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

Adam FLAKUS and Martin KUKWA

Abstract: New records of 15 *Lepraria* species from South America are presented. Two species are newly described from the Bolivian Andes: *Lepraria achariana* Flakus & Kukwa (major compounds: lecanoric, angardianic/roccellic acids and anthraquinones) and *L. neojackii* Flakus & Kukwa (major compounds: porphyrilic, angardianic/roccellic, *cf.* rangiformic acids and anthraquinone). *Lepraria impossibilis*, *L. lecanorica* and *L. rigidula* are reported as new for the Southern Hemisphere, *L. alpina*, *L.* aff. *caesiella* and *L. squamatica* as new to South America, and other species as new to several countries (Argentina, Bolivia, Brazil, Peru, Uruguay). In addition, two putative, undescribed species are discussed. Chemistry, ecology and general information concerning distribution of the species are presented, and the differentiation of some critical taxa discussed. A provisional key to *Lepraria* in South America is provided.

Key words: biogeography, *Lepraria* key, lichenized fungi, Neotropics, new species, South America, taxonomy.

Introduction

The genus *Lepraria* Ach. is widely distributed in the world and comprises permanently sterile lichenized fungi with a leprose to byssoid thallus and entirely sorediate surface. For a long time it was much neglected, but the recent use of secondary metabolites along with the very recent application of molecular studies in taxonomy have intensified interest in the genus (e.g. Laundon 1989, 1992; Tønsberg 1992; Leuckert *et al.* 1995; Ekman & Tønsberg 2002; Bayerová *et al.* 2005). In addition, the intensification of research in poorly studied areas has resulted in the description of many new taxa (e.g. Orange *et al.* 2001*a*; Sipman 2004; Tønsberg 2004, 2007; Orange & Wolseley 2005; Knudsen & Elix 2007; Lendemer & Harris 2007). At present *c.* 50 species have been described worldwide.

Hitherto, *Lepraria* species have been assumed to be rare in South America because few taxa have been reported (e.g. Sipman 2004; Feuerer 2006). The present study clearly shows that this group is much more common, especially in mountainous areas. In this paper 15 species are presented, 2 of which are new to science, 3 are new to the Southern Hemisphere and 3 are reported for the first time for South America. Altogether, 19 species are now known from South America.

The aim of this paper is to contribute to the knowledge of *Lepraria* in South America, and to stimulate further research on this poorly known genus. For that reason we provide a provisional identification key for all taxa reported so far from the continent. In the key we include some taxa which we suspect may occur in South America, and also the recently recorded *Lecanora leuckertiana* Zedda (see Flakus *et al.* 2006), which probably belongs to *Lepraria*.

A. Flakus: Laboratory of Lichenology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. Email: ibflakus@ib-pan.krakow.pl
M. Kukwa: Department of Plant Taxonomy and Nature Conservation, University of Gdańsk, Al. Legionów 9, PL-80-441 Gdańsk, Poland.

Material and Methods

Most of the specimens examined were collected by the first author in Bolivia and Peru (2004–2006) and are deposited in KRAM (Krakow), with duplicates donated to LPB (La Paz) and UGDA (Gdansk). Some additional specimens were requested on loan from BM (London), GZU (Graz) and H (Helsinki). The abbreviation *F* in specimens examined denotes *A. Flakus*.

Morphology was studied using a stereomicroscope, and the anatomy was examined by light microscopy on squash preparations mounted in water or KOH solution (K) with or without pre-treatment with acetone. The measurements of soredia were made in water.

Chemical analyses were carried out using thin layer chromatography (TLC). Methods follow Orange *et al.* (2001*b*). 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. When the substance was always present it is marked with (+), but if the metabolite was absent from some specimens (±) is used.

Results

Lepraria achariana Flakus & Kukwa sp. nov.

Thallus leprosus, non stratosus, effusus, virido-albidus vel virido-griseus; soredia farinosa; acidum lecanoricum, anthraquinones et acidum angardianicum/roccellicum (±) continens.

Typus: Bolivia, Dept. La Paz, Prov. Manco Kapac, Mt. Horca del Inca near Copacabana village, alt. 3974 m, 16°10′15″S, 69°05′05″W, high Andean Puna vegetation, on rock, 18 June 2006, *A. Flakus* 8670 (KRAM-L—holotypus).

Paratypes: **Bolivia:** *Dept. Cochabamba*: Prov. Chapare, near Incachaca village, alt. 2400 m, 17°14′17″S, 65°48′54″W, *F* 7904 (UGDA); *Dept. La Paz*: Prov. Murillo, near Cumbre pass, alt. 4604 m, 16°21′59″S, 68°02′37″W, *F* 5788 & 5809 (KRAM, LPB); upper part of valley under the Mt. Chackaltaya, alt. 4980 m, 16°20′41″S, 68°08′10″W, *F* 4452/1 & 4453 (KRAM, LPB).

Thallus thin, leprose, not delimited and not lobate, green-grey to greyish, medulla not differentiated; hypothallus white, or in parts orange due to the presence of anthraquinones, usually well-developed, but of non densely packed hyphae; soredia rounded, up to 45 µm diam., usually in consoredia up to 75 µm (–150 µm); soredial wall rather well developed, but not complete, usually without, but rarely with few projecting hyphae up to 10 µm long; soredia (consoredia) at the thallus margin and those lying loose on the substratum with long projecting hyphae from the lower surface; photobiont chlorococcoid, up to 13 µm, sometimes with autospores visible inside.

Chemistry. Lecanoric (+) and angardianic/roccellic acids (±) and 2–4 anthraquinones (±) of which the two most highly concentrated have the following Rf class values: A7, B6, C8 and A5–6, B5–6, C5. Thallus C+ carmine red, P−, mostly K−, but orange patches on lower side of thallus K+ purple due to the presence of anthraquinones.

Etymology. This new species is dedicated to Swedish lichenologist Eric Acharius, the 'father of lichenology', who described the genus *Lepraria*.

Notes. Lepraria achariana is a very distinct taxon characterized by the non-lobate, farinose thallus producing lecanoric acid as a main diagnostic substance. Additionally, the species may contain angardianic/roccellic acid and/or anthraquinones, but only in two (including the type) of the six specimens examined were all substances present. In one specimen only lecanoric acid was detected.

Lecanoric acid is known also in *L. atrotomentosa* Orange & Wolseley, *L. goughensis* Elix & Øvstedal, *L. impossibilis* Sipman and *L. lecanorica* Tønsberg. All these taxa differ in their chemistry, as *L. atrotomentosa* additionally produces atranorin and zeorin, *L. goughensis* gyrophoric acid and strepsilin, *L. impossibilis* pannaric acid-6-methylester with related metabolites and *L. lecanorica* atranorin (Elix *et al.* 2005; Orange *et al.* 2001*a*; Tønsberg 2004; Sipman 2004). There are also morphological differences. *Lepraria atrotomentosa* has a well-developed layer of blue-grey to almost black hyphae on the lower side of thallus, *L. goughensis* does not possess any hypothallus and *L. impossibilis* and *L. lecanorica* develop thick rosette-like thalli, sometimes with poorly developed lobes (see literature cited above).

Ecology and distribution. *Lepraria achariana* is so far known only from four Bolivian localities. The species was found on humus,

terricolous bryophytes and rocks in open areas of high Andean Puna vegetation and upper montane cloud forest.

Lepraria alpina (de Lesd.) Tretiach & Baruffo

in Baruffo *et al.*, *Nova Hedwigia* **83:** 390 (2006).—*Crocynia alpina* de Lesd., *Bull. Soc. Bot. France* **61:** 85 (1914).

Chemistry. All specimens contained atranorin (+) and porphyrilic acid (+) with angardianic/roccellic acid (±) and an unidentified fatty acid (±) (appearing below the latter on TLC plates) in two specimens (*Flakus* 5732 & 5792).

Notes. The species is a member of the *L. neglecta* group, which is characterized by a granular thallus, frequent production of rangiformic and angardianic/roccellic acids and occurrence in rain-exposed habitats (Tønsberg 1992; Leuckert *et al.* 1995). It can be distinguished from all similar taxa in this group by the presence of porphyrilic acid in the thallus (e.g. Tønsberg 1992; Leuckert *et al.* 1995). Our specimens have a slightly more powdery appearance than those examined from Europe. The South American material may belong to an as yet undescribed species, but this needs more extensive studies on better material.

The name *L. cacuminum* (A. Massal.) Lohtander was previously in use for this species, but it was shown to be a synonym of *Buellia insignis* (Hepp) Th. Fr. (Baruffo *et al.* 2006).

Distribution and ecology. Lepraria alpina has not previously been reported from South America.

In the study area it was found on siliceous schist (sometimes containing calcium carbonate, HCl+) and terricolous bryophytes in high Andean Puna vegetation. The species has been found elsewhere on soil, rocks and bryophytes over those substrata, but it has also been recorded from tree bark (Tønsberg 1992; Lohtander 1995; Kukwa 2006*a*).

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, East Cordillera, near Cumbre pass, alt. 4550-4672 m, 16°19′18″–16°21′59″S, 68°02′20″–68°04′42″W, *F* 5732, 5735, 5736, 5737, 5792, 5793, 5797, 5806 & 8593 (KRAM, LPB, UGDA).

Lepraria aff. caesiella R. C. Harris

in Lendemer, *Opuscula Philolichenum* **2:** 52 (2005).

Chemistry. Atranorin (+), zeorin (+), unidentified fatty acid (+) and an unidentified substance were found in the specimen.

Notes. The species has been recently described from North America (Lendemer 2005). It has a leprose, non-delimited thallus, soredia without long projecting hyphae and produces atranorin and zeorin. Our specimen agreed in many respects with that taxon, but we are reluctant to ascribe it to *L. caesiella* with certainty as the specimen was rather fragmentary and not well preserved.

Distribution and ecology. Our specimen was growing on wood. In North America *L. caesiella* is mainly a corticolous lichen, rarely occurring on wood and rocks (Lendemer 2005).

Specimens examined. **Chile:** *Prov. de Nűble*: Chillán Bureo, 1931, *Barros* s.n. (H). In addition 10 specimens of *L. caesiella* were examined for comparison, including the holotype (seen at BG) and isotypes (in B, H and UGDA).

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

Lichenologist **24:** 32 (1992).—*Crocynia caesioalba* de Lesd., *Bull. Soc. Bot. France* **61:** 84 (1914).

Chemistry. Two chemical strains have been found in the material studied: chemotype I with atranorin (+), angardianic/roccellic acid (+) and fumarprotocetraric acid (+) with protocetraric acid (±); and chemotype III with atranorin (+), angardianic/roccellic acid (±; lacking in *Flakus* 5787), psoromic acid (+) and 2′-*O*-demethylpsoromic acid (+, trace) (see Leuckert *et al.* 1995).

Notes. Lepraria caesioalba belongs to the *L. neglecta* group and seems to be non-

monophyletic at species level (Ekman & Tønsberg 2002). As there are no names available for some lineages, we treat our specimens under *L. caesioalba*. Chemotypes I and III seem to be especially phylogenetically closely related (see Ekman & Tønsberg 2002) and may represent one taxon. More studies are required, however, before the final conclusions can be drawn.

Distribution and ecology. In South America *L. caesioalba* has been previously recorded only from Colombia and Peru (Sipman 2004). Here we report the species as new to Argentina and Bolivia.

In the study area the species was found growing on terricolous bryophytes, soil, small stones and siliceous schist containing calcium carbonate (HCl+) mainly in high Andean Puna vegetation.

Specimens examined. **Argentina:** *Gobernación del Neuquén*: Lago Aluminé, alt. c. 1350 m, *Kalela* 167a (H; chemotype I). *Tierra del Fuego*: Dept. Ushuaia, Montes Martial bei Ushusia, oberhalb Acrosilla, alpine Heiden und Rasen, Moore, Silikatfelsen im Krummholzbereich, S- und SE Hänge, 700–1000 m, *Poelt* s.n. (GZU; chemotype I); Dept. Rio Grande, N-Rand der Anden, Cerro Chenen E Hacienda Chenen, felsinger NE-Hang, 200–230 m (über verlassener Cabana), *Poelt* s.n. (GZU; chemotype I).—**Bolivia:** *Dept. La Paz*: Prov. Murillo, East Cordillera, valley under Chackaltaya Mt., alt. 4550 m, 16°19′18″S, 68°04′42″W, *F* 8589, 8590 & 8604 (KRAM, LPB; chemotypes I and III); *ibid*., near Cumbre pass, alt. 4604–4672 m, 16°20′14″–16°21′59″S, 68°02′20″–68°02′37″W, *F* 5734, 5739 & 5787 (KRAM, LPB, UGDA; chemotype III).

Lepraria ecorticata (J. R. Laundon) Kukwa

Mycotaxon **97:** 64 (2006).—*Lecanora ecorticata* J. R. Laundon, *Nova Hedwigia* **76**: 100 (2003).

Chemistry. Usnic acid (+), zeorin (+) and traces of unknown terpenoids (±) were found. Additionally, one Peruvian specimen (*Flakus* 9529) contained atranorin and two Bolivian specimens (*Flakus* 8587 & 8601) porphyrilic acid. The last substance has not been reported from the species before (Laundon 2003; Kukwa 2006*b*).

Notes. *Lepraria ecorticata* is characterized by the presence of usnic acid and zeorin, a thick, non-lobate thallus lacking a medulla, and soredia well separated from one another (Kukwa 2006*b*). These features make the species distinct from the chemically very similar *Lecanora leuckertiana*, *Lepraria coriensis* (Hue) Sipman and *L. usnica* Sipman (Sipman 2004; Kukwa 2006*b*).

Distribution and ecology. So far *L. ecorticata* has been reported in South America only from Chile (Kukwa 2006*b*). Here it is reported from Bolivia, Brazil and Peru for the first time.

The specimens studied were collected from siliceous rocks, saxicolous bryophytes and moribund lichens, from high Andean vegetation to lowland Amazon forest. In the Northern Hemisphere it has also been reported from tree bark (Kukwa 2006*b*).

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, East Cordillera, near Cumbre pass, alt. 4550 m, 16°19′18″S, 68°04′42″W, *F* 8587 & 8601 (KRAM, LPB). *Dept. Beni*: Prov. Vaca Diez, Cachuela Esperanza village, alt. 128 m, 10°32′09″S, 65°34′55″W, *F* 7499 (KRAM, LPB).—**Brazil:** RS. Mun. Osório, W da cidade, *Ahti* 64, *Stenroos, Fleig & Medeiros* (H).—**Peru:** *Dept. Arequipa*: Prov. Caylloma, by Cañon del Colca, near Cabanaconde village, alt. 3462 m, 15°37′56″S, 71°57′49″W, *F* 9528, 9529 & 9530 (KRAM, UGDA); Cañon del Colca, above Tapay village, alt. 3705 m, 15°33′56″S, 71°55′32″W, *F* 9690 & 9691 (KRAM).

Lepraria impossibilis Sipman

Herzogia **17:** 30 (2004).

Chemistry. Pannaric acid-6-methylester (+), 4-oxypannaric acid-6-methylester (+), lecanoric acid (+), 'vouauxii unknown 1' (±) (for the characteristics of the substance see Tønsberg 1992), unidentified anthraquinones (±) and atranorin (±, trace). In three specimens containing anthraquinones lower parts of thalli reacted K+ purplish.

Notes. The species is characterized mainly by the co-occurrence of lecanoric acid and pannaric acid-6-methylester with related substances (Sipman 2004). When the species was first described, Sipman (2004) found only pannaric acid-6-methylester, lecanoric acid and atranorin (in trace), but at

that time only the type collection was known. Analyses of 16 new specimens showed the species to contain also 4-oxypannaric acid-6-methylester, commonly 'vouauxii unknown 1' and traces of unidentified anthraquinones (in three specimens only). The species is also more variable in the thallus colour than previously known, as it ranges from greenish grey, as in the type collection (Sipman 2004), to grey-brown with an orange tinge.

Lepraria impossibilis is both chemically and morphologically very similar to *L. vouauxii*, but the latter taxon does not contain lecanoric acid (e.g. Tønsberg 1992; Sipman 2004). *Lepraria sipmaniana* also produces similar dibenzofurans, but that species lacks lecanoric acid and has a broadly lobate thallus (Sipman 2004). On the other hand, the production of lecanoric acid makes *L. impossibilis* similar to *L. achariana*, *L. goughensis*, *L. lecanorica* and the Asiatic *L. atrotomentosa*, but these taxa do not contain substances related to pannaric acid-6-methylester (Orange *et al.* 2001*a*; Sipman 2004; Tønsberg 2004; Elix *et al.* 2005).

Distribution and ecology. *Lepraria impossibilis* was previously known from El Salvador only (Sipman 2004). Here it is reported for the first time for the Southern Hemisphere from Bolivia, Chile and Peru.

The species has a wide ecological amplitude, as it was found on terricolous and saxicolous bryophytes, soil, humus, siliceous rock, schist and tree bark, mainly in open high Andean vegetation.

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, East Cordillera, valley below Chackaltaya Mt., alt. 4550–4980 m, 16°19′18″–16°21′59″S, 68°02′37″–68°08′10″W, *F* 4453/2, 4456 5788/1, 5789, 5790, 5796, 5803, 5804, 5805, 5807, 8591 & 8594 (KRAM, LPB, UGDA); Prov. Manco Kapac, Horca del Inca Mt., near Copacabana village, alt. 3974 m, 16°10′15″S, 69°05′05″W, *F* 8671 (KRAM). *Dept. Cochabamba*: Prov. Chapare, the East Cordillera, near Incachaca village, alt. 2400 m, 17°14′17″S, 65°48′54″W, *F* 7903 (KRAM, LPB).—**Chile:** *V Region*: Parque Nacional La Campana, alt. 1200 m, 32°56′S, 71°08′W, *Nothofagus obliqua* forest, *Coppins* 4801, *Galloway, Guzmán & James* (BM); Concepción village, *Barros* 72 (H).—**Peru:** *Dept. Arequipa*: Prov. Caylloma, Valle del Colca valley, near Soccoro village, alt. 3349 m, 15°38′32″S, 71°43′22″W, *F* 9417 & 9418 (KRAM).

Lepraria incana (L.) Ach.

Method. Lich.: 4 (1803).—*Byssus incana* L., *Spec. Plant.* **2:** 1169 (1753).

Chemistry. Divaricatic acid (+) and zeorin (+) were found in our specimen.

Notes. It is characterized by the non-lobate thallus and production of divaricatic acid and zeorin, sometimes with traces of nordivaricatic acid (Laundon 1992; Tønsberg 1992; Leuckert *et al.* 1995). *Lepraria nigrocincta* Diederich, Sérusiaux & Aptroot is the only other taxon known to have similar chemistry in the tropics, but it does not produce zeorin and has a very different thallus structure with a rather dense, partly blackish hypothallus (Aptroot *et al.* 1997).

Distribution and ecology. In South America it has previously been reported from Colombia only (Kümmerling *et al.* 1991). Here it is reported as new to Bolivia. *Lepraria incana* has very few records from the Southern Hemisphere, but it is a widely distributed lichen in the Northern Hemisphere (e.g. Kümmerling *et al.* 1991; see also Kukwa 2006*a*).

In Bolivia the species was growing on trunk and bryophytes over a tree fern in high Andean Yungas cloud forest. In Europe the species has a wide habitat amplitude and grows on almost all types of substrata (e.g. Kümmerling *et al.* 1991; Tønsberg 1992; Kukwa 2006*a*).

Specimen examined. **Bolivia:** *Dept. Santa Cruz*: Prov. Caballero, East Cordillera, La Palma village, alt. 2582 m, 17°49′12″S, 64°40′28″W, *F* 4560 (KRAM, LPB, UGDA).

Lepraria lecanorica Tønsberg

in Nash *et al.* (eds), *Lichen Flora of the Greater Sonoran Desert Region* **2:** 326 (2004).

Chemistry. Lecanoric acid (+) and atranorin (+) were detected in three specimens examined.

Notes. The species is characterized by the delimited, whitish thallus and always produces lecanoric acid and atranorin only (Tønsberg 2004). *Lepraria achariana*, *L. atrotomentosa*, *L. goughensis* and *L. impossibilis* also contain lecanoric acid, but they differ morphologically and chemically (see under *L. achariana* and *L. impossibilis*).

Distribution and ecology. *Lepraria lecanorica* has been reported only from North America so far. Here it is reported as new to the Southern Hemisphere from Bolivia and Chile.

The specimens studied grew on siliceous rock containing calcium carbonate (HCl+) and on bark of *Nothofagus obliqua*. In North America *L. lecanorica* is an epiphyte (Tønsberg 2004).

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, East Cordillera, near Cumbre pass, alt. 4550 m, 16°19′18″S, 68°04′42″W, *F* 8595 (KRAM, LPB).—**Chile:** *V Region*: Parque Nacional La Campana, alt. 1200 m, 32°56′S, 71°08′W, *Coppins* 6024, *Galloway, Guzmán & James* (BM).

Lepraria lobificans Nyl.

Flora **56:** 196 (1873).

Chemistry. The specimens always contained atranorin (+), zeorin (+) and the stictic acid complex (+) with stictic and constictic acids as major substances.

Notes. *Lepraria lobificans* is characterized by an obscurely lobed, woolly thallus with a very conspicuous medulla-like layer, soredia bearing long projecting hyphae and production of atranorin, zeorin and the stictic acid complex (Tønsberg 1992, 2004; Kümmerling *et al.* 1993; Sipman 2004; Kukwa 2006*a*). *Lepraria elobata* Tønsberg is chemically identical, but differs in its nonlobate, leprose thallus, soredia without projecting hyphae and distinctly separated from each other. So far *L. elobata* is not known from South America. Two additional taxa produce atranorin and the stictic acid complex, *L. multiacida* Aptroot known from Brazil (Aptroot 2002) and *L. leprolomopsis* Diederich & Sérus. described from Papua New Guinea (Aptroot *et al.* 1997). They are most easily separated by their chemistry, as the former additionally contains salazinic and consalazinic acids and the latter produces an unidentified terpenoid instead of zeorin (Aptroot *et al.* 1997; Aptroot 2002).

Distribution and ecology. *Lepraria lobificans* seems to be widespread in the tropics (Sipman 2004). Here it is reported for the first time from Bolivia and Uruguay.

The specimens examined were collected on siliceous schist, humus soil, bryophytes and a thin layer of soil on an overhanging boulder; they grew in high Andean vegetation, mountain cloud forest and lowlands. The species has a wide ecological amplitude and grows also on other substrata (see Sipman 2004; Kukwa 2006*a*).

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, East Cordillera, near Cumbre pass, alt. 4604 m, 16°21′59″S, 68°02′37″W, *F* 5795 (KRAM, LPB). *Dept. Beni*: Prov. Chapare, near Incachaca village, alt. 2198–2400 m, 17°14′09″–17°14′17″S, 65°48′51″–65°49′02″W, *F* 7867, 7896, 7871, 8360 with *Cykowska*, 8382 & 8596 (KRAM, LPB, UGDA).—**Uruguay:** *Dept. Minas*: Sierra Arequita, alt. 120–300 m, 1932, *Blühend & Fruchtend* s.n. (H).

Lepraria neojackii Flakus & Kukwa sp. nov.

Thallus leprosus, non stratosus, effusus, virido-albidus; soredia farinosa; a *Lepraria jackii* acido porphyrilico, anthraquinonibus, acido angardianico/roccellico (+) et *cf.* acido rangiformico differt; atranorinum nullum.

Typus: Bolivia, Dept. Cochabamba, Prov. Chapare, near Incachaca village, alt. 2400 m, 17°14′17″S, 65°48′54″W, upper mountain cloud forest, on decaying bryophytes and humus, 10 June 2006, *A. Flakus* 7902 (KRAM-L—holotypus; LPB, UGDA—isotypi).

Thallus thin to quite thick, green-grey, leprose, not delimited, not lobed, usually stratified, hypothallus entirely whitish or partly orange due to anthraquinones; medulla absent but sometimes with pseudomedulla of bleached and dead soredia mixed with hypothallus hyphae; soredia rounded, up to 20 μm diam., sometimes formed by only one algal cell surrounded by mycobiont hyphae, simple or in consoredia up to 40 μm; soredial wall rather poorly developed, completed, usually without but rarely with a few projecting hyphae, up to *c.* 5 μm

long; photobiont chlorococcoid, up to 10 µm.

Chemistry. Porphyrilic (+), angardianic/roccellic (+) and *cf*. rangiformic acids (+) and anthraquinones (+) with the following Rf class values: A7, B6, C7–8 have been detected in the thallus.

Etymology. The name '*neojackii*' refers to the first impression that the specimen was similar to *L. jackii* Tønsberg.

Notes. This new species belongs to the morphologically quite uniform group of taxa with pale, diffuse, finely granular thalli containing fatty acids. This group comprises *L. atlantica* Orange, *L. celata* Slavíková, *L. humida* Slavíková & Orange, *L. jackii*, *L. sylvicola* Orange, *L. toensbergiana* Bayerová & Kukwa and a putative taxon known from Russia (Tønsberg 1992; Orange 2001; Kukwa *et al.* 2003; Bayerová *et al.* 2005; Slavíková-Bayerová & Orange 2006; M. Kukwa, unpublished). None of these taxa has been reported from S America so far. *Lepraria neojackii* can be very easily separated from all similar taxa by the chemistry: the absence of atranorin, the presence of porphyrilic acid, two fatty acids and anthraquinone. This combination of substances has never been reported in any species. Also the sizes of soredia and consoredia are smaller than those reported for other taxa.

One can argue that *L. neojackii* is only a chemotype of another taxon as the differences are not very significant. Other recently described taxa such as *L. celata* and *L. sylvicola*, were also considered to be only chemical races of *L. jackii*, and not deserving species status; however, when molecular methods were applied, it was proved that the rank of species is most appropriate (e.g. Slavíková-Bayerová & Orange 2006). There are only minor chemical and morphological features distinguishing these species from *L. jackii*, but these features, especially the type of fatty acids, appear to be taxonomically significant. Therefore, considering the differences in morphology, chemistry and distribution of *L. neojackii*, in our opinion it deserves to be described as a new species.

The material of *L. neojackii* is very similar to some muscicolous specimens of *L. achariana*, but these two species can be easily separated by the presence of porphyrilic acid and lecanoric acid, respectively. *Lepraria neojackii* is quite similar in thallus characters to *L. incana*; both species having rather densely packed soredia. *Lepraria incana*, however, differs in having larger soredia and by the presence of divaricatic acid and zeorin (e.g. Tønsberg 1992).

Distribution and ecology. The species has been found on bryophytes, on humus and on rocks. It was collected in mountain cloud forest. So far the species is known only from the type collection.

Lepraria pallida Sipman

Herzogia **17:** 31–32 (2004).

Chemistry. Atranorin (+), zeorin (+) and an unidentified fatty acid (+) were detected in examined specimens. In addition, the Brazilian specimen contains an unidentified terpenoid.

Notes. This species differs from other lobate *Lepraria* species with a black, tomentose hypothallus by the presence of atranorin and zeorin (Sipman 2004). *Lepraria caesiella* also produces these substances, but it can be easily distinguished by its non-lobate, diffuse thallus (Lendemer 2005).

Distribution and ecology. So far this species was known only from Brazil in South America (Sipman 2004). Here it is reported as new to Bolivia and a new locality from Brazil is also recorded.

Sipman (2004) reported the species to occur on rocks and tree bark. Specimens presented here were collected on humus, soil and a thin layer of soil over rock.

Specimens examined. **Bolivia:** *Dept. Cochabamba*: Prov. Chapare, East Cordillera, near Incachaca village, alt. 2400 m, 17°14′17″S, 65°48′54″W, *F* 7901 & 7906 (KRAM, LPB, UGDA).—**Brazil:** *Minas Gerais*: Lima Duarte, Parque Estadual do Ibitipoca, alt. c. 1270 m, 21°40′S, 43°55′W, *Stenroos* 3862a, *Ahti, Krieger & Marcelli* (H).

Lepraria rigidula (de Lesd.) Tønsberg

Sommerfeltia **14:** 205 (1992).—*Crocynia rigidula* de Lesd., in Hue, *Bull. Soc. Bot. France* **71:** 331–332 (1924).

Chemistry. This species produces atranorin (+) and nephrosteranic (+) acid. One specimen (*Flakus 8592*) also contained traces of anthraquinones, but that could have been due to contaminants.

Notes. *Lepraria rigidula* is characterized by a more or less whitish thallus, soredia with projecting hyphae and by the production of nephrosteranic acid (Tønsberg 1992). This is the only *Lepraria* with that substance known so far, and that makes it very distinct from all other taxa.

Distribution and ecology. The species is reported here as new to South America. To our knowledge it has never been reported before from the Southern Hemisphere.

All the specimens examined from South America came from schist, and terricolous and saxicolous bryophytes in high Andean vegetation. In Europe the species is usually an epiphyte (Tønsberg 1992; Kukwa 2006*a*).

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, the East Cordillere, near Cumbre pass, alt. 4550–4604 m, 16°19′18″–16°21′59″S, 68°02′37″–68°04′42″W, *F* 5786, 5794, 5801, 5808, 8592 & 8597 (KRAM, LPB, UGDA); Prov. Manco Kapac, Horca del Inca Mt. near Copacabana village, alt. 3974 m, 16°10′15″S, 69°05′05″W, *F* 8672 (KRAM).

Lepraria sipmaniana (Kümmerling & Leuckert) Kukwa

Ann. Bot. Fennici **39:** 226 (2002).—*Leproloma sipmanianum* Kümmerling & Leuckert, *Nova Hedwigia* **52:** 27 (1991).

Chemistry. Pannaric acid-6-methylester (+), 4-oxypannaric acid-6-methylester (+, trace), anthraquinones (+) and 'vouauxii unknown' 1 (+) (see Tønsberg 1992) were detected. The last substance has not been previously reported from this species.

Notes. This tropical taxon is characterized mainly by the prominent lobes with raised margins, rather smooth surface with few granules and the production of pannaric acid-6-methylester as the main substance (Leuckert & Kümmerling 1991; Sipman 2004). *Lepraria membranacea* (Dicks.) Vain. is the only morphologically similar taxon containing dibenzofurans, but it can be distinguished by the production of pannaric acid as a diagnostic metabolite (Laundon 1989; Leuckert & Kümmerling 1991). In South America, *L. membranacea* has only been recorded from Chile (Laundon 1989).

Distribution and ecology. Here we present the first record of *L. sipmaniana* from Peru. So far the species has been collected from El Salvador, Columbia, Brazil and Venezuela in the Americas, southern Africa, Sri Lanka and Taiwan (Leuckert & Kümmerling 1991; Sipman 2004).

Our sample was found on siliceous rock and soil in high mountain vegetation of semi-desert inter-Andean valleys. The species has also been reported on tree bark and plant remains (Leuckert & Kümmerling 1991; Sipman 2004).

Specimen examined. **Peru:** *Dept. Arequipa*: Prov. Caylloma, Cañon del Colca canyon, below Tapay village, alt. 2774 m, 15°35′07″S, 71°56′37″W, *F* 9665 (KRAM, LPB, UGDA).

Lepraria squamatica Elix

Australasian Lichenology **58:** 20 (2006).

Chemistry. The specimens contained squamatic (+) and baeomycetic (+) acids and traces of 2 unknowns (probably contaminants).

Notes. This is the only *Lepraria* species containing squamatic and baeomycetic acids, which makes the taxon very distinct (Elix 2006).

Distribution and ecology. So far the species has been known only from Australia (Elix 2006). This record is the first one from South America.

Our specimens were epiphytic in the high Andean Yungas cloud forest. The altitude reported below is the highest known for this species so far. In Australia the species was also collected on wood and rocks in humid forests to open woodland (Elix 2006).

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Caballero, East Cordillera, Siberia region near La Palma village, alt. 2582 m, 17°49′12″S, 64°40′28″W, *F* 4703 & 4657/1 (KRAM, LPB).

Lepraria vouauxii (Hue) R. C. Harris

in Egan, *Bryologist* **90:** 163 (1987).—*Crocynia vouauxii* Hue, *Bull. Soc. Bot. France* **71:** 392 (1924).

Chemistry. Pannaric acid-6-methylester (+), 4-oxypannaric acid-6-methylester (+) and usually a substance named 'vouauxii unknown 1' (±). Some specimens also contained anthraquinones, unidentified substances and/or a trace of atranorin. In two specimens (*Flakus 7872 & 8673*) roccellic acid was detected and in one (*Flakus 8381*) zeorin, but the latter might be only a contaminant.

Notes. There are only two other *Lepraria* taxa containing pannaric acid-6-methylester as the main diagnostic substance, *L. impossibilis* and *L. sipmaniana*. *Lepraria impossibilis* is morphologically very similar to *L. vouaxii*, but differs in the presence of lecanoric acid. *Lepraria sipmaniana* is almost identical chemically, but differs in the broadly lobate thallus (Sipman 2004; see also notes under these taxa above).

Distribution and ecology. In South America *L. vouauxii* has been reported from Ecuador and Peru (Laundon 1989; Leuckert & Kümmerling 1991). Here it is reported as new to Bolivia.

Specimens included in this study were collected from siliceous to calcareous rocks, humus, soil, saxicolous and terricolous bryophytes, occurring in open high Andean situations and mountain cloud forest. In general, the species has a rather wide ecological amplitude and was found on many different substrata (Laundon 1989; Tønsberg 1992; Kukwa 2006*a*).

Specimens examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, East Cordillera, near Cumbre pass, alt. 4672 m, 16°20′14″S, 68°02′20″W, *F* 5729, 5730, 5731, 5733, 5738 & 5740 (KRAM, LPB); *ibid.*, alt. 4604 m, 16°21′59″S, 68°02′37″W, *F* 5791 & 5798 (KRAM); *ibid.*, alt. 4550 m, 16°19′18″S, 68°04′42″W, *F* 8584/1, 8586, 8589, 8593/1, 8600, 8603, 8605 & 8606 (KRAM, LPB, UGDA); Prov. Manco Kapac, Horca del Inca Mt. near Copacabana village, alt. 3974 m, 16°10′15″S, 69°05′05″W, *F* 8673 (KRAM). *Dept. Cochabamba*: Prov. Chapare, East Cordillera, near Incachaca village, alt. 2198–2400 m, 17°14′09″S–17°14′17″S, 65°48′51″W–65°48′54″W, *F* 7872 & 8381 (KRAM, LPB).—**Peru:** *Dept. Arequipa*: Prov. Caylloma, Valle del Colca valley, near Soccoro village, alt. 3349 m, 15°38′32″S, 71°43′22″W, *F* 9416 & 9419 (KRAM); by Cañon del Colca canyon, near Cabanaconde village, alt. 3462 m, 15°37′56″S, 71°57′49″W, *F* 9531, 9532 & 9533 (KRAM); *ibid.*, alt. 3179 m, 15°36′11″S, 71°57′05″W, *F* 9644 (KRAM); Cañon del Colca canyon, above Tapay village, alt. 3705 m, 15°33′56″S, 71°55′32″W, *F* 9692 & 9693 (KRAM); *ibid.*, alt. 4140 m, 15°33′40″S, 71°55′15″W, *F* 9766 (KRAM).

Lepraria sp. 1

Chemistry. The only known specimen contains alectorialic, lecanoric and protocetraric acids.

Notes. This combination of substances has not been reported from *Lepraria* before. The chemistry of the collection was checked again in case some substances might have been contaminants, but the same substances were found. In our opinion, it represents an undescribed species; however, as the specimen was small and in rather poor condition, we prefer to wait for more collections before formal description and to see if the chemistry is constant.

Distribution and ecology. The species was found on siliceous schist and saxicolous bryophytes in high Andean Puna vegetation in Bolivia.

Specimen examined. **Bolivia:** *Dept. La Paz*: Prov. Murillo, the East Cordillera, near Cumbre pass, alt. 4604 m, 16°21′59″S, 68°02′37″W, *F* 5785 (KRAM, LPB).

Lepraria sp. 2

Chemistry. Atranorin, alectorialic acid, stictic acid complex and zeorin were detected.

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Notes. The chemistry was checked twice, and without doubt all substances occurred in one thallus. None of the taxa so far recognized produce such a combination of substances and we think it may belong to an undescribed taxon. However, as the specimen is small, we prefer to wait for discovery of additional collections. Morphologically the specimen is quite similar to *L. elobata* (Tønsberg 1992), but with greenish thallus, but this species does not produce alectorialic acid.

Distribution and ecology. The specimen was found on a tree in mountain Yungas cloud forest in Bolivia.

Specimen examined. **Bolivia:** *Dept. Santa Cruz*: Prov. Caballero, East Cordillera, Siberia region near La Palma, alt. 2583 m, 17°49′12″S, 64°40′28″W, *F* 4709 (KRAM).

Provisional key to species of *Lepraria* for South America (including leprose *Lecanora* species)

1	Thallus granular, soredia coarse, in habitats exposed to direct rain (the *Lepraria neglecta* group)	2
	Thallus powdery, byssoid or sometimes weft-like, in habitats protected from direct rain	4
2(1)	Alectorialic acid present	**L. neglecta**
	Thallus lacking alectorialic acid	3
3(2)	Porphyrilic acid present	**L. alpina**
	Depsidones present: fumarprotocetraric acid with traces of protocetraric acid (chemotype I), or psoromic acid (chemotype III)	**L. caesioalba**
4(1)	Divaricatic acid present, thallus UV+ white	**L. incana**
	Divaricatic acid absent	5
5(4)	Dibenzofurans present	6
	Dibenzofurans absent	9
6(5)	Lecanoric acid present	**L. impossibilis**
	Lecanoric acid absent	7
7(6)	Pannaric acid as major dibenzofuran present, thallus distinctly lobate	**L. membranacea**
	Pannaric acid 6-methylester as major dibenzofuran present	8
8(7)	Thallus distinctly and broadly lobate	**L. sipmaniana**
	Thallus not lobate or obscurely lobate	**L. vouauxii**
9(5)	Stictic acid complex present	10
	Stictic acid complex absent	12
10(9)	Alectorialic acid present	**L. sp. 2**
	Alectorialic acid absent	11
11(10)	Salazinic acid present	**L. multiacida**
	Salazinic acid absent	**L. lobificans**
12(9)	Thallus reacting KC+ red, alectorialic and/or lecanoric acid present	13
	Thallus reacting KC −, alectorialic and lecanoric acid absent	16
13(12)	Alectorialic acid present with or without lecanoric acid	14
	Lecanoric acid present without alectorialic acid	15

14(13) Lecanoric acid present . . . . . **L. sp. 1**
Lecanoric acid absent . . . **L. eburnea** (possibly occurring in South America)

15(13) Atranorin present, thallus rosette-like . . . . . **L. lecanorica**
Atranorin absent, angardianic/roccellic acids (±) and anthraquinones (±) present, thallus diffuse . . . . . **L. achariana**

16(12) Usnic acid present 17
Usnic acid absent 19

17(16) Thallus distinctly minutely lobate . . . . . **L. usnica**
Thallus not lobate, or only with some obscure lobes 18

18(17) Thallus without medulla, soredia well separated from one another . **L. ecorticata**
Thallus stratified, woolly, soredia embedded in medullary hyphae, hardly separated form one another . . . . . **Lecanora leuckertiana**

19(16) Porphyrilic and fatty acids and anthraquinone present, atranorin absent . . . . . **L. neojackii**
Porphyrilic acid absent, atranorin present or not 20

20(19) Squamatic acid present . . . . . **L. squamatica**
Squamatic acid absent 21

21(20) Atranorin and zeorin present 22
Atranorin and fatty acids present 23

22(21) Thallus not lobate . . . . . **L. caesiella**
Thallus distinctly lobate . . . . . **L. pallida**

23(21) Nephrosteranic acid present . . . . . **L. rigidula**
Jackinic and roccellic (±) acids present . . . . . **L. jackii** (possibly occurring in South America)

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