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A new species and new combinations and records of *Hypotrachyna* and *Remototrachyna* from Bolivia

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Abstract — *Remototrachyna sipmaniana* is described as new to science, and three new combinations, *R. aguirrei*, *R. consimilis*, and *R. singularis*, are proposed. Ten *Hypotrachyna* and two *Remototrachyna* species are reported as new to Bolivia, including the southernmost localities of *H. halei* and *H. partita*, the first record of *H. primitiva* from the southern hemisphere, and the second locality for *H. neoscytodes*.

Key words — foliose lichens, Neotropics, *Parmeliaceae*, South America

Introduction

Parmeliaceae Zenker (*Lecanorales*, *Lecanoromycetes*) is a large family of *Ascomycota* consisting of foliose, fruticose or rarely crustose lichens, but also lichenicolous non-lichenized taxa (e.g. Elix 1993, Lumbsch & Huhndorf 2007, Peršoh & Rambold 2002). It is believed to be one of the richest in species within the phylum and comprises about 1500 species (Blanco et al. 2006). This group has been extensively investigated by several researchers for more than 50 years, so the worldwide distribution of many taxa is well known. However, some areas, especially in the tropics, need further study; one of these is Bolivia. Data on *Parmeliaceae* from this country are not numerous and are mostly included in monographic treatments (e.g. Hale 1965, 1975, 1976; Culberson & Culberson 1981, Nash et al. 1995, Sipman et al. 2009) or rarely floristic papers (e.g. Herzog 1922, Feuerer & Sipman 2005).

During several lichenological expeditions to Bolivia we have collected more than 20,000 specimens and, in addition, further samples have been obtained on loan from several herbaria. Among the macrolichens, a large proportion were representatives of *Parmeliaceae*. This is the first paper dealing with new distributional data for *Parmeliaceae* in Bolivia. Here we report a new species and records for two morphologically similar, but phylogenetically distant genera, *Hypotrachyna* (Vain.) Hale and *Remototrachyna* Divakar & A. Crespo. Additionally, we propose transferring three additional species from *Hypotrachyna* to *Remototrachyna* based on anatomical features.

Material & methods

The material studied is deposited in B, KRAM, LPB, UGDA and herb. Flakus. Additional specimens from B, TUR-Vain and TNS were investigated for comparison. Lichen substances were studied by thin-layer chromatography (TLC) using the methods of Culberson & Kristinsson (1970) and Orange et al. (2001). Spot-test reactions with C, K and P were applied to determine the location of secondary metabolites in some specimens.

The genus *Hypotrachyna* in the Neotropics, including some species of *Remototrachyna*, has recently been revised by Sipman et al. (2009), so the descriptions and secondary chemistry of the species are not repeated here. The characteristics of many taxa can also be found in Hale (1975).

Results

The genus *Hypotrachyna*

The diagnostic characters of the genus include the dichotomously or subdichotomously branched lobes with truncate apices, bifusiform conidia, sparsely to richly dichotomously branched rhizines, and an outer exciple consisting of plectenchyma with thin cell walls (Crespo et al. 2010, Divakar et al. 2010). In its current circumscription the genus is paraphyletic (see Blanco et al. 2006, Divakar et al. 2006, Crespo et al. 2010) and needs further study for a better understanding of its relationship to other morphologically similar genera, e.g., *Everniastrum* Hale ex Sipman, *Parmelinopsis* Elix & Hale.

Recently the genus *Remototrachyna* was segregated from *Hypotrachyna* basing mainly on the structure of the cupulate excipulum (plectenchymatous with very thick-walled cells) and genetic differences (Divakar et al. 2010). During our study we investigated several fertile specimens of *Hypotrachyna* from the Neotropics, and in three species, *H. aguirrei*, *H. consimilis* and *H. singularis*, the excipulum appeared typical for *Remototrachyna*; thus those taxa are transferred to *Remototrachyna* (see below).

We also observed that the plectenchyma in the cupulate exciple of *Hypotrachyna* can have thicker cell walls than presented by Divakar et al. (2010), but cell lumina are more or less rounded or ellipsoid, never elongated

and sigmoid in shape as in *Remototrachyna* (for iconography see Divakar et al. 2010).

Hypotrachyna aspera C.H. Ribeiro & Marcelli, in Marcelli & Ribeiro, Mitt. Inst. Allg. Bot. Hamburg 30–32: 133. 2002.

This species has been recently described from Brazil (Marcelli & Ribeiro 2002, Sipman et al. 2009). Here it is reported as new to Bolivia, which represents the first record outside of Brazil.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Franz Tamayo, sendero Keara-Mojos, bajando por la senda de Tokuaqe a Fuertecillo, 2250 m, 14°36′S 68°56′W, 2001, Jimenez 5318 (LPB); **Dept. Tarija.** Prov. Aniceto Arce, Filo de Sidras, 1064 m, 22°14′50″S 64°33′28″W, 2010, Flakus 18431 (LPB, herb. Flakus).

Hypotrachyna dentella (Hale & Kurok.) Hale, Smithsonian Contr. Bot. 25: 33. 1975.

In the Neotropics this species is widespread, but rare; it is also known from the southeastern United States (Hale 1975, Sipman et al. 2009 and literature cited therein). Here the first Bolivian records are presented.

Specimens examined — **BOLIVIA. Dept. Tarija.** Prov. Aniceto Arce, Filo de Sidras, near campamento de guardaparques, 2 hours of Tarija, 1065 m, 22°14′50″S 64°33′28″W, 2010, Flakus 18529, 18615 (KRAM, LPB, UGDA, herb. Flakus); Serranía de Propiedad Arnold, 1309 m, 22°13′19″S 64°33′41″W, 2010, Flakus 18757 (KRAM, LPB).

Hypotrachyna halei Sipman, Elix & T.H. Nash, Fl. Neotrop. Monogr. 104: 76. 2009.

Sipman et al. (2009) reported *H. halei* from Costa Rica, Venezuela, Colombia, and Ecuador; we now report it from Bolivia. The new localities below represent the southernmost known for this species.

Specimens examined — **BOLIVIA. Dept. Cochabamba.** Prov. Chapare, Corani, 3261 m, 17°13′36″S 65°53′25″W, 2009, Flakus 12921 (KRAM, LPB); **Dept. La Paz.** Prov. Franz Tamayo, Piñalito, cerro 29 km en linea recta al Este de Apolo, por el camino a San Jose, 2000-2490 m, 14°29′42″S 68°15′26″W, 2002, Fuentes 5119 (LPB); Prov. Nor Yungas, 4 km del camino principal de Chuspipata hacia Coroico, 2750 m, 16°23′S 67°48′W, 1997, Bach et al. 542 (LPB); PN y ANMI Cotapata, 30 minutes of Unduavi by Sillu Tincara pre-Columbian route, 3437 m, 16°17′38″S 67°53′33″W, 2009, Flakus 16331 & Rodriguez (KRAM, LPB); 5 hours of Unduavi by Sillu Tincara pre-Columbian route, 3429 m, 16°16′33″S 67°52′60″W, 2010, Flakus 16897, 16967, 16972, 16997 & Rodriguez (KRAM, LPB, UGDA, herb. Flakus).

Hypotrachyna lividescens (Kurok.) Hale, Phytologia 28: 341. 1974.

In the Neotropics this species has been reported from Colombia, Guatemala, and Mexico (Sipman et al. 2009), and we now report it from Bolivia. The species is also known from Africa, Australia, and Europe (see Sipman et al. 2009, and literature cited therein). The following record is the southernmost in the Neotropics.

Specimens examined — **BOLIVIA. Dept. Tarija.** Prov. Aniceto Arce, Papachacra, Tucumano-Boliviano montane forest, 2195 m, 21°41′36″S 64°29′33″W, 2010, Flakus 19847, 19848 & Quisbert (KRAM, LPB, herb. Flakus).

Hypotrachyna neoscytodes Elix, T.H. Nash & Sipman, in Sipman et al., Fl. Neotrop. Monogr. 104: 106. 2009.

This species is new to Bolivia and previously known only from the type locality in Colombia (Sipman et al. 2009).

Specimen examined — **BOLIVIA. Dept. La Paz.** Prov. Nor Yungas, Carretera Cotapata-Santa Barbara, Paramo yungueño, 3573 m, 16°19′23″S 67°56′36.8″W, 2007, Rodriguez 453 (LPB).

Hypotrachyna partita Hale, Smithsonian Contr. Bot. 25: 52. 1975.

This species was previously known from Colombia, Costa Rica, Mexico, Panama, Venezuela, and Ecuador, usually from subpáramo dwarf forests (Sipman et al. 2009). The following Bolivian records extend its distributional range southward.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Camacho, Pacoamba cerca Wila Kala, 4286 m, 15°24′40″S 69°04′24″W, 2010, Flakus 17696/3, 17699, 17755 & Rodriguez (KRAM, LPB, UGDA, herb. Flakus); Prov. Nor Yungas, PN y ANMI Cotapata, 5 hours of Unduavi by Sillu Tincara pre-Columbian route, 3429 m, 16°16′33″S 67°52′60″W, 2010, Flakus 16863, 16882 & Rodriguez (KRAM, LPB).

Hypotrachyna primitiva Hale & López-Fig., Bryologist 81: 592. 1979 ["1978"].

H. primitiva was previously known from Colombia and Venezuela (Hale & López-Figueiras 1979, Sipman et al. 2009). The Bolivian localities presented here are the southernmost known and the first records for the Southern Hemisphere.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Franz Tamayo, laguna Tolca Cocha, al NE de Keara Nuevo, 3900 m, 14°41′13″S 69°05′18″W, 2006, Fuentes, Mendoza, Lopez, Madariaga 9927 (LPB, herb. Flakus); Prov. Nor Yungas, Cotapata, 3050 m, 16°17′S 67°51′W, 1998, Franken, Meneses, Villavicencio 6 (LPB).

Hypotrachyna protocetrarica Elix, T.H. Nash & Sipman, in Sipman et al., Fl. Neotrop. Monogr. 104: 127. 2009.

This species, previously known from Ecuador and Peru (Sipman et al. 2009), is reported as new to Bolivia.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Franz Tamayo, laguna Tolca Cocha, al NE de Keara Nuevo, 3900 m, 14°41′13″S 69°05′18″W, 2006, Fuentes, Mendoza, Lopez, Madariaga 9909 (LPB, herb. Flakus); Prov. Murillo, Valle de Zongo, laguna Viscachani, 3840 m, 1989, Coello 6 (LPB); ibid., 1988, Arrazola 29 (LPB).

Hypotrachyna pseudosinuosa (Asahina) Hale, Smithsonian Contr. Bot. 25: 58. 1975.

The widely distributed species in tropical and subtropical regions of the world (Hale 1975, Sipman et al. 2009, and literature cited therein) is recorded for the first time to Bolivia.

Specimens examined — **BOLIVIA. Dept. Cochabamba.** Prov. Chapare, near Incachaca village, 2294 m, 17°14′13″S 65°49′02″W, 2006, Flakus 8222, 8256 (KRAM,

LPB, herb. Flakus); **Dept. La Paz.** Prov. Iturralde, forest above Tumupasa village, 14°08′51″S 67°53′34″W, 350 m, 2008, Kukwa 7023a (UGDA, LPB).

Hypotrachyna subformosana Hale ex Elix, T.H. Nash & Sipman, in Sipman et al., Fl. Neotrop. Monogr. 104: 153. 2009.

This species, widespread but rare in the Neotropics, is reported here as new to Bolivia. It is also known from Fiji (Hale 1975, Sipman et al. 2009).

Specimen examined — **BOLIVIA. Dept. La Paz.** Prov. Nor Yungas, Coroico village, 1550 m, 16°11′10″S 67°43′16″W, 2010, Flakus 16414, 16449 & Rodriguez (KRAM, LPB, herb. Flakus).

The genus *Remototrachyna*

This genus is morphologically very similar to *Hypotrachyna* but differs in having a scleroplectenchymatous cupulate exciple, broad, subirregular lobes with rounded apices, short, mostly dichotomously branched rhizines, a high hymenium, and large ellipsoid ascospores; it is distantly related genetically to *Hypotrachyna* (Divakar et al. 2010). In the course of this study we observed larger variability in exciple structure of *Hypotrachyna* than reported by Divakar et al. (2010). The cells can have thicker walls than previously reported, but in *Remototrachyna* the hyphae are much more thick-walled, with very elongated, thin, and linear to sigmoid cell lumina, which are usually almost vertically orientated.

Basing on anatomical and morphological characters, four additional species were recognized, one new and three transferred from *Hypotrachyna* (see below). Probably more *Hypotrachyna* members should be transferred to *Remototrachyna*, but further investigations of fertile material are needed.

According to Divakar et al. (2010), the ancestral range of *Remototrachyna* was restricted to India. In the light of the new results the genus has a much wider distribution and is more diverse in the Neotropics than previously supposed. Possibly, the ancestral origins of *Remototrachyna* should be reevaluated.

Remototrachyna aguirrei (Sipman, Elix & T.H. Nash) Flakus, Kukwa & Sipman, **comb. nov.**

MycoBank MB 561981

≡ *Hypotrachyna aguirrei* Sipman, Elix & T.H. Nash, Fl. Neotrop. Monogr. 104: 25. 2009.

This species has been recently described from Bolivia, Costa Rica, Colombia, and Peru (Sipman et al. 2009).

Remototrachyna consimilis (Vain.) Flakus, Kukwa & Sipman, **comb. nov.**

MycoBank MB 561982

≡ *Parmelia consimilis* Vain., Acta Soc. Fauna Fl. Fenn. 7(1): 58. 1890.

≡ *Hypotrachyna consimilis* (Vain.) Hale, Smithsonian Contr. Bot. 25: 28. 1975.

Type — [Brasil] Minas Minas Geraës, Caraça, 1885. Vainio, Lich. Brasil. Exs. 1295 (TUR-V 3022 – lectotype, selected by Hale 1975: 28).

This species is known from Mexico, the Caribbean, Venezuela, and Brazil in the Neotropics, and also Taiwan and Papua New Guinea (Hale 1975, Louwhoff & Elix 2002, Sipman et al. 2009 and literature cited therein). Here it is reported as new to Bolivia.

Specimens examined — **BOLIVIA. Dept. Cochabamba.** Prov. Carrasco, Carrasco National Park, near Phaqcha, 20 km of Monte Punku village, 17°27′13″S 65°16′44″W, 2850 m, 2008, Kukwa 6161 (UGDA, LPB); **Dept. La Paz.** Prov. B. Saavedra, Cerro Asunta Pata, 1500 m, 15°05′S 68°29′W, 1997, Bach et al. 204 (LPB).

Additional specimen examined — Vainio, Lich. Brasil. Exs. 1133 (TUR-V 3021, fertile).

Remototrachyna singularis (Hale) Flakus, Kukwa & Sipman, **comb. nov.**

MycoBank MB 561983

≡ *Parmelia singularis* Hale, Phytologia 28: 267. 1974.

≡ *Hypotrachyna singularis* (Hale) Hale, Smithsonian Contr. Bot. 25: 63. 1975.

This rare Neotropical species previously known from Colombia, Ecuador and Peru (Hale 1975, Sipman et al. 2009), is reported as new to Bolivia.

Specimen examined — **BOLIVIA. Dept. Cochabamba**. Prov. Chapare, near Incachaca village, 2317 m, 17°14′11″S 65°49′02″W, 2006, Flakus 8320 (KRAM, LPB, herb. Flakus).

Remototrachyna sipmaniana Kukwa & Flakus, **sp. nov.** PLATE 1

MycoBank MB 561927

Remototrachynae *speciebus medulla acidum protocetraricum et isidiis cortice acida lecanoricum et gyrophoricum continente differt.*

Type — Bolivia, Dept. Cochabamba, Prov. Carrasco, Carrasco National Park, near Phaqcha, 20 km of Monte Punku village, 17°27′13″S 65°16′44″W, 2850 m, Yungas montane cloud forest, close to the river, on rock, 20 July 2008, M. Kukwa 6166 (UGDA-L 15224 – **holotype**; LPB – **isotype**).

Etymology — The species is named after Harrie J.M. Sipman (Botanisches Museum, Berlin Dahlem), an eminent lichenologist dealing with tropical lichens, and co-author of the monograph of the genus *Hypotrachyna* in the Neotropics.

Morphological Characters — thallus saxicolous, 10–20 cm wide, moderately adnate, not coriaceous, irregularly lobate; lobes subirregular, broad, 5–8(–10) mm wide, usually black-rimmed, with entire, crenate, dissected or irregularly incised margins and subrotund apices, usually distinctly ciliate, sometimes with few short and ciliate laciniae; upper surface gray to whitish-gray, sometimes brownish at the tips, smooth or finely rugulose, shiny, in older parts usually delicately cracked, isidiate, lacking soredia, pustules, dactyls or lobules; isidia laminal (mostly present in older parts of the thallus), rarely marginal, scattered to moderately dense, slender, erect, simple to branched, concolorous with thallus, but apices brown, rarely slightly procumbent, intact, few with very short cilia; cilia abundant, black, similar to rhizines, simple to dichotomously branched; medulla white; lower surface black, shiny,

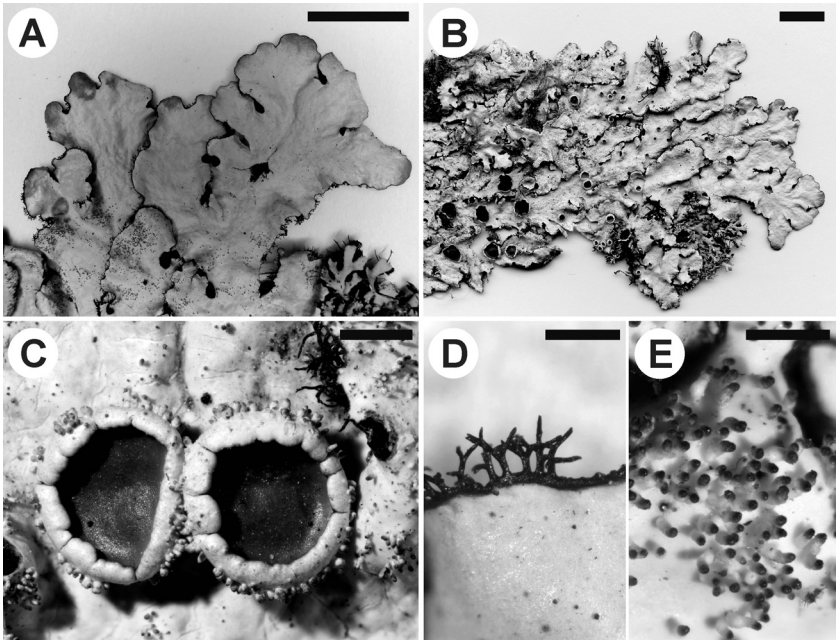

Plate 1. Morphology of *Remototrachyna sipmaniana* (holotype). A: lobes; B: thallus; C: apothecia with isidiate margin; D: branched marginal cilia; E: isidia. Scale bars: A, B = 1 cm; C = 1 mm; D, E = 0.5 mm.

smooth, with a bare brown marginal zone; rhizines moderately dense, but scarce and shorter near the margin, simple (at the margin) or more often up to 3 times dichotomously branched, black to dark brown, with paler apices; apothecia laminal, subpedicellate, 2–5 mm wide; disc concave, light brown to chest-nut brown; thalline margin entire or crenate, concolorous with the thallus, rarely brown near the disc, usually isidiate (isidia shorter and wider than those present on the thallus); cupulate exciple c. 50 µm high, consisting of plectenchyma with thick cell walls; hymenium c. 50 µm high; subhymenium c. 40 µm; asci 8-spored; ascospores hyaline, ellipsoid, 9.5–11 × 5.5–6 µm; pycnidia not seen.

Chemistry — Atranorin (major; thalline and apothecial margin cortex), protocetraric acid (major; medulla of thallus and apothecial margin) and gyrophoric acid (submajor, with minor amounts of lecanoric acid; cortex of isidia). Spot test reaction and fluorescence: upper cortex of thallus and apothecial margin: K+ yellow, C–, P–, UV–; medulla of thallus, isidia and apothecial margin: P+ red-orange, C–; cortex of isidia: P–, C+ pink red.

Distribution and habitat — The new species is known only from two localities in Carrasco National Park, Bolivia. It grows on boulders in Yungas mountain cloud forest.

Additional specimens examined — **BOLIVIA. Dept. Cochabamba.** Prov. Chapare, near Incachaca village, 17°14′09″S 65°48′51″W, 2198 m, Yungas montane cloud forest, on rock, 2006, Flakus 7852 (B, KRAM, LPB, herb. Flakus).

Reference material examined — **JAPAN. Prov. Kii**: Koya. Saxicolous. October 19, 1952. Coll. Y. Asahina 52101 (TNS – isolectotype of *Parmelia koyaensis*).

Comments — *Remototrachyna sipmaniana* is distinguished from all other species of the genus by the abundant, branched cilia. However, the structure of the cupulate exciple and the general morphology agree with the diagnostic characters of *Remototrachyna*.

The species shows considerable variation in the production of isidia. In the holotype they are very abundant on the thallus as well as on the apothecial margin, but in the paratypes isidia are less frequent; in some thalli they are sparse and many apothecia are not isidiate.

Remototrachyna sipmaniana is also distinguished by the production of protocetraric acid in the medulla of the thallus, isidia and apothecial margin whereas gyrophoric acid is restricted to the cortex of the isidia. Three other isidiate species of *Remototrachyna*, *R. incognita* (Kurok.) Divakar & A. Crespo, *R. consimilis* and *R. koyaensis* (Asahina) Divakar & A. Crespo are chemically similar, but differ in other characters. *Remototrachyna incognita* contains gyrophoric acid, but together with protolichesterinic acid (Divakar & Upreti 2005), whereas *R. sipmaniana* produces protocetraric and gyrophoric acids; the former occurs in Asia (Divakar & Upreti 2005), while the latter occurs in the Neotropics.

Both *R. consimilis* and *R. koyaensis* contain protocetraric acid (e.g., Hale 1975, Divakar & Upreti 2005, Sipman et al. 2009), and although gyrophoric acid has been detected in some specimens in minor or trace amounts, the reaction with C has been always reported as negative (Louwhoff & Elix 2002, Sipman et al. 2009). *Remototrachyna consimilis* has very similar ascospore dimensions to *R. sipmaniana* (see Sipman et al. 2009), but it differs by having much narrower lobes, (0.5–)1–2(–3) mm wide, and partly yellow-pigmented lower medulla (Sipman et al. 2009). *Remototrachyna koyaensis* can be readily separated by the production of caperatic acid (absent in *R. sipmaniana*) and the ascospore size (9.5–11 × 5.5–6 µm in *R. sipmaniana*; versus more than 14 µm long and 7 µm wide in *R. koyaensis*) (Louwhoff & Elix 2002, Divakar & Upreti 2005, Sipman et al. 2009, sub *Hypotrachyna*). Additionally, they differ in distribution: *R. koyaensis* occurs in Asia, Papua New Guinea and in Mexico (Louwhoff & Elix 2002, Sipman et al. 2009), whereas *R. sipmaniana* occurs in Bolivia. We examined the types of *Parmelia consimilis* and *P. koyaensis* and did not detect

gyrophoric acid by TLC nor did the isidia react with C. Possibly gyrophoric acid is a relatively rare accessory substance in *R. consimilis* and *R. koyaensis*, but the chemical variability needs to be studied in more collections.

In the Neotropics *R. sipmaniana* could be also confused with two other isidiate species, *R. costaricensis* (Nyl.) Divakar & A. Crespo and *R. rhabdiformis* (Kurok.) Divakar & A. Crespo. However, both have alternative chemistry, the former produces fatty acids and the latter norstictic, salazinic and consalazinic acids (Sipman et al. 2009).

The new species could also be mistaken for some chemically similar isidiate species of *Hypotrachyna*, but they do not contain major quantities of both protocetraric and gyrophoric acids in the same thallus, nor are they distributed as in *R. sipmaniana*.

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