species. In addition 4-*O*-methylleprolomin is discovered in lichens for the second time from a new species of *Lepraria*, and is new to *Lepraria*. Most of the taxa presented here were discussed previously by Flakus & Kukwa (2007) and Saag *et al.* (2009), so we present only a brief mention of the characteristics of each species.

Material and Methods

Most of the examined specimens were collected by the authors in Bolivia and Peru in 2008, and these are deposited in KRAM, LPB and UGDA, with duplicates donated to B, BG, CANB, NY, UCR and hb. Flakus. Additional specimens studied were requested on loan from B, H, PRA and S. The abbreviations *AF*, *MK* and *PR* in specimens examined stand for *A. Flakus*, *M. Kukwa* and *P. Rodriguez*, respectively.

A. Flakus: Laboratory of Lichenology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland.

J. A. Elix: Research School of Chemistry, Building 33, Australian National University, Canberra, ACT 0200, Australia.

P. Rodriguez: Herbario Nacional de Bolivia, Instituto de Ecología, Universidad Mayor de San Andrés, Calle 27, Cota Cota, Casilla 10077, La Paz, Bolivia.

M. Kukwa: Department of Plant Taxonomy and Nature Conservation, University of Gdańsk, Al. Legionów 9, PL-80-441 Gdańsk, Poland. Email: dokmak@univ.gda.pl

Lichen morphology and anatomy were examined using standard stereo- and compound microscopes. Squash preparations were studied in water or KOH solution (K), with or without pre-treatment with acetone. The granules and crystals covering hyphae of *L. nothofagi* were also studied in polarized light. The measurements of soredia were made on material mounted in water.

Chemical analyses were carried out using thin-layer chromatography (TLC) following the methods of Orange *et al.* (2001). Extracts were run on aluminium or glass TLC plates in solvent systems A, B and C. Confirmation of identified substances was achieved in some cases by running the extracts adjacent to an extract containing known substances. Some specimens of newly described taxa were analysed by HPLC. When the substance was invariably present it is marked with (+), but if the metabolite was absent from some specimens (\pm) is used.

Results

Lepraria achariana Flakus & Kukwa

Chemistry. Lecanoric (+) and angardianic/roccellic (\pm) acids.

Notes. Known in South America only from Bolivia; here we report a fifth locality. The specimen lacked anthraquinones, which were reported for this species by Flakus & Kukwa (2007).

Specimens examined. **Bolivia:** Dept. Cochabamba: Prov. Carrasco, Carrasco National Park, between Sehuenas and Monte Punku villages, alt. c. 2650 m, MK 6572, 6573 & 6582a (LPB, UGDA).

Lepraria adhaerens K. Knudsen, Elix & Lendemer

Chemistry. Pannarin (+) and zeorin (+), as well as two unidentified substances (visible in long UV wavelength as ice-blue spots before charring, and after charring on fresh plates) (+) in Rf class: A7, B7, C6–7 and A5, B4, C5.

Notes. For the characteristics of *L. adhaerens* see Knudsen *et al.* (2007). Our specimens are morphologically and chemically (pannarin and zeorin present) very similar to the isotype deposited in UGDA, so we have attributed them to *L. adhaerens*. However, they always produce two additional un-

identified substances (see above), so far not recorded for this species or any other member of the genus. The taxonomic significance of these unknown metabolites is not certain and needs further study on more extensive collections. The South American collections may eventually represent an undescribed taxon, but this should be clarified by using molecular methods.

Lepraria santamonicae K. Knudsen & Elix is morphologically similar to *L. adhaerens*, but is greener in colour and contains argopsin and norargopsin. So far it has not been reported outside North America (Knudsen & Elix 2007a; Saag *et al.* 2009).

Previously *L. adhaerens* has been reported only from North America (Pennsylvania, Missouri, California), where it grows on soil and acid or limestone rocks (Knudsen *et al.* 2007; Knudsen & Elix 2007b). Here we record this species for the first time from the Southern Hemisphere. Peruvian specimens were found on soil, terricolous bryophytes, rocks, and sometimes on small twigs in an open semi-desert montane area.

Specimens examined. **Peru:** Dept. Arequipa: Prov. Caylloma, Cañon del Colca canyon, Llahuar village, alt. 2085 m, 15°34'52"S, 72°00'37"W, AF 10143 (KRAM), MK 6115 & 6118 (UGDA); between Soro and Llahuar villages, alt. 2100 m, 15°34'41"S, 72°01'01"W, AF 10130, 10137 (KRAM, hb. Flakus) & MK 6102 & 6109 (UGDA); Soro village, alt. 2050 m, 15°34'50"S, 72°01'51"W, MK 6136 (UGDA).

Lepraria alpina (B. de Lesd.) Tretiach & Baruffo

Chemistry. TLC: atranorin (+), porphyrylic acid (+) and an unknown substance below porphyrylic acid (\pm). No fatty acids were found in the material studied, but they have been reported by Flakus & Kukwa (2007).

Notes. For the descriptions of *L. alpina* see Tønberg (1992), Leuckert *et al.* (1995) and Baruffo *et al.* (2006). Most specimens of *L. alpina* from South America that we examined are characterized by a whiter and powdery thallus surface (for more details, see Flakus & Kukwa 2007). The status of this material from South America is not clear and can be resolved only by molecular studies.

In South America *L. alpina* was previously known only from Bolivia. Here the species is reported as new to Chile, Colombia, Peru and Venezuela. It is mainly a saxicolous (on sandstone, siliceous or basic rocks) and muscicolous species, but rarely occurs on bark.

Specimens examined. **Chile:** *Terr. Magellanes:* Lago del Toro (*L. Maravilla*), Estancia Rio Payne, above the river, *Santesson* 6579 (S-L42671); Natales, Cerro Dorotea, *Santesson* 2183 & 8260 (S-L42669 & L42670).—**Colombia:** *Risaralda:* Mnpio. de Sta. Rosa de Cabal, Camino real entre Termales de Sta. Rosa y Hda. La Sierra, 4°50'N, 75°31'W, alt. 3190 m, *Wolf* 981 (B).—**Peru:** *Dept. Arequipa:* Prov. Caylloma, by road to Huambo village near Lagunillas pass, alt. 4240 m, 15°55'10"S, 72°09'12"W, *AF* 10128 (KRAM) & *MK* 6092 (UGDA).—**Venezuela:** *Sierra Nevada:* Edo. Merida, Mun. Libertador, in 4105 m Höhe, *Wiegleb* 580 (B). *Region de Araucaria:* Mininco, zwischen Gestein, trocken Stellen, häufig, *Kunkel* 2074 (B).

***Lepraria borealis* Lohtander & Tønsberg**

Chemistry. Atranorin (+), rangiformic (+) and norrangiformic acids (+).

Notes. *Lepraria borealis* is morphologically very similar to other members of the *L. neglecta* group (particularly to *L. caesioalba*), but Ekman and Tønsberg (2002) confirmed that it is a distinct species. For descriptions of the species see Tønsberg (2004), Kukwa (2006a), Slaviková-Bayerová & Fehrer (2007) and Saag *et al.* (2009).

Previously *L. borealis* was known from Europe, North America including Greenland, Antarctica and Africa (Canary Islands) (Tønsberg 2004; Baruffo *et al.* 2006; Kukwa 2006a; Saag *et al.* 2009). Here the species is reported for the first time from South America. The Chilean specimen was collected on wood.

Specimen examined. **Chile:** *Ñuble:* Chillán (Bureo), *Barros* 106 (H).

***Lepraria caesioalba* (B. de Lesd.) J. R. Laundon**

Chemistry. The South American specimens are represented by chemotype I (see Leuckert *et al.* 1995) containing fumar-

protocetraric (+) acid and atranorin (+), and chemotype III with atranorin (+), psoromic (+), and consporomic acids (+), with accessory roccellic, rangiformic and/or unknown fatty acids.

Notes. *Lepraria caesioalba* s. lat. was thought to be a paraphyletic species (see Ekman & Tønsberg 2002; Slaviková-Bayerová & Fehrer 2007). It was represented by several chemotypes (see Leuckert *et al.* 1995; Tønsberg 2004 and literature cited therein), of which the chemotype with stictic acid has been recently segregated as *L. svalbardensis* Tønsberg (Øvstedal *et al.* 2009); other chemotypes may also represent separate species. Amongst the South American material we encountered chemotypes I and III *sensu* Leuckert *et al.* (1995), which are phylogenetically closely related and may represent one chemically variable species (see Ekman & Tønsberg 2002). See also Flakus & Kukwa (2007).

In South America *L. caesioalba* is known from Argentina, Bolivia, Colombia and Peru (Sipman 2004; Flakus & Kukwa 2007; Sipman *et al.* 2008), and appears to be rather common in open, high montane areas. Here it is reported as new to Venezuela where it was found on soil, rock and terricolous bryophytes in Andean vegetation.

Specimens examined. **Argentina:** *South-West Patagonia:* Lago Frio, western side, *James* 1240 (BM). *Tierra del Fuego:* Sierra Alvear, the southern slope, above Las Cotorras (about 20 km ENE of Ushuaia), c. 600 m, *Santesson* 774 (S-L42673; chemotype I).—**Peru:** *Prov. Canchis:* Sibinasallma village, Murrurani sector, W of la Laguna Sibinacocha, alt. 4952 m, 13°50'05"S, 71°04'06"W, *PR* 567 (LPB; chemotype III).—**Venezuela:** *Sierra Nevada:* Edo. Merida, Mun. Libertador, unterhalb des Pico Espejo, Weg Loma Redonda – Pico Espejo, alt. 4440 m, *Wiegleb* 622a (B; chemotype I).

***Lepraria diffusa* (J. R. Laundon) Kukwa**

Chemistry. Atranorin (±), 4-oxypannaric acid 2-methyl ester (+), pannaric acid (+), angardianic/roccellic acid (±) and traces of unknowns (+).

Notes. This species is characterized by the production of 4-oxypannaric acid-2-methyl

ester and related substances (for more detail see Laundon 1989; Elix & Tønsberg 2004; Tønsberg 2004; Kukwa 2006a; Saag *et al.* 2009). In South America *L. diffusa* can be confused with the morphologically and chemically similar *L. vouauxii*. The two species can readily be distinguished chemically, as *L. vouauxii* contains high concentrations of pannaric acid 6-methyl ester (Tønsberg 2004; Kukwa 2006a).

Previously this species was known from Europe, North America and Asia (e.g., Tønsberg 2004; Saag *et al.* 2009). Here it is recorded for the first time from the Southern Hemisphere, from Bolivia, Ecuador and Peru, where it was collected from soil in the Andes, mainly in cloud forests and Páramo vegetation.

Specimens examined. **Bolivia:** Dept. Cochabamba: Prov. Carrasco, Carrasco National Park, Monte Punku village, alt. 2800 m, 17°35'01"S, 65°18'03"W, MK 6152 & 6156 (LPB, UGDA); between Sehuencas and Monte Punku villages, alt. c. 2650 m, MK 6572 (LPB, UGDA); near Sehuencas village by Rio Lopez Mendoza river, alt. 2226 m, 17°30'26"S, 65°16'55"W, MK 6590 (LPB, UGDA).—**Chile:** X Region: Parque Nacional Puyehue, Anticura, Los Derrumbes, 40°40'S, 72°10'W, alt. c. 600 m, Coppins, Galloway, Guzmán & James 4643 (BM; mixed in specimen of *L. simpsoniani*).—**Ecuador:** Prov. Pichincha: Volcán Pichincha, E slope, along road to antennas at summit, 00°10'S, 78°35'W, 3200–3700 m, Harris 17054 (B); Prov. Carchi: Volcán Chiles, at road-side between Maldonado and Tufiño above the lake Laguna Verde, c. 1.5–1.8 km SSE of the peak of Volcán Chiles, alt. 4050 m, 00°48' N, 77°55'30" W, Etayo & Palice 8357 (PRA).—**Peru:** Dept. Junin: Prov. Tarma, c. 10 km (road distance) NNE of Palca, c. 2600 m 11°18'S, 75°32'W, Santesson P12:60 & Moberg (S-L42642).

***Lepraria ecorticata* (J. R. Laundon) Kukwa**

Chemistry. Usnic acid (+), zeorin (+) and trace of unidentified substance (±).

Notes. The specimens cited below fall well within the variation exhibited by *L. ecorticata* (for the characteristics of the species see Laundon 2003; Kukwa 2006b; Flakus & Kukwa 2007), but we have also seen specimens (not cited here) with the same chemistry but different morphology. One saxicolous Bolivian specimen consisted of soredia dis-

persed over a very thin layer of prothallus; the soredia were fluffy and possessed short projecting hyphae. Four specimens, three from Peru and one from Bolivia, had irregularly shaped granules and were morphologically very similar to *L. texta* K. Knudsen, Elix & Lendemer (see Knudsen & Elix 2007b), but lacked atranorin and fatty acids. The identification of those specimens no doubt requires a molecular approach.

Recently the phylogenetic position of two *Lepraria* species containing usnic acid and zeorin, *L. coriensis* (Hue) Sipman and *L. usnica* Sipman, was studied and it was shown that they do not belong to *Lepraria* s. str. (Nelsen *et al.* 2008). This is also possibly the case with *L. ecorticata* and with *L. leuckertiana*, treated below.

In South America *L. ecorticata* has been reported from Bolivia, Brazil, Chile and Peru (Kukwa 2006b; Flakus & Kukwa 2007). In this paper we present new records from Bolivia and Peru. Usually this species occurs on rocks, saxicolous bryophytes and moribund lichens in high, open Andean vegetation and montane cloud forests, and on siliceous rocks in lowland Amazon forest.

Specimens examined. **Bolivia:** Dept. La Paz: Prov. Nor Yungas, near Pacallo village, alt. 1360 m, 16°12'10"S, 67°50'39"W, AF 11820 & MK (KRAM, LPB).—**Peru:** Dept. Cuzco: Prov. Urubamba, Malaga Chico (Tastiyioc), NNW of Ollantaytambo, alt. 4000–4100 m, 13°04'S, 72°22'W, Santesson P93:122 & Moberg (S-L42651).

***Lepraria incana* (L.) Ach.**

Chemistry. Divaricatic acid (+) and zeorin (+) were detected in the specimen studied.

Notes. For the characteristics of this common species and the differentiation with other taxa see Tønsberg (1992), van den Boom *et al.* (1994), Aptroot *et al.* (1997) and Kukwa (2006a).

Lepraria incana is a rather widespread species, but in South America it was previously known only from Bolivia and Colombia (Flakus & Kukwa 2007; Sipman *et al.* 2008); here it is reported for the first time for Chile and from a second locality in Bolivia. The South American material

occurred on tree ferns, epiphytic bryophytes or *Parnettya* twigs.

Specimens examined. **Bolivia:** Dept. Cochabamba: Prov. Carrasco, Carrasco National Park, near Sehuencas village, alt. 2220 m, 17°30'12"S, 65°16'30"W, MK 6559 (LPB, UGDA).—**Chile:** Juan Fernandez Islands: Masatierra, Pangal, 500 m, Kunkel 305/4 (B).

Lepraria lecanorica Tønsberg

Chemistry. Atranorin (+) and lecanoric acid (+).

Notes. For a description of the species see Tønsberg (2004).

Lepraria lecanorica is known from North and South America (Tønsberg 2004; Flakus & Kukwa 2007). Here the reported locality is the third for South America and the second for Chile.

Specimen examined. **Chile:** Prov. Coquimbo: Depto. Ovalle, Fray Jorge, alt. 300 m, Sparre 3087 (S).

Lepraria leuckertiana (Zedda) L. Saag

Chemistry. Usnic acid (+) and zeorin (+).

Notes. For the characteristics of the species see Zedda (2000), Flakus et al. (2006) and Saag et al. (2009).

Lepraria leuckertiana is known mainly from southern Europe and north Africa, but it has also recently been found in South America (Zedda 2000; Flakus et al. 2006; Saag et al. 2009 and literature cited therein). Here we report a second South American locality for this species from Peru, where it grew on soil.

Specimen examined. **Peru:** Dept. Pasco: Prov. Cerro de Pasco, c. 7 km NE of Cerro de Pasco, alt. c. 3900 m, 10°40'S, 76°14'W, Santesson P29:5 & Moberg (S).

Lepraria lobificans Nyl.

Chemistry. Atranorin (+), zeorin (+) and the stictic acid complex (+). In some specimens a pink spot due to an unknown substance (±) was sometimes found below zeorin.

Notes. For the characteristics of the species see Tønsberg (1992, 2004) and Flakus & Kukwa (2007).

Lepraria lobificans is a common species in South America, especially in temperate and colder regions (e.g. Sipman 2004; Flakus & Kukwa 2007). According to our knowledge, this is the first report of this species from Argentina. The specimens listed here were collected on rock, tree bark, soil and saxicolous bryophytes in forests and semi-desert montane areas.

Specimens examined. **Argentina:** Prov. Tucuman: Dep. Monteros, Río de los Sosas, alt. 1000 m, Digilio-Grassi 912 (S).—**Bolivia:** Dept. Cochabamba: Prov. Carrasco, Carrasco N. P., near Sehuencas village, alt. 2220 m, 17°30'12"S, 65°16'30"W, AF 10479, 10507, 10551, MK 6418 & 6463 & PR (KRAM, LPB, UGDA); 18 km N of Monte Punku village, between Ch'iqta rumi and Phaqcha settlements, alt. 2700 m, 17°27'22"S, 65°16'24"W, AF 10242, MK 6256, 6263 & PR (KRAM, LPB, UGDA); Prov. Nor Yungas, near Pacallo village, alt. 1360 m, 16°12'10"S, 67°50'39"W, AF 11820/1, 11815, 11818, 11828, 11835 & MK 7130, 7133, 7134, 7143, 7145 (KRAM, LPB, UGDA, herb. Flakus).—**Chile:** Prov. Valdivia: Lago Riñihue, Riñihue, Cerro Tralcan, Santesson 3809 (S). *Juan Fernandez Islands:* Caves of the Expelled, near Bahía de Cumberland, Kunkel 336a/22 (B).—**Peru:** Dept. Arequipa: Prov. Caylloma, Cañon del Colca canyon, between Soro and Llahuar villages, alt. 2100 m, 15°34'41"S, 72°01'01"W, MK 6099 (UGDA).

Lepraria nothofagi Elix & Kukwa sp. nov.

Similis speciei *Lepraria lecanorica*, sed acidum porphyriticum et strepsilinum continente differt.

Typus: Argentina, Gobernación del Neuquén, Lago Quillén, on point by the easternmost bend of the lake, on level ground on N shore, *Nothofagus obliqua* forest, on bark of *Nothofagus*, 28 December 1937, A. Kalela 173b (H—holotypus; UGDA—isotypus).

Thallus white to ivory white, in one specimen with a yellowish tinge in part, delimited to obscurely lobed, when young consisting of aggregations of ± loose soredia; *medulla* absent or present in older thalli, thick, but perhaps consisting only of old and bleached soredia, as some algal cells were found among hyphae; *hypothallus* of sparse hyphae attaching the thallus to the substratum, hyphae up to 3.5 µm wide, branched, rarely anastomosing, bare or covered with granules (not apparent in polarized light, insoluble in K, N and acetone) and crystals (up to c. 10 × 5 µm, white in polarized light, insoluble in K and acetone, but soluble in N);

soredia simple or forming consoredia, free-laying or embedded in the medulla; *soredia* up to 90(–150) μm diam., *consoredia* up to c. 180(–250) μm diam.; projecting hyphae present, up to 15(–40) μm long, or absent; soredial wall not complete; *photobiont* chlorococcoid, up to 10 μm diam.

Chemistry. Atranorin (+; major), strepsilin (+; major to minor), porphyritic acid (+; major to minor) and lecanoric acid (+; trace) were detectable by TLC. Two specimens were studied by HPLC, and atranorin (+; major), strepsilin (+; major to minor), porphyritic acid (+; major to minor), lecanoric acid (+; trace), norascomatic acid (\pm ; minor), di-*O*-methylstrepsilin (\pm ; trace), pannaric acid (\pm ; minor) were found. Some soredia reacted C+ green due to the presence of strepsilin.

Notes. This new species is characterized by the white, thick, obscurely lobate and stratified thallus and the production of atranorin, strepsilin, porphyritic acids and a constant trace of lecanoric acid. Morphologically *L. nothofagi* closely resembles *L. lecanorica*, but the latter contains lecanoric acid in high concentrations and lacks strepsilin and porphyritic acid (Tønberg 2004). Chemically, this new species is similar to *L. xerophila* Tønberg, especially to chemotype II due to the presence of strepsilin. That chemotype, however, produces norascomatic acid as a major secondary metabolite, lacks porphyritic and lecanoric acids, and strepsilin occurs always as a minor compound. In chemotype I of *L. xerophila*, pannaric acid 6-methyl ester is always present as the major secondary substance, sometimes together with porphyritic and pannaric acids (Elix & Tønberg 2004; Tønberg 2004). Additionally, the morphology of *L. xerophila* is very different; the thallus can be squamulose to crustose with an effigurate to placodioid margin, the thallus surface bears numerous regular to irregular and deformed, fragile, more or less dorsiventral (sometimes capitate) easily detached lobules which act as diaspores, and a distinct algal layer is present in the thallus (Tønberg 2004).

Strepsilin also occurs in *L. dibenzofuranica* Elix, *L. goughensis* Elix & Øvstedal and *L. multiacida* Aptroot (Elix & Tønberg 2004; Elix *et al.* 2005; Elix & Kalb 2008). *Lepraria dibenzofuranica* has a powdery, whitish green to greenish or bluish grey thallus containing several dibenzofurans (strepsilin in minor or trace amounts), anthraquinones and fatty acids (Elix & Kalb 2008). *Lepraria goughensis* produces lecanoric and gyrophoric acids and anthraquinones in addition to strepsilin and has a powdery thallus but lacks a hypothallus and medulla (Elix *et al.* 2005). *Lepraria multiacida* differs in having a stratified and sometimes lobate thallus containing atranorin, the stictic acid complex, consalazinic and salazinic acids, terpenoids, and some other substances in addition to strepsilin (Aptroot 2002; Elix & Tønberg 2004).

Porphyritic acid is more commonly produced than strepsilin by various *Lepraria* species (Elix & Tønberg 2004; Kukwa & Flakus 2009; Saag *et al.* 2009), and in all cases, the taxa differ significantly in chemistry. In South America two taxa are known to produce porphyritic acid: *L. alpina* and *L. neojackii* Flakus & Kukwa (Flakus & Kukwa 2007). The first species belongs to the *L. neglecta* group and has a coarsely granular thallus, often produces fatty acids and lacks strepsilin (see under that species above). *Lepraria neojackii* has a green-grey, leprose thallus containing porphyritic acid, fatty acids, anthraquinones but lacks atranorin (Flakus & Kukwa 2007).

At present this species is known from several locations near the type locality in Argentina. It has always been found on the bark of *Nothofagus* in forest dominated by *Austrocedrus* or *Nothofagus* species (*N. dombeyi*, *N. obliqua* or *N. pumilio*).

Specimens examined (all paratypes). **Argentina:** *Gobernacion del Neuquen:* Lago Trafal, steep N slope near lake shore, c. 2 km W of the school, alt. 854 m, *Kalela* 52a (H); Lago Lacar, on dry E slope N of San Martin, *Kalela* 197b (H); Lago Quillén, on gentle N slope of S shore of the lake, *Kalela* 178 (H); Lago Quillén, N shore of the lake, *Kalela* 171b (H); Lago Quillén, S of slope of hill at the eastern end of the lake, *A. Kalela* 181b:c (H); Lago Quillén, by the eastern bend of the lake, *A. Kalela* 174e, 177b & 180c (H); Lago Quillén, on level ground on rock at the E end of the lake, *A. Kalela* 187a (H). Lago Trafal, steep slope N of the

school, *A. Kalela* 50d (H, UGDA); Lago Correntoso, on top of little height on the isthmus between Lago Correntoso and Lago Espejo, *A. Kalela* 29h (H, UGDA).

Lepraria pallida Sipman

Chemistry. Atranorin (+), zeorin (+) and two unidentified fatty acids (+).

Notes. For the characteristics of the species see Sipman (2004). Some of the Bolivian specimens appeared juvenile, with only obscurely lobed thalli and a poorly developed hypothallus, being composed mainly of white to grey hyphae. Such material was usually mixed with typical, well-developed specimens.

This species has been reported from South America (Bolivia, Brazil), Madagascar, the Seychelles and Asia (Sipman 2004; Flakus & Kukwa 2007; Kukwa & Flakus 2009). Here it is recorded for the first time from Peru. Specimens cited below were collected on rock, soil, tree bark and saxicolous bryophytes in montane forests.

Specimens examined. **Bolivia:** Dept. Cochabamba: Prov. Carrasco, Carrasco N. P., near Sehuencas village, alt. 2220 m, 17°30'12"S, 65°16'30"W, AF 10387, 10469, 10471, 10473, MK 6462, 6496, 6543 & PR (KRAM, LPB, UGDA); Dept. La Paz: Prov. Nor Yungas, near Pacallo village, alt. 1360 m, 16°12'10"S, 67°50'39"W, AF 11805, 11814 & MK (KRAM, LPB, hb. Flakus).—**Peru:** Dept. San Martín: Prov. San Martín, Cerro Escalera (NE of Tarapoto), NW of the tunnel, alt. c. 1000 m, 06°26'S, 76°15'W, Santesson P74:91 & Thor (S).

Lepraria sipmaniana (Kümmerling & Leuckert) Kukwa

Chemistry. Pannaric acid 6-methylester (+), 4-oxypannaric acid 6-methylester (+), anthraquinones (±), 'vouauxii unknown 1' (±) and traces of unknowns (±).

Notes. For the characteristics of the species see Leuckert & Kümmerling (1991), Sipman (2004) and Flakus & Kukwa (2007).

Recently we revised the specimens of *L. membranacea* (Dicks.) Vain. reported from Chile by Laundon (1989). They are indeed morphologically similar to *L. membranacea*, but contain pannaric acid 6-methylester as

the major dibenzofuran, have distinctly raised lobe margins and possess granules dispersed over the surface; this latter characteristic is typical of *L. sipmaniana*, described several years after Laundon's monograph on the *L. membranacea* group (see Leuckert & Kümmerling 1991). As a consequence, the Chilean records of *L. membranacea* are considered to be erroneous.

Lepraria membranacea has also been reported from Argentina (Calvelo & Liberatore 2002). However, we have not seen this material, and given the distribution of *L. sipmaniana* and *L. membranacea*, the Argentinian records of the latter should be considered as doubtful.

In South America *L. sipmaniana* has been recorded from Brazil, Colombia and Peru (Leuckert & Kümmerling 1991; Flakus & Kukwa 2007). Here it is reported as new to Bolivia and Chile. In the latter localities it grew on soil, rocks and terricolous bryophytes in open, high Andean, semi-desert areas or in montane forests.

Specimens examined. **Bolivia:** Dept. Cochabamba: Prov. Carrasco, Carrasco N. P., near Sehuencas village, alt. 2220 m, 17°30'12"S, 65°16'30"W, MK 6479 (LPB, UGDA).—**Brazil:** Rio de Janeiro: Restinga südlich der Stadt, Mattick 1613 (B).—**Chile:** IX Region: La Araucanía, 5 km NE of Melipeuco, alt. 400–600 m, 38°49'S, 71°40'W, Coppins, Galloway, Guzmán & James 5635 (BM; as *Leproloma membranaceum*). X Region: Parque Nacional Puyehue, Anticura, Los Derrumbes, 40°40'S, 72°10'W, alt. c. 600 m, Coppins, Galloway, Guzmán & James 4643 (BM; as *L. membranaceum*).—**Peru:** Dept. Arequipa: Prov. Caylloma, below Lagunillas pass, alt. 4200 m, 15°54'54"S, 72°10'12"W, AF 10132 & MK (KRAM); Prov. Caylloma, Cañon del Colca canyon, between Soro and Llahuar villages, alt. 2100 m, 15°34'41"S, 72°01'01"W, MK 6097 & 6098 (UGDA). Dept. Huanuco: Prov. Huanuco, valley of Rio Higuera, c. 17 km (road distance) W of Huanuco, alt. 2300 m, 09°55'S, 76°22'W, Santesson P48:9 & Moberg (S). Dept. Junín: Prov. Tarma, c. 10 km (road distance) NNE of Palca, c. 2600 m, 11°18'S, 75°32'W, Santesson P12:60 & Moberg (S, mixed in specimen of *L. diffusa*).

Lepraria squamatica Elix

Chemistry. Squamatic (+) and baeomycetic (+) acids.

Notes. For a description of the species see Elix (2006).

Previously *L. squamatica* was only known from scattered localities in Australia (Elix 2006, 2009), South America (Bolivia) (Flakus & Kukwa 2007) and North America (Lendemer 2008). Here it is reported as new to Peru.

Specimen examined. **Peru:** Dept. San Martín: Prov. Lamas, Cerro Blanco, c. 58 km W-WNW of Tarapoto (road distance), c. 06°25'S, 76°40'W, c. 1000 m, Santesson P73:41 & Thor (S).

***Lepraria stephaniana* Elix, Flakus & Kukwa sp. nov.**

Thallus leprosus, virido- vel flavido-albidus, plerumque non stratosus, elobatus, soredia crassa, cum hyphis filamentosis projectis; acidum salazinicum, zeorinum, 4-*O*-methylleprolominum et terpenum ignotus (Rf A6, B6, C6) continens.

Typus: Bolivia, Dept. La Paz, Prov. Iturralde, between Ixiamas and Santa Rosa de Maravillas villages, alt. 305 m, 13°49'16"S, 68°07'18"W, preandean Amazon forest, on bark of tree, 28 July 2008, *M. Kukwa* 6828 (UGDA-L—holotypus; B, BG, KRAM, LPB, NY, UCR—isotypi).

Paratypes: **Bolivia:** Dept. La Paz: locality as for the holotype, 28 July 2008, *A. Flakus* 11192 & *M. Kukwa* 6852 (CANB, KRAM, UGDA, LPB, herb. Flakus).

Thallus crustose, thick, usually not delimited nor lobed, green-grey to creamy white, not stratified, but sometimes with a poorly differentiated, pseudo-medullary layer of decaying soredia; *hypothallus* indistinct; *soredia* irregularly spreading over the substratum, coarse with soft appearance, irregularly rounded, up to 100(–200) µm diam., composed of very lax hyphae mixed with algal cells, usually with projecting hyphae up to c. 30(–50) µm long; soredial wall incomplete; *photobiont* chlorococcoid, cells up to 12 µm diam.

Chemistry. 4-*O*-methylleprolomin (major), salazinic acid (minor), zeorin (minor) and an unknown terpenoid (minor) with Rf class values A6, B6, C6 were detected in all specimens. Thallus reacts K+ yellow, turning brownish to red, P+ yellow, C–, KC–.

Etymology. The new species is named in honour of the prominent German botanist, Dr. Stephan G. Beck (La Paz), the founder of Herbario Nacional de Bolivia in La Paz,

for his substantial contributions to the knowledge of the Bolivian flora.

Notes. *Lepraria stephaniana* is a very distinctive species characterized by the thick, unstratified and non-lobed thallus composed of coarse soredia with soft appearance, and unique chemistry. This is the first species of the genus known to produce 4-*O*-methylleprolomin as a major secondary substance. This unique diphenyl ether has been previously detected in a *Pannaria* species (A. Elvebakk & J. A. Elix, unpublished).

In addition to *L. stephaniana*, salazinic acid is only known from two other *Lepraria* species, namely *L. multiacida* and *L. salazinicica* Tønsberg (Aptroot 2002; Elix & Tønsberg 2004; Tønsberg 2007). *Lepraria multiacida* can be clearly distinguished by its stratified, often lobate thallus containing numerous substances (stictic, norstictic, connorstictic and consalazinic acids, atranorin and strepsilin) not present in *L. stephaniana* (Aptroot 2002; Elix & Tønsberg 2004). *Lepraria salazinicica*, known only from North America, has smaller soredia (up to 30 µm in diam.) than *L. stephaniana*, and contains additional atranorin and angardianic/roccellic acid (Tønsberg 2007) rather than 4-*O*-methylleprolomin and terpenoids.

The new species has been found in pre-Andean Amazon forest in Bolivia, where large populations were observed on the bark of two trees. So far it is known only from the type locality.

***Lepraria vouauxii* (Hue) R. C. Harris**

Chemistry. Pannaric acid 6-methylester (+), 4-oxypannaric acid 6-methylester (+), 'vouauxii unknown 1' (±, see Tønsberg 1992), atranorin (±) and traces of unknowns (±).

Notes. For descriptions of the species see Elix & Tønsberg (2004), Flakus & Kukwa (2007) and Saag *et al.* (2009).

Lepraria vouauxii is a widely distributed, but still under-recorded species known from

various substrata (see e.g. Laundon 1989; Leuckert & Kümmerling 1991; Tønsberg 1992, 2004; Kukwa & Flakus 2007, 2009; Elix 2009). Here new records from Bolivia, Chile, Ecuador and Peru are added.

Specimens examined. **Bolivia:** Dept. La Paz: Prov. Franz Tamayo, W of La Paz city near Ulla Ulla village, Mt. Puntani, PR 565 (LPB).—**Chile:** Terr. Magallanes: Lago del Toro (L. Maravilla), Estancia Rio Payne, above the river, Santesson 6594 (S).—**Ecuador:** Prov. León: Railway station Cotopaxi, alt. 3550 m, *Asplund* L63 (S); Prov. Pichincha: c. 25 km N of Quito, S-side of Pululagua caldera, alt. 2750–2800 m, *Palice* 3761 & *Soldán* (PRA); Prov. Cotopaxi: Cotopaxi N. P., NNE slope of Volcán Cotopaxi, alt. 4200–4250 m, 00°39' S, 78°25' W, *Palice* 4604 (PRA).—**Peru:** Prov. Canchis: Sibinacocha, Murmurani sector, W of la Laguna Sibinacocha, PR 566a, 566b (LPB). Dept. Arequipa: Prov. Caylloma, Cañon del Colca canyon, between Soro and Llahuar villages, alt. 2100 m, 15°34'41" S, 72°01'01" W, AF 10135, 10139 & MK 6107, 6108 (KRAM, UGDA). Dept. Cuzco: prov. Urubamba, valley of Rio Piri, 22 km (road distance) c. NW of Ollantaytambo, alt. 3400 m, 13°06' S, 72°22' W, Santesson P86: 17 (S). Dept. Lima: Prov. Huarochiri, valley of Rio Santa Eulalia, NE of Carampoma, alt. c. 3700 m, 11°38' S, 76°27' W, Santesson P24: 5 & R. Moberg (S). Dept. Junín: Prov. Tarma, c. 10 km (road distance) NNE of Palca, alt. c. 2600 m, 11°18' S, 75°32' W, Santesson P12: 60 & Moberg (S, mixed in specimen of *L. diffusa*).

Lepraria yunnaniana (Hue) Zahlbr.

Syn. *Lepraria nigrocincta* Diederich et al., *Bibliotheca Lichenologica* 64: 78 (1997).

Chemistry. Divaricatic acid.

Notes. For the characteristics of the species see Aptroot et al. (1997), Laundon (2008) and Kukwa & Flakus (2009).

Lepraria yunnaniana is known from numerous localities in Africa, Asia, Australia, Papua New Guinea, Central America (Costa Rica) and South America (Bolivia, Ecuador) (e.g. Aptroot et al. 1997; Aptroot & Feijen 2002; Kukwa 2006a; Elix 2007, 2009; Nöske et al. 2007; Laundon 2008; Nelsen & Gargas 2008; Kukwa & Flakus 2009). Here it is reported for the first time from Colombia, from humid montane forest, where it grew on moribund bryophytes.

Specimen examined. **Colombia:** Depto. del Antioquia: Municipio de Medellín, c. 14.5 km SE de Medellín hacia Rionegro, c. 06°10' N, 75°30' W, elev. 2000 m, *Sastre-De Jesús & Churchill* 898 (B).

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